Exhibit A –

Scope of Works and Technical Criteria

Appendix 1 – Locality Map

for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

November 2016

Document Author: Roads & Maritime Services

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About this document

Project data

Project name:	Western Sydney Infrastructure Plan, The Northern Road Upgrade - Stage 3 North Project
Contract type:	Design and Construction
Contract number:	15.3662.2254
Location:	Penrith, New South Wales
Road name:	The Northern Road and M4 Motorway
Local government area(s):	Penrith City Council

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Version and date:	Contract Execution V2
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The following figures identify the location and route of the Project.

Figure 1-1 Project Location

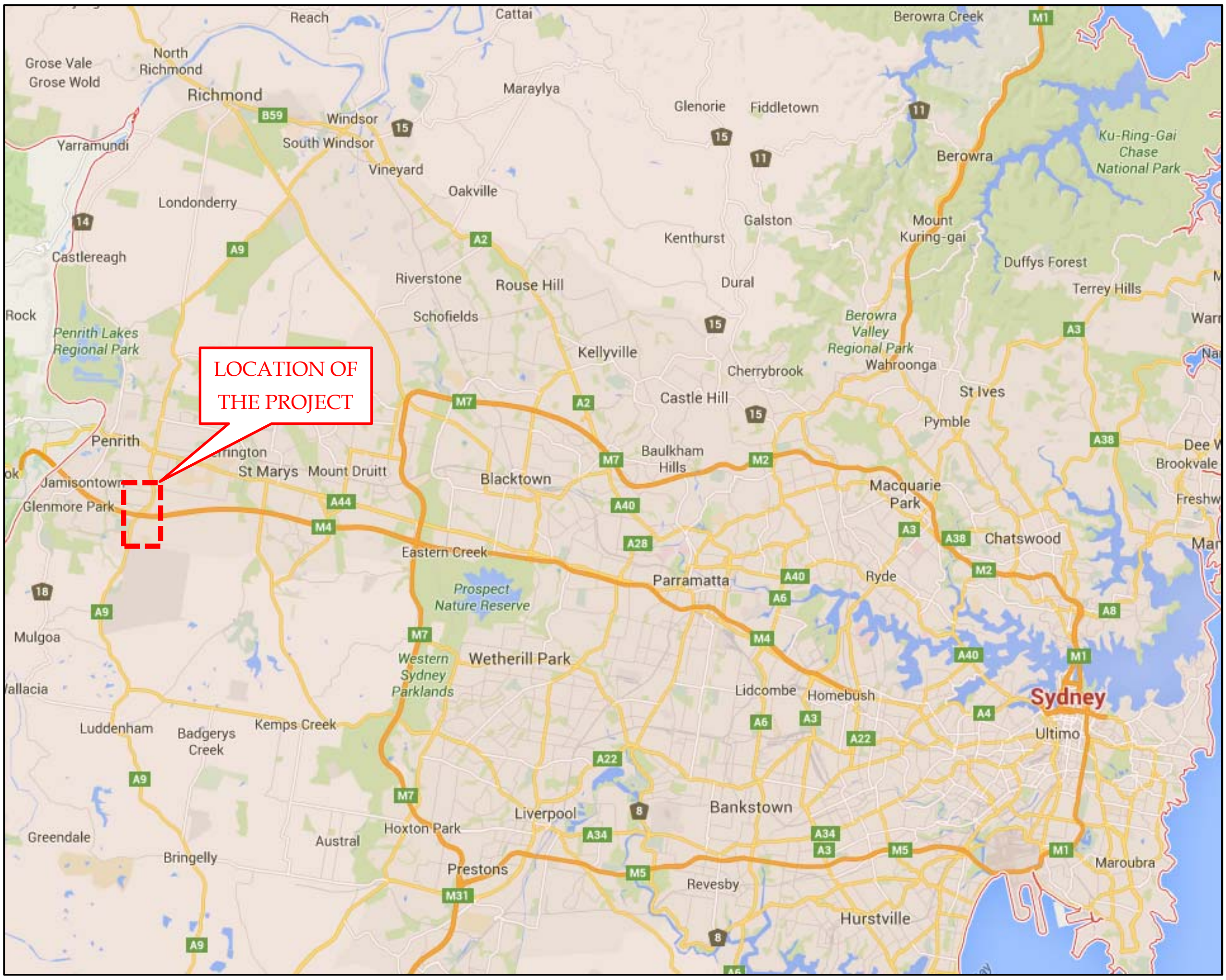

Figure 1-2 Project Route

Exhibit A –

Scope of Works and Technical Criteria

Appendix 2 – Site, Local Road Works Areas and Temporary Works Areas

for

Design and Construction of

Western Sydney Infrastructure Road Upgrade – Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

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Table of Contents

1. General

(a) This Appendix 2 defines the Site and Temporary Works Areas.

(b) The drawings identified in Table 2-1 below are provided as electronic files on a separate disc titled:

Design and Construction of
The Northern Road Upgrade - Stage 3 North
Contract No.15.3662.2254
Exhibit F - Electronic Files

Table 2-1: Site Access Information Drawings

Title	Electronic File Reference
Site and Temporary Works Areas Plans	TNR3N Site and Temporary Works Areas Plans.pdf

(c) The boundary of each property that define the Site and Temporary Works Areas is identified using a series of unique ID numbers called "Points".

(d) These "Points" along with the corresponding coordinates are shown in Table 2-2 and align with the drawings listed in Table 2-1.

Table 2-2: List of Site Boundary Coordinates

Point	Easting (MGA56)	Northing (MGA56)
4	286998.0740	6258071.5375
5	287009.2237	6258158.2815
6	287025.9038	6258288.0505
7	287066.3458	6258297.1464
12	286936.3352	6258233.6005
13	286946.0926	6258288.8136
14	286691.4474	6258327.6702
15	286700.0596	6258357.5241
16	286657.4577	6258380.6603
17	286593.3403	6258392.8804
18	286571.4632	6258395.2561
19	286934.5734	6258223.6068
20	287166.0134	6258281.1097
21	287219.0160	6258282.6137
22	287220.8034	6258295.3280
23	287285.4137	6258291.5346
24	287301.6280	6258288.9916
25	287305.9279	6258283.1547

Point	Easting (MGA56)	Northing (MGA56)
26	287296.6147	6258217.2685
27	287316.4367	6258214.4833
28	287325.6663	6258279.9724
29	287331.3028	6258284.1323
30	287401.6974	6258272.9483
31	287405.0017	6258293.0303
32	287352.2450	6258301.4991
33	287352.7187	6258304.6142
34	287298.4562	6258312.8669
35	287226.4071	6258329.7821
36	287211.4475	6258332.1779
37	287150.5216	6258333.8858
38	287038.8017	6258351.7782
39	287027.6847	6258382.9746
40	287047.9683	6258507.3250
41	287065.9215	6258575.4137
42	287058.3424	6258576.5639
43	287059.9024	6258586.5038
44	287086.9537	6258670.8681
45	287093.7931	6258669.8276
46	287130.7455	6258754.4444
47	287142.4370	6258768.5088
48	287146.8886	6258766.2321
49	287163.0690	6258797.8699
50	287158.6174	6258800.1466
51	287179.4391	6258842.8044
52	287213.8488	6258918.5943
53	287236.0441	6258949.5123
54	287257.5082	6258963.8363
55	287323.8924	6258966.1269
56	287377.1372	6258965.8735
57	287442.6639	6258955.9172
58	287445.8174	6258975.7041
59	287412.1140	6258980.8700
60	287314.6867	6259012.4043
61	287309.6552	6259022.8191
62	287389.6922	6259135.3517
63	287437.4236	6259147.4328
64	287546.5706	6259156.8338

Point	Easting (MGA56)	Northing (MGA56)
65	287595.0978	6259158.7282
66	287643.6750	6259165.9470
67	287663.2441	6259165.2073
68	287735.0260	6259156.8390
69	287776.6514	6259151.7462
70	287861.0271	6259146.1174
71	287929.5248	6259141.5670
72	287982.4154	6259140.5458
73	288002.7049	6259140.1579
74	288080.8078	6259138.6140
75	288222.9710	6259129.0152
76	288385.3954	6259156.0095
77	288495.5705	6259170.2406
78	288536.5705	6259175.5392
79	288557.8320	6259178.1438
80	288620.0770	6259185.6960
81	288744.6810	6259200.7420
82	288766.9089	6259204.7119
83	288754.2807	6259311.5483
84	288671.2931	6259292.2180
85	288635.3650	6259285.9620
86	288572.5342	6259274.9274
87	288511.0001	6259271.8560
88	288185.1152	6259255.6339
89	288018.9577	6259247.3968
90	287998.4457	6259246.3803
91	287876.7890	6259249.4700
92	287797.2724	6259261.6069
93	287736.4991	6259284.4004
94	287683.4007	6259289.6440
95	287582.7114	6259308.6926
96	287571.8763	6259325.1747
97	287590.4031	6259352.6618
98	287603.9024	6259378.4951
99	287634.3024	6259416.9583
100	287670.4787	6259451.7119
101	287718.8006	6259504.7225
102	287791.5604	6259572.7745
103	287818.2279	6259581.9370

Point	Easting (MGA56)	Northing (MGA56)
104	287896.4483	6259578.8929
119	288052.1835	6259591.7622
120	288039.7480	6259586.4716
121	287884.9184	6259610.4813
122	287860.9002	6259638.3759
123	287883.0483	6259657.3183
124	287915.6605	6259694.6934
125	287954.1588	6259732.1518
126	288004.6095	6259786.6808
127	288026.3664	6259815.2090
128	288067.5200	6259883.3679
129	288053.6169	6259859.2961
130	288097.9078	6259947.5504
131	288115.1445	6259990.0471
140	288197.3126	6260069.0373
141	288200.3698	6260088.9449
142	288147.2189	6260097.1001
143	288137.3585	6260112.1834
144	288145.4216	6260150.6914
145	288144.9012	6260196.7483
146	288155.5565	6260252.4999
147	288160.5432	6260285.3192
148	288164.1176	6260317.4277
149	288171.1878	6260328.5890
150	288183.8030	6260348.4792
151	288191.7790	6260358.0081
152	288195.1321	6260362.0194
153	288198.4861	6260366.0335
154	288264.3944	6260444.9491
155	288351.6117	6260549.6570
156	288336.4629	6260562.3759
157	288329.8687	6260523.5101
158	288321.1974	6260513.0822
159	288301.0686	6260488.8756
160	288192.2582	6260090.1893
164	287642.2046	6259424.8492
165	287645.4492	6259296.5942
166	287081.7533	6258656.0335
167	287073.8295	6258632.2958

Point	Easting (MGA56)	Northing (MGA56)
168	287064.9289	6258603.7144
174	286913.8275	6258066.8859
175	286915.1334	6258076.8051
176	286921.2027	6258122.4734
177	286921.9842	6258128.4119
179	286930.0132	6258189.2545
180	287551.4737	6258248.8902
181	287554.5455	6258269.0387
182	287596.4096	6258262.3262
183	287605.0620	6258268.6376
184	287590.8358	6258242.6476
185	287597.9380	6258234.0701
186	287570.9008	6258245.7845
187	287623.2418	6258230.0087
188	287632.5379	6258235.9394
189	287670.0837	6258229.9356
190	287673.1482	6258250.0122
191	287623.7784	6258257.9354
192	287774.5314	6258905.4900
193	287723.9090	6258913.1720
194	287703.9927	6258916.2007
195	287656.4253	6258943.7753
196	287652.9358	6258923.9612
197	287107.7039	6259008.5994
198	287104.9863	6258988.6411
199	287170.2230	6258979.7350
200	287171.5410	6258977.2240
201	287105.7267	6258859.2296
202	287100.7932	6258862.1028
203	287071.4307	6258811.6850
204	287074.1959	6258810.0745
205	287057.7772	6258782.2796
206	287069.3783	6258777.1690
207	287042.1477	6258715.3553
208	287022.3113	6258643.3421
209	287009.4623	6258606.7464
210	287004.4920	6258592.5870
211	286996.8235	6258563.1870
212	286989.1550	6258533.7870

Point	Easting (MGA56)	Northing (MGA56)
213	286987.1001	6258522.0888
214	286962.0354	6258379.4054
215	286931.2068	6258369.8674
216	286733.3253	6258404.0992
217	286734.1831	6258409.7223
218	286773.7962	6258403.6796
219	286772.3352	6258394.1022
220	286671.9571	6258407.3911
221	286672.8619	6258413.3225
222	286559.0175	6258430.7403
223	286597.7671	6258424.8775
224	286596.9315	6258418.8358
225	287162.9780	6258980.7241
226	287179.6196	6258998.7508
227	287183.1377	6259000.6182
228	287189.9476	6259014.0219
229	287257.8849	6259120.2933
230	287273.7833	6259173.4694
231	287255.4863	6259191.5070
232	287144.8818	6259225.6647
233	287036.0446	6259256.6070
234	287037.4105	6259261.4168
235	286962.6918	6259282.6666
236	286620.2901	6259362.7871
237	286529.5678	6259380.4730
238	286509.1585	6259384.7468
239	286508.4628	6259379.6263
240	286347.2497	6259412.2743
241	286219.0977	6259446.5326
242	286249.4487	6259572.5834
243	286587.5493	6259474.1553
244	286710.1918	6259438.4208
245	287019.2410	6258634.6040
246	287696.5210	6258917.3369
247	287702.8411	6258908.6649
248	287701.6060	6258936.9100
249	287775.7037	6258925.7687
250	287777.3030	6258925.5220
251	287686.9303	6258671.3152

Point	Easting (MGA56)	Northing (MGA56)
252	287674.2393	6258588.4722
253	287653.2954	6258584.7237
254	287672.5856	6258710.8045
255	287675.6079	6258730.5784
256	287628.0068	6258419.1367
257	287640.6636	6258501.9284
258	287661.7214	6258506.5182
259	287275.2868	6258293.1672
260	287260.7866	6259130.0000
261	286715.3759	6259437.7165
262	286733.5107	6259435.2536
263	286751.6453	6259432.7913
264	286769.7797	6259430.3293
265	286787.9140	6259427.8674
266	286806.0483	6259425.4054
267	286824.1825	6259422.9435
268	286842.3168	6259420.4815
269	286860.4512	6259418.0195
270	286878.5858	6259415.5577
271	286896.7207	6259413.0963
272	286694.1554	6259443.0940
273	286675.1432	6259448.6337
274	286654.0142	6259454.7881
275	286641.7131	6259458.3724
276	286914.8561	6259410.6356
277	286932.9921	6259408.1760
278	286951.1287	6259405.7179
279	287347.7850	6259351.9107
280	287411.1922	6259356.7661
281	287422.7851	6259365.1647
282	287448.7632	6259383.9838
283	287523.6203	6259449.8882
284	287537.2051	6259448.0425
285	287537.9550	6259461.6630
286	287553.4119	6259474.3605
287	287570.6839	6259488.5502
288	287587.9555	6259502.7403
289	287603.4110	6259515.4385
290	287618.8664	6259528.1364

Point	Easting (MGA56)	Northing (MGA56)
291	287634.3210	6259540.8333
292	287658.6582	6259560.8290
293	287669.9462	6259552.8349
294	287727.3226	6259604.9543
295	287762.5475	6259636.9517
296	287775.8747	6259649.0573
297	287775.6931	6259654.9927
298	287760.7584	6259666.9818
299	287742.9442	6259674.0133
300	287741.9531	6259674.1472
301	287742.9485	6259694.3541
302	287762.7669	6259691.6650
303	287782.5853	6259688.9760
304	287802.4038	6259686.2871
305	287814.9826	6259684.5810
306	287866.0482	6259730.4826
307	287870.2460	6259740.4836
308	287932.7619	6259796.5020
309	287939.9876	6259798.9424
310	287957.7754	6259818.3847
311	287961.9016	6259822.3692
312	287974.7185	6259838.0198
313	287977.6845	6259841.6432
314	287985.7962	6259852.8426
315	287993.2981	6259863.2020
316	287996.5913	6259868.3616
317	288060.2770	6260052.0571
318	288061.2231	6260057.0835
319	288064.7016	6260059.6071
320	288054.8212	6260061.6800
321	288049.9191	6260028.5000
322	288057.0383	6260027.5352
323	288038.3720	6259986.1542
324	288037.1694	6259983.5744
325	288042.7919	6259967.4451
326	288017.9460	6259904.1287
327	288007.6224	6259885.6449
328	288088.0568	6260206.3826
329	288087.0430	6260222.2842

Point	Easting (MGA56)	Northing (MGA56)
330	288096.3661	6260280.8750
331	288096.4365	6260326.6087
332	288092.9943	6260335.8133
334	288000.6398	6260348.2592
335	287981.4237	6260358.5386
336	287641.2405	6260408.8833
337	287622.6715	6260409.0000
338	287614.0615	6260404.3738
339	287588.6502	6260408.2998
340	287591.1373	6260425.9256
341	287560.3247	6260430.2734
342	287563.5362	6260453.5830
343	287594.3461	6260448.7626
344	287600.4531	6260453.6830
345	287604.2128	6260481.1669
346	287624.8457	6260479.8856
347	287620.8669	6260451.3076
348	287626.8186	6260443.6201
349	287656.4132	6260439.3205
350	287672.4787	6260437.0084
351	287689.3071	6260434.6099
352	287705.5705	6260432.2454
353	287721.7341	6260429.8589
354	287738.4915	6260427.3602
355	287755.1235	6260424.9015
356	287771.4907	6260422.5403
357	287787.9399	6260420.1550
358	287804.3891	6260417.7269
359	287821.2578	6260415.2723
360	287837.8047	6260412.8185
361	287854.9714	6260410.3277
362	287871.8909	6260407.8572
363	287888.1625	6260405.4998
364	287904.7110	6260403.0946
365	287920.7789	6260400.7016
366	287939.4247	6260397.9590
367	287963.4048	6260394.4339
371	288107.3645	6260413.6076
372	288103.0516	6260449.5078

Point	Easting (MGA56)	Northing (MGA56)
374	288025.2916	6260491.0770
375	288105.1153	6260500.7009
376	288076.9617	6260493.4789
377	288105.7596	6260520.6934
378	288101.7873	6260538.5603
379	288105.4580	6260522.4511
380	288039.1362	6259987.7939
381	288006.5458	6259883.9585
382	287829.6832	6259697.9344
384	288326.6173	6260550.5642
385	288315.3820	6260537.1216
386	288298.9592	6260517.3930
387	288293.3890	6260510.6906
388	288277.9463	6260491.9833
389	288261.4336	6260472.3491
390	288247.1507	6260455.2839
391	288243.3062	6260450.6974
392	288175.5605	6260413.4223
393	288167.5296	6260430.7132
394	288165.1820	6260465.3364
395	288160.1771	6260481.5327
396	288159.9015	6260487.6218
397	288151.7941	6260487.2549
398	288149.3852	6260504.3552
399	288150.6901	6260496.7456
400	288146.0788	6260523.6352
401	288142.0325	6260543.0547
402	288144.9311	6260530.3303
403	288137.5980	6260562.5311
404	288132.6577	6260581.8851
405	288127.7072	6260601.2352
406	288122.7580	6260620.5838
407	288117.9499	6260639.3696
408	288113.0123	6260658.6479
409	288107.9548	6260678.3808
410	288102.7604	6260698.6363
411	288097.3671	6260719.6626
412	288091.9128	6260740.9239
413	288086.8286	6260760.7286

Point	Easting (MGA56)	Northing (MGA56)
414	288142.5894	6260775.0328
415	288131.3917	6260816.5559
416	288076.1351	6260802.3824
417	288070.3817	6260824.8109
418	288064.6282	6260847.2393
419	288058.8759	6260869.6676
420	288053.1226	6260892.0949
421	288047.3669	6260914.5207
422	288042.2575	6260934.4150
423	288037.6553	6260952.3308
424	288032.1279	6260973.8477
425	288022.1829	6261012.5540
426	287979.9071	6261177.1793
427	287987.4380	6261193.2468
428	288025.7392	6261188.0277
429	288045.5233	6261185.3339
430	288048.8710	6261184.8790
431	288051.6002	6261204.8218
432	288048.2127	6261205.2823
433	288028.4637	6261207.9807
434	288010.3401	6261210.4567
435	287992.2179	6261212.9330
436	287990.9497	6261213.1063
437	287962.3803	6261245.5042
438	287957.7591	6261263.5147
439	287952.3045	6261284.7712
440	287946.8498	6261306.0277
441	287937.5169	6261345.1081
442	287934.4737	6261360.6806
443	287930.8520	6261379.2003
444	287930.2873	6261382.8297
445	287926.8263	6261405.0888
446	287925.5222	6261413.4961
447	287924.1604	6261425.2702
448	287922.3133	6261441.2601
449	287920.8566	6261456.8708
450	287919.6680	6261472.4232
451	287918.8896	6261482.6079
452	287918.6894	6261487.9461

Point	Easting (MGA56)	Northing (MGA56)
453	287918.1116	6261503.4107
454	287917.5950	6261517.3282
455	287917.6270	6261534.2148
456	287917.6571	6261549.6353
457	287918.1861	6261564.9932
458	287918.7994	6261580.3129
459	287919.7541	6261595.6068
460	287921.7915	6261621.4737
461	287923.2071	6261625.1268
462	287926.2664	6261627.5332
463	287930.1007	6261628.0418
464	287943.4377	6261626.2299
465	287963.3747	6261623.5241
466	287983.2576	6261620.8271
467	287997.1531	6261618.9369
468	288011.0499	6261617.0443
469	288019.5105	6261615.8895
470	288024.7289	6261609.0274
471	288039.8297	6261606.9621
472	288042.1822	6261610.9911
473	288046.6946	6261612.1764
474	288023.5409	6261613.5392
475	288057.5659	6261610.6913
476	288073.0209	6261608.5774
477	288076.5211	6261637.6153
478	288066.9040	6261638.6839
479	288050.3717	6261640.2459
480	288047.3912	6261640.5196
481	288044.3439	6261640.7987
482	288026.2887	6261642.5093
483	288006.2705	6261645.0094
484	287986.2106	6261647.4567
485	287969.6073	6261649.4743
486	287966.2989	6261649.8757
487	287946.2745	6261652.2553
488	287929.5885	6261654.2852
489	287926.0175	6261655.6206
490	287923.6487	6261658.6998
491	287923.2569	6261662.6612

Point	Easting (MGA56)	Northing (MGA56)
492	287925.9568	6261682.0545
493	287930.0750	6261706.4763
494	287926.2225	6261683.6232
495	287934.3646	6261728.3130
496	287935.7913	6261735.4759
497	287938.8164	6261748.6085
498	287941.8981	6261761.9064
499	287945.9140	6261778.1237
500	287919.0633	6261586.8384
501	287917.6614	6261552.0926
502	287917.5976	6261518.8531
503	287921.5368	6261447.9721
504	287945.4962	6261311.3029
505	288222.2478	6260394.4846
506	288242.6735	6260450.3165
507	287281.9487	6258965.2247
508	287297.6600	6258224.6635
509	286529.1291	6258409.9585
510	286502.8648	6258397.6271
511	286427.4721	6258403.4390
512	286407.1778	6258409.0688
513	286388.6098	6258414.2199
514	286374.1752	6258418.2243
515	286370.9921	6258419.0681
516	286361.2997	6258421.3604
517	286353.4807	6258422.8015
518	286326.4023	6258427.3033
519	286327.9799	6258437.6932
520	286311.0888	6258440.4996
521	286283.2533	6258434.3600
522	286289.0933	6258435.8387
523	286306.7910	6258440.3207
524	286279.3400	6258432.4371
525	286275.3468	6258429.2979
526	286257.2577	6258426.0505
527	286249.3514	6258428.1291
528	286243.1573	6258433.1039
529	286230.8056	6258451.7269
530	286222.0561	6258445.9236

Point	Easting (MGA56)	Northing (MGA56)
531	286206.9118	6258468.7522
532	286209.1682	6258483.6729
533	286196.3243	6258485.5467
534	286198.1572	6258498.4670
535	286172.2878	6258501.4437
536	286162.3860	6258502.5833
537	286139.1969	6258514.6577
538	286113.0751	6258515.1151
539	286119.4478	6258446.6248
540	286148.4412	6258442.4341
541	286167.7371	6258439.6025
542	286193.1629	6258444.0630
543	286206.3743	6258415.2519
544	286210.0778	6258407.0552
545	286230.2872	6258385.7835
546	286256.1693	6258371.0358
547	286261.8917	6258371.9052
548	286269.9330	6258374.1048
549	286293.0731	6258381.3436
550	286314.2357	6258387.9643
551	286311.2503	6258397.5100
552	286316.0369	6258399.0068
553	286334.1438	6258397.9366
554	286370.6507	6258384.2017
555	286374.1386	6258377.0177
556	286393.6400	6258372.5678
557	286399.5483	6258375.9658
558	286423.0609	6258369.2533
559	286432.1379	6258366.6656
560	286442.5940	6258363.5707
561	286441.5770	6258353.4390
562	286463.3301	6258346.1568
563	286479.9431	6258339.8825
564	286483.5259	6258338.6169
565	286486.8401	6258333.6203
566	286499.3042	6258332.4204
567	286503.8433	6258336.6589
568	286507.5044	6258337.1985
569	286518.1667	6258339.1740

Point	Easting (MGA56)	Northing (MGA56)
570	286522.3193	6258339.7196
571	286524.4113	6258339.8292
572	286527.7528	6258352.5245
573	286544.9167	6258383.9192
574	286489.0333	6258395.4631
575	286327.5323	6258434.7270
576	286520.2356	6258339.5009
577	288158.3187	6260487.5502
578	287930.4744	6261708.8385
579	287942.2618	6261763.3704
580	287958.0460	6261826.9844
581	287963.6274	6261830.5231
582	287979.1777	6261827.4007
583	287990.5043	6261825.1457
584	287994.1423	6261845.1154
585	287974.0678	6261848.7724
586	287966.3553	6261850.5506
587	287964.5356	6261853.3310
588	287969.0738	6261871.6253
589	287937.3529	6261874.8643
590	287934.3719	6261863.0939
591	287927.4613	6261858.3578
592	287903.2750	6261862.8116
593	287857.1409	6261851.8941
594	287910.9229	6261841.0883
595	287923.5318	6261838.5572
596	287927.3031	6261835.9643
597	287928.0643	6261831.5753
598	287922.1517	6261807.7966
599	287918.4716	6261793.0231
600	287914.7913	6261778.2485
601	287911.1098	6261763.4728
602	287907.4271	6261748.6967
603	287903.7433	6261733.9114
604	287900.0649	6261719.1261
605	287896.3919	6261704.3417
606	287892.6722	6261689.3240
607	287886.7852	6261665.6293
608	287884.0048	6261661.6151

Point	Easting (MGA56)	Northing (MGA56)
609	287879.2625	6261660.4512
610	287866.3710	6261662.0300
611	287848.1143	6261664.2650
612	287829.8626	6261666.4966
613	287811.6261	6261668.7184
614	287793.3364	6261671.0276
615	287771.3474	6261673.5133
616	287756.2497	6261675.7371
617	287741.4005	6261677.9502
618	287726.4509	6261680.1600
619	287711.0008	6261682.4611
620	287696.1616	6261684.6723
621	287680.9240	6261686.8747
622	287665.1423	6261689.1783
623	287646.3890	6261691.8922
624	287629.2947	6261694.4503
625	287625.9254	6261669.4148
626	287644.2835	6261666.8235
627	287664.4431	6261664.0036
628	287668.4407	6261663.4053
629	287684.9895	6261661.1207
630	287700.6271	6261658.9382
631	287717.0879	6261656.6486
632	287732.8912	6261654.9484
633	287748.8974	6261652.7642
634	287760.9774	6261651.1164
635	287763.5850	6261647.6844
636	287783.1014	6261641.9392
637	287789.9757	6261647.1596
638	287800.8542	6261645.6740
639	287817.1988	6261643.4436
640	287833.5443	6261641.2141
641	287849.8899	6261638.9849
642	287866.2325	6261636.7570
643	287874.9342	6261635.5707
644	287878.6602	6261634.0482
645	287881.1900	6261630.9083
646	287881.8871	6261626.9313
647	287879.8427	6261600.7330

Point	Easting (MGA56)	Northing (MGA56)
648	287878.9423	6261589.2338
649	287877.4293	6261552.9379
650	287877.3530	6261524.0620
651	287877.3422	6261516.6102
652	287877.6394	6261508.6113
653	287878.2203	6261493.1445
654	287878.7029	6261480.3245
655	287878.9071	6261477.6558
656	287880.0978	6261462.1050
657	287881.2889	6261446.5521
658	287883.0021	6261430.9261
659	287885.6461	6261408.0859
660	287891.2181	6261372.2430
661	287898.1768	6261336.6228
662	287906.4263	6261301.6783
663	287922.3601	6261239.5782
664	287914.8247	6261223.5143
665	287885.6100	6261227.5087
666	287870.5090	6261229.5739
667	287853.2952	6261231.9274
668	287850.2756	6261232.3398
669	287847.2561	6261232.7498
670	287831.2028	6261234.9443
671	287828.5615	6261214.9719
672	287878.4712	6261208.1450
673	287896.0869	6261205.7338
674	287911.1816	6261203.6674
675	287925.5316	6261187.4653
676	287939.8947	6261171.2497
677	287881.4739	6261444.1337
678	288097.6450	6260556.3820
679	288093.1003	6260574.0974
680	288088.5558	6260591.8129
681	288084.0114	6260609.5284
682	288079.4672	6260627.2440
683	288074.9231	6260644.9596
684	288070.3792	6260662.6753
685	288065.8352	6260680.3910
686	288061.2913	6260698.1068

Point	Easting (MGA56)	Northing (MGA56)
687	288056.7472	6260715.8226
688	288052.2031	6260733.5383
689	288047.6589	6260751.2540
690	288043.1147	6260768.9697
691	288019.0743	6260862.6867
692	288015.1360	6260878.0403
693	288011.1977	6260893.3941
694	288007.2596	6260908.7480
695	288002.7155	6260926.4639
696	287998.1712	6260944.1800
697	287993.6266	6260961.8961
698	287989.0820	6260979.6109
699	287984.5351	6260997.3300
700	287979.9877	6261015.0487
701	287975.4399	6261032.7670
702	287970.8918	6261050.4851
703	287966.3434	6261068.2031
704	287961.7949	6261085.9209
705	287957.2464	6261103.6384
706	287952.6981	6261121.3556
707	287948.1506	6261139.0721
708	287943.6044	6261156.7875
709	287020.3917	6258245.1674
710	287209.5237	6258215.7134
711	287174.6440	6258488.0881
712	287937.6039	6259602.3113
714	288201.8398	6260152.7384
715	288202.8635	6260483.4664
716	287974.0278	6260751.2488
717	287934.1596	6260756.6770
718	287928.9420	6260763.5392
719	287933.7882	6260799.1328
720	287990.3756	6260806.1098
721	287979.3710	6260852.5014
722	287806.2267	6261441.4441
723	287808.2927	6261456.5433
724	287810.3577	6261471.6492
725	286908.6717	6258027.1488
726	286983.6686	6258015.4278

Point	Easting (MGA56)	Northing (MGA56)
727	286999.3326	6258081.3298
728	287058.9613	6258072.0736
729	287057.4273	6258062.1919
730	287185.1920	6258042.3590
731	287197.3470	6258129.0460
732	286928.1917	6258175.5093
733	286796.1820	6258195.6536
734	286794.3926	6258202.0723
735	286928.9919	6258181.5581
736	288050.3575	6260031.4670
737	288029.9817	6260034.2257
738	288033.0932	6260055.2867
739	288043.2466	6260053.7866
740	288051.9657	6260042.3526
741	288098.5240	6259992.5950
742	288099.2837	6259994.5427
743	288108.2241	6260028.1975
744	288118.3456	6260081.1762
745	287759.3246	6259542.6244
746	287804.2424	6259538.6259
747	287849.1602	6259534.6274
748	287847.1634	6259512.1962
749	287873.5119	6259515.3125
750	287896.7684	6259540.5506
751	287904.5810	6259577.6914
752	287923.6746	6259574.8706
753	287937.7385	6259562.4523
754	287961.4496	6259558.5433
755	287979.6930	6259569.9798
756	288034.1169	6259561.6887
757	288041.7699	6259560.5007
758	288050.7797	6259582.5416
759	287968.3427	6260397.7316
760	287972.5487	6260426.9820
761	287968.5547	6260444.5744
762	287959.7642	6260458.9674
763	287949.2498	6260466.2884
764	287959.3463	6260479.4057
765	287967.7742	6260472.6324

Point	Easting (MGA56)	Northing (MGA56)
766	287973.8472	6260465.1716
767	287979.9203	6260457.7109
768	287989.7530	6260456.1997
769	288000.0662	6260469.0433
770	288006.9597	6260483.8719
771	288009.0866	6260490.9852
772	288028.7491	6260447.2238
773	288040.6680	6260409.7627
774	287962.2670	6259740.9154
775	287969.0348	6259738.7593
776	287961.8480	6259716.4485
777	287944.3054	6259722.5646
778	287092.0610	6259386.6120
779	288038.3771	6260343.1731
780	288034.3856	6260313.4418
781	288017.8550	6260315.6683
782	288013.0741	6260316.8814
783	288005.6905	6260321.5980
784	288001.6471	6260327.0396
785	287999.4115	6260334.0382
786	287999.4372	6260340.1447

Exhibit A –

Scope of Works and Technical Criteria

Appendix 3 – Property Adjustments

for

Design and Construction for

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

November 2016

Document Author: Roads & Maritime Services

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About this document

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Table of Contents

1 General

(a) This Appendix 3 defines the Property Adjustments required for the Project.

(b) The Contractor must provide, as a minimum, the property adjustments and associated requirements identified in Table 3-1 and Table 3-2.

(c) The lot and deposited plan numbers which are referred to in Table 3-1 are references to lot and deposited plan numbers identified on survey plans lodged with and registered by Land & Property Information.

(d) The Property ID Number and corresponding Lot/Deposited Plan number in Table 3-1 are unique identifiers for properties detailed in Appendix 2 (Site, Local Road Works Areas and Temporary Works Areas) of the SWTC.

(e) The Property Adjustment drawings consist of the drawings listed in Table 3-3.

(f) Property Adjustments shall be undertaken on a "like for like" basis.

(g) Grades on property access roads and driveways must be no greater than 12%.

(h) Property access roads and driveways must be constructed of 150mm SL82 reinforced concrete as described in Penrith Council's Engineering Construction Specification for Civil Works.

(i) The Contractor must plan and construct the Property Adjustments in a manner that maintains the amenity and utility of any property which is affected by Property Adjustments, and minimises inconvenience and disruption to the owners, occupiers and users of these properties. It is likely that this will often require the completion of Property Adjustments prior to commencing adjacent Works.

Table 3-1 Minimum Requirements for Property Adjustments

Property ID Number	Lot/Deposited Plan Number	Use of Land	Minimum Requirements for Property Adjustment
200B	186/DP239628	Temporary Works	Refer Table 3-2
Penrith Christian School	11/DP831409 121/DP1135914	N/A	**Fencing** 1. Provide new fencing of equivalent standard to the existing, along the Site between Points 092, 093, 094, 165, 095, 096, 097, 098, 099, 164, 100, 101, 745, 102, 103, 104, 751,752, 753,754, 755, 756 and 757 (as listed under the column titled "Point" in Table 2-2 (List of Site

Property ID Number	Lot/Deposited Plan Number	Use of Land	Minimum Requirements for Property Adjustment
			Boundary Coordinates) in Appendix 2 (Site, Local Road Works Areas and Temporary Works Areas)). A gate is required between points 753 and 754. **Sports Playing Field** 2. Relocate the existing sports playing field. Whilst keeping the relocated sports playing field as close as possible to its existing location, the new sports playing field must: a. be located on a level surface of 120m by 70m; b. have line-marking so to facilitate both soccer and rugby similar to the existing sports playing field arrangement; c. be provided with the existing dual purpose soccer and rugby goal posts; d. ensure that any turfed areas impacted by the relocation are reinstated; e. be provided with a longitudinal aggregate drainage system and sprinkler system, which is extended from the existing drainage system and sprinkler system to suit the relocated sports playing field; and f. have the existing culvert and drainage pit (located at the south-west corner of the existing sports playing field) re- location to a new location that

Property ID Number	Lot/Deposited Plan Number	Use of Land	Minimum Requirements for Property Adjustment
			suites the final location of the Sports Playing Field. 3. Re-shape embankments on the northern and eastern side of the sports playing field to suit the relocated sports playing field. **Fenced Maintenance Area on Eastern Side of Sports Playing Field** 4. On the eastern side of the existing sports playing field, all existing civil, mechanical and electrical assets associated with the above ground water storage tank (including the above ground water storage tank itself), if impacted by the Project Works, are to be: a. relocated to a location as close as possible to the existing assets to suit the new sports playing field location; b. re-connected to existing services including pipework, cables and the like; and c. enclosed within a new fence of equivalent standard to the existing. 5. On the eastern side of the existing sports playing field, within the existing above ground water storage tank fenced area, there is an existing standpipe. If impacted by the Project Works, the standpipe is to be relocated into the new fenced area required under item 4. above. In addition, the new standpipe must be lowered to be at least

Property ID Number	Lot/Deposited Plan Number	Use of Land	Minimum Requirements for Property Adjustment
			150mm below the surrounding ground level and must be located within a new drained chamber. The new chamber must have an access cover suitable for the chamber's location. All existing connections to the existing standpipe must be reinstated to the new standpipe. **Imagine Nations Church and Penrith Christian School Entrance Signage** 6. The existing 'Imagine Nations and Penrith Christian School' entrance sign which is located south east corner of the TNR/Frogmore intersection, must be relocated as a result of the Project Works. The relocated entrance sign must be located as close as possible to the existing sign location and to an equivalent quality and standard of the existing sign. 7. All existing lettering on must be reinstated on the new entrance sign. **New access road from Frogmore Road roundabout** 8. Provide an access road from the southern leg of the roundabout on Frogmore Road (located on Frogmore Road, between The Northern Road and Simeon Road), to the north-west corner of the existing Penrith Christian School carpark.
Penrith Golf Club	14/DP128940 15/DP128940 18/DP128940 1617/DP871803	Site	**Fencing and Wire Screen** 1. Provide new fencing of equivalent standard to the existing, along the Site between Points 198, 225, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208,

Property ID Number	Lot/Deposited Plan Number	Use of Land	Minimum Requirements for Property Adjustment
			245, 209, 210, 211, 212, 213, 214, 215, 219, 218, 217, 216, 221 and 220 (as listed under the column titled "Point" in Table 2-2 (List of Site Boundary Coordinates) in Appendix 2 (Site, Local Road Works Areas and Temporary Works Areas)). 2. Provide a new wire screen along the western side of the access road as described in Item 3 below. The new wire screen is to be able to prevent the passage of golf balls. **Access Road** 3. Construct a new 7m wide sealed access road from the new Penrith Golf Club entrance (as required in accordance with Item 21 of Table 9-1 (Minimum Configuration Requirements) in Appendix 9 of the SWTC) to the existing Penrith Golf Club carpark. 4. The new access road must accommodate a design vehicle of an 8.8m service vehicle and a check vehicle of a 14.5m bus. **Entrance Gate** 5. Provide a new gate of equivalent standard to the existing, at the new Penrith Golf Club entrance (as required in accordance with Item 21 of Table 9-1 (Minimum Configuration Requirements) Appendix 9 of the SWTC)). 6. Provide a 1.5m wide gate for the pedestrian entrance along TNR at approximately point 212 (as listed under the column titled "Point" in Table 2-2 (List of Site Boundary Coordinates) in

Property ID Number	Lot/Deposited Plan Number	Use of Land	Minimum Requirements for Property Adjustment
			Appendix 2 (Site, Local Road Works Areas and Temporary Works Areas)). **Penrith Golf Club Entrance Signage** There are three existing signs at the Penrith Golf Club Entrance these are the: Penrith Golf Club variable message sign, brick wall entrance sign for the Penrith Golf Club and Penrith Golf and Recreational Club advertising sign. The associated works to each sign are: 7. **Penrith Golf Club variable message sign:** The existing variable message sign must be relocated along TNR at approximately point 212 (as listed under the column titled "Point" in Table 2-2 (List of Site Boundary Coordinates) in Appendix 2 (Site, Local Road Works Areas and Temporary Works Areas)). 8. **Brick wall entrance sign for the Penrith Golf Club:** Provide a new brick wall entrance sign for the new Penrith Golf Club entrance (provided in accordance with Item 21 of Table 9-1 (Minimum Configuration Requirements) Appendix 9 of the SWTC) with a similar size and design to the existing brick wall entrance sign for the Penrith Golf Club. This new signage must: a. be visible at night; b. provide landscaping in front of the new brick wall entrance sign for the Penrith Golf Club; c. reinstate the lettering shown on the existing brick wall entrance sign

Property ID Number	Lot/Deposited Plan Number	Use of Land	Minimum Requirements for Property Adjustment
			for the Penrith Golf Club; and d. incorporate the gate as require by item 5 above. **Penrith Golf and Recreational Club advertising sign:** Must be relocated near the new Penrith Golf Club entrance (provided in accordance with Item 21 of Table 9-1 (Minimum Configuration Requirements) Appendix 9 of the SWTC).
	122/DP870188	Site	Refer Table 3-2
	121/DP870188	Site	Refer Table 3-2
025	2/DP711076	Site	Refer Table 3-2
	113/DP1015911	Site	Refer Table 3-2
	132/DP1002668	Site	Refer Table 3-2
	11/DP1204969	Site	Refer Table 3-2
	2/DP1033226	Site	Refer Table 3-2
024	3/DP711076	Site	Refer Table 3-2
	15/DP26658	Site	Refer Table 3-2
023B	40/DP853672	Temporary Works	
023A	40/DP853672	Site	Refer Table 3-2
320	1/DP803128	Site	Refer Table 3-2
088	8299/DP1003801	Site	
022A	5/DP548308	Site	Refer Table 3-2
022B	5/DP548308	Temporary Works	
318	6/DP548308	Site	Refer Table 3-2
021	5/DP540425	Site	Refer Table 3-2
020	5231/DP1013008	Site	Refer Table 3-2
019	5232/DP1013008	Site	Refer Table 3-2
018	2/DP550005	Site	Refer Table 3-2
017	3/DP550005	Site	Refer Table 3-2
016	1/DP543975	Site	Refer Table 3-2
324	55/DP850645	Site	Refer Table 3-2
305	2/DP238339	Site	Refer Table 3-2

Property ID Number	Lot/Deposited Plan Number	Use of Land	Minimum Requirements for Property Adjustment
	54/DP850645	Site	Refer Table 3-2
	53/DP850645	Site	Refer Table 3-2
	1/DP29318	Site	Refer Table 3-2
	4/DP551767	Site	Refer Table 3-2
095	261/DP869597	Site	Refer Table 3-2
094	262/DP869597	Site	Refer Table 3-2
015A	27/DP238741	Site	Refer Table 3-2
015B	27/DP238741	Temporary Works	
306	3/DP238339	Site	Refer Table 3-2
303	14/DP831409	Site	Refer Table 3-2
	9/DP778436	Site	Refer Table 3-2
	8/DP778436	Site	Refer Table 3-2
012A	13/DP831409	Site	Refer Table 3-2
012B	13/DP831409	Temporary Works	
011	1/DP218571	Site	Refer Table 3-2
010	2/DP218571	Site	Refer Table 3-2
009	2/DP602150	Site	Refer Table 3-2
008	1/DP602150	Site	Refer Table 3-2
007	4/DP218571	Site	Refer Table 3-2
194	8/DP264332	Site	Refer Table 3-2
006	1/DP1031515	Site	Refer Table 3-2
005B	19/DP1028818	Temporary Works	
005A	19/DP1028818	Site	Refer Table 3-2
004	17/DP1028818	Site	Refer Table 3-2
003	16/DP1028818	Site	Refer Table 3-2
002	15/DP1028818	Site	Refer Table 3-2
001	41/DP1037264	Site	Refer Table 3-2
	3/DP26607	Site	Refer Table 3-2
198A	26/DP247948	Site	Refer Table 3-2
198B	26/DP247948	Temporary Works	

Property ID Number	Lot/Deposited Plan Number	Use of Land	Minimum Requirements for Property Adjustment
197A	11/DP236368	Site	Refer Table 3-2
197B	11/DP236368	Temporary Works	
199	27/DP250337	Site	Refer Table 3-2
	19/DP247948	Site	Refer Table 3-2
	20/DP247948	Site	Refer Table 3-2
200A	186/DP239628	Site	Refer Table 3-2
	21/DP247948	Site	Refer Table 3-2
	185/DP239628	Site	Refer Table 3-2
	184/DP239628	Site	Refer Table 3-2
	183/DP239628	Site	Refer Table 3-2
	22/DP247948	Site	Refer Table 3-2
	23/DP247948	Site	Refer Table 3-2
	24/DP247948	Site	Refer Table 3-2
	25/DP247948	Site	Refer Table 3-2
	227/DP260948	Site	Refer Table 3-2
	182/DP239628	Site	Refer Table 3-2
	181/DP239628	Site	Refer Table 3-2
	180/DP239628	Site	Refer Table 3-2
	179/DP239628	Site	Refer Table 3-2
	228/DP260948	Site	Refer Table 3-2
	229/DP260948	Site	Refer Table 3-2
	230/DP260948	Site	Refer Table 3-2
	331/DP626554	Site	Refer Table 3-2
	332/DP626554	Site	Refer Table 3-2
	233/DP260948	Site	Refer Table 3-2
	178/DP239628	Site	Refer Table 3-2
	177/DP239628	Site	Refer Table 3-2
	176/DP239628	Site	Refer Table 3-2
	175/DP239628	Site	Refer Table 3-2
	174/DP239628	Site	Refer Table 3-2
	173/DP239628	Site	Refer Table 3-2
	172/DP239628	Site	Refer Table 3-2

Property ID Number	Lot/Deposited Plan Number	Use of Land	Minimum Requirements for Property Adjustment
288	220/DP260512	Site	Refer Table 3-2
	234/DP260948	Site	Refer Table 3-2
	235/DP260948	Site	Refer Table 3-2
	236/DP260948	Site	Refer Table 3-2
215	10/DP236368	Temporary Works	
	171/DP239628	Site	Refer Table 3-2
	170/DP239628	Site	Refer Table 3-2
	169/DP239628	Site	Refer Table 3-2
	168/DP239628	Site	Refer Table 3-2
	167/DP239628	Site	Refer Table 3-2
	166/DP239628	Site	Refer Table 3-2
	237/DP260948	Site	Refer Table 3-2
	238/DP260948	Site	Refer Table 3-2
	239/DP260948	Site	Refer Table 3-2
	240/DP260948	Site	Refer Table 3-2
	241/DP260948	Site	Refer Table 3-2
	137/DP236826	Site	Refer Table 3-2
	26/DP236368	Site	Refer Table 3-2
	25/DP236368	Site	Refer Table 3-2
	24/DP236368	Site	Refer Table 3-2
	23/DP236368	Site	Refer Table 3-2
	22/DP236368	Site	Refer Table 3-2
	21/DP236368	Site	Refer Table 3-2
	20/DP236368	Site	Refer Table 3-2
	19/DP236368	Site	Refer Table 3-2
	18/DP236368	Site	Refer Table 3-2
	17/DP236368	Site	Refer Table 3-2
	122/DP236826	Site	Refer Table 3-2
	8/DP233983	Site	Refer Table 3-2
	7/DP240675	Site	Refer Table 3-2
	8/DP240675	Site	Refer Table 3-2
	9/DP240675	Site	Refer Table 3-2

Property ID Number	Lot/Deposited Plan Number	Use of Land	Minimum Requirements for Property Adjustment
	10/DP240675	Site	Refer Table 3-2
	15/DP239342	Site	Refer Table 3-2
	14/DP239342	Site	Refer Table 3-2
	13/DP239342	Site	Refer Table 3-2
	12/DP239342	Site	Refer Table 3-2
	11/DP239342	Site	Refer Table 3-2
	33/DP539162	Site	Refer Table 3-2
	44/DP527441	Site	Refer Table 3-2
	43/DP527441	Site	Refer Table 3-2
	2/DP232763	Site	Refer Table 3-2
	1/DP232763	Site	Refer Table 3-2
	321/DP554043	Site	Refer Table 3-2
	8/DP232763	Site	Refer Table 3-2
	7/DP232763	Site	Refer Table 3-2
	6/DP232763	Site	Refer Table 3-2
245	12/DP220581	Temporary Works	
246	11/DP220581	Temporary Works	
	10/DP220581	Site	Refer Table 3-2
	9/DP220581	Site	Refer Table 3-2
	8/DP220581	Site	Refer Table 3-2
	7/DP220581	Site	Refer Table 3-2
	26/DP220581	Site	Refer Table 3-2
	25/DP220581	Site	Refer Table 3-2
	24/DP220581	Site	Refer Table 3-2
	23/DP220581	Site	Refer Table 3-2
	22/DP220581	Site	Refer Table 3-2
	21/DP220581	Site	Refer Table 3-2
	20/DP220581	Site	Refer Table 3-2
	19/DP220581	Site	Refer Table 3-2
	18/DP220581	Site	Refer Table 3-2
	17/DP220581	Site	Refer Table 3-2

Property ID Number	Lot/Deposited Plan Number	Use of Land	Minimum Requirements for Property Adjustment
	16/DP220581	Site	Refer Table 3-2
	1/DP1199098	Site	Refer Table 3-2
	1/DP220581	Site	Refer Table 3-2
	16/DP27993	Site	Refer Table 3-2
	15/DP27993	Site	Refer Table 3-2
	14/DP27993	Site	Refer Table 3-2
	13/DP27993	Site	Refer Table 3-2
	12/DP27993	Site	Refer Table 3-2
	15/DP220581	Site	Refer Table 3-2
	522/DP557389	Site	Refer Table 3-2
	521/DP557389	Site	Refer Table 3-2
	4/DP29318	Site	Refer Table 3-2
	3/DP29318	Site	Refer Table 3-2
304	1/DP1033168	Site	Refer Table 3-2
	269/DP240695	Site	Refer Table 3-2
	270/DP240695	Site	Refer Table 3-2
	271/DP240695	Site	Refer Table 3-2
	148/DP240695	Site	Refer Table 3-2

(j) Table 3-2 Detailed Minimum Requirements for Property Adjustments is provided as an electronic file on a separate disc titled:

Design and Construction of
The Northern Road Upgrade - Stage 3 North
Contract No.15.3662.2254
Exhibit F - Electronic Files

Table 3-2 Detailed Minimum Requirements for Property Adjustments

(k) The drawings identified in Table 3-3 below are provided as electronic files on a separate disc titled:

Design and Construction of
The Northern Road Upgrade - Stage 3 North
Contract No.15.3662.2254
Exhibit F - Electronic Files

Table 3-3: Property Adjustment Drawings

Drawings Number	Drawing Title	Date	Revision	Electronic File Reference
Property Works				
TNR3N - PW - DRG - 0101	PROPERTY WORKS - PLAN - SHEET 1	23/09/2016	2	PROPERTY ADJUSTMENTS-CONCEPT-DESIGN-DRGS.pdf
TNR3N - PW - DRG - 0102	PROPERTY WORKS - PLAN - SHEET 2	23/09/2016	2	
TNR3N - PW - DRG - 0103	PROPERTY WORKS - PLAN - SHEET 3	23/09/2016	2	
TNR3N - PW - DRG - 0104	PROPERTY WORKS - PLAN - SHEET 4	23/09/2016	2	
TNR3N - PW - DRG - 0105	PROPERTY WORKS - PLAN - SHEET 5	23/09/2016	2	
TNR3N - PW - DRG - 0106	PROPERTY WORKS - PLAN - SHEET 6	23/09/2016	2	
TNR3N - PW - DRG - 0107	PROPERTY WORKS - PLAN - SHEET 7	23/09/2016	2	
TNR3N - PW - DRG - 0108	PROPERTY WORKS - PLAN - SHEET 8	23/09/2016	2	

TNR3N - PW - DRG - 0109	PROPERTY WORKS - PLAN - SHEET 9	23/09/2016	2	
TNR3N - PW - DRG - 0110	PROPERTY WORKS - PLAN - SHEET 10	23/09/2016	2	
TNR3N - PW - DRG - 0111	PROPERTY WORKS - PLAN - SHEET 11	23/09/2016	2	
TNR3N - PW - DRG - 0131	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG – 0132	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG - 0133	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG - 0134	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG - 0135	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG - 0136	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG - 0137	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG - 0138	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG - 0139	PROPERTY WORKS - PLAN	23/09/2016	2	

TNR3N - PW - DRG - 0140	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG - 0141	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG – 0142	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG - 0151	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG – 0152	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG – 0153	PROPERTY WORKS - PLAN	23/09/2016	2	
TNR3N - PW - DRG – 0115	PROPERTY WORKS - PLAN - SHEET 12	23/09/2016	2	
TNR3N - PW - DRG – 0116	PROPERTY WORKS - PLAN - SHEET 13	23/09/2016	2	

Exhibit A –
Scope of Works and Technical Criteria
Appendix 4 – Additional Environmental Requirements
for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

November 2016

Document Author: Roads & Maritime Services

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About this document

Project data

Project name:	Western Sydney Infrastructure Plan, The Northern Road Upgrade - Stage 3 North Project
Contract type:	Design and Construction
Contract number:	15.3662.2254
Location:	Penrith, New South Wales
Road name:	The Northern Road and M4 Motorway
Local government area(s):	Penrith City Council

Data for this document

Document name:	WSIP The Northern Road Upgrade - Stage 3 North Project Exhibit A – SWTC Appendix 4
Version and date:	Contract Execution V2
Prepared by:	Roads & Maritime Services
Objective document ID and Version No.	qA1764323

Table of Contents

1 Additional Environmental Requirements

This Appendix 4 also contains the documents identified in the table below and which are included as electronic files. The electronic files are provided on the disc titled:

Design and Construction of
The Northern Road Upgrade - Stage 3 North
Contract No. 15.3662.2254
Exhibit F - Electronic Files

Table 4-1: Additional Environmental Requirements Electronic Files

Title	Electronic File Reference
Template Construction Environmental Management Plan	SWTC Appendix 4.1 (Additional Environmental Requirements) - Template CEMP.zip
Template Consistency Assessment Template	SWTC Appendix 4.2 (Additional Environmental Requirements) - Template REF Consistency Review.docx
Template Addendum Review of Environmental Factors	SWTC Appendix 4.3 (Additional Environmental Requirements) - Template Addendum REF.docx

1.1 Contractor's Obligations

(a) Notwithstanding references to "RMS", "RTA" or the "contractor" or the "proponent" in some of the other Environmental Documents, the Contractor must undertake all the obligations, suggestions and recommendations including monitoring, mitigation, safeguards, procedures, measures, controls, reporting and commitments, arising from the Environmental Documents unless specifically stated otherwise in Schedules 28 and 41 of the deed.

(b) In the other Environmental Documents, requirements, actions, recommendations and the like which are contemplated by or arise from the Environmental Documents and which could be interpreted as optional, including those qualified by or containing the words "could", "should", "would", "may" and words of similar effect, must be read as mandatory requirements or actions which must be implemented and complied with, unless stated otherwise in this Appendix 4 to the Scope of Works and Technical Criteria.

(c) Further to the recommendation in the determination specified in Item 10 of Schedule 1 of the deed, the design and construction of the Project Works and Temporary Works and the performance of the Contractor's Work is subject to the implementation of all safeguards and mitigation measures identified, described in or contemplated by The Northern Road Stage 3 North (Jamison Road to Glenmore Parkway) Review of Environmental Factors and associated Submissions Report.

1.2 Environmental Workshops

(a) Prior to the commencement of construction activities, a workshop must be held by the Contractor, with the RMS Representative and a cross section of the Contractor's personnel, to develop ideas and actions to improve environmental culture, to optimise performance and to establish good relationships with regulatory Authorities and all parties to the deed during the performance of the Contractor's Work.

(b) Early in the development of the Contractor’s Construction Environmental Management Plan (CEMP) and no later than 4 weeks after the date of the deed, the Contractor must hold a workshop with the Contractor’s personnel, and the Contractor's Environmental Manager. RMS Representative, relevant Authorities and personnel nominated by RMS Representative must be invited and permitted to attend and participate in the workshop. The objective of the workshop is to optimise and expedite the production of the CEMP and associated submissions to the relevant Authorities.

(c) Early in the development of the Design Documentation, which must be no later than 12 weeks from the date of the deed and prior to the Contractor’s submission of an application for an environment protection licence, the Contractor must hold a workshop to review the locations of water quality control measures and seek feedback and constructive input to the design, sizing, management and any other related construction and operational water quality issues for the construction and operational water quality control measures. The workshop must include representatives of all key regulatory Authorities, including EPA, OEH, RMS Representative and personnel nominated by RMS Representative, and relevant Contractor's personnel including the Contractor's project soil conservationist. A detailed agenda, including objectives for the meeting and supporting material including relevant Design Documentation, must be circulated to all attendees 14 days prior to the workshop taking place.

1.3 Cross Section Dimensions

Notwithstanding cross section dimensions in other Environmental Documents, where cross section dimensions, including separation and clearances are provided in the Scope of Works and Technical Criteria, including Appendix 9, they must be used in the design of the Project Works.

1.4 Traffic Data

(a) Notwithstanding traffic data in other Environmental Documents, where traffic data is provided in the Scope of Works and Technical Criteria, it must be used for the design of the Project Works.

1.5 Re-Vegetation Management Sub-Plan

(a) Further to the Review of Environmental Factors, the Contractor must prepare a Vegetation Management Plan, in consultation with local Landcare groups, Penrith City Council and OEH as part of the Contractor’s Flora and Fauna Management Plan and consistent with the Urban Design and Landscape Plan.

(b) The Vegetation Management Plan must incorporate and address restoration, regeneration and rehabilitation of areas of native vegetation impacted by the Project Works and Temporary Works.

(c) Further to the Review of Environmental Factors, the Contractor must prepare a Revegetation Strategy in consultation with OEH, including the Heritage Division, Council and community as part of and consistent with the Urban Design and Landscape Plan, and prepare a Revegetation Management Sub-plan in consultation with OEH as part of the Flora and Fauna Management Plan.

(d) The Revegetation Strategy and Revegetation Management Sub-plan must incorporate and address restoration, regeneration and rehabilitation of areas of native vegetation in the vicinity of the Project Works disturbed by the Project construction, including a rehabilitation program for the restoration of riparian habitat as agreed by DPI (Fisheries) and NOW (NSW Office of Water).

(e) The Revegetation Management Sub-plan shall nominate specific methods to incorporate local native species across all revegetation and landscaping efforts along the adjoining Project area, including plant species, densities and pot sizes. Nominated plant species are to be consistent with the species composition of threatened ecological communities listed in the Review of Environmental Factors as being potentially impacted.

1.6 Clearing of Native Vegetation

(a) Further to the Review of Environmental Factors, the Reference Document 'RTA Biodiversity Guidelines Protecting and Managing Biodiversity on RTA Projects (Sept 2011)', and requirements of the other Environmental Documents:

(i) The Contractor must design and construct the Project Works and Temporary Works to minimise native vegetation clearing, subject to other requirements of the deed including RMS D&C G40;

(ii) The Contractor must design and construct the Project Works and Temporary Works to lie completely within the clearing limits identified in RMS D&C G40 of Appendix 6 of the Scope of Works and Technical Criteria, except where:

A. clearing does not impact native vegetation;

B. native vegetation clearing for drainage structures, including scour protection, temporary sediment basins and operational water quality basins (including maintenance access tracks and measures to convey runoff to basins), does not extend further than 2 metres beyond the design footprint of the drainage structure;

C. native vegetation clearing for Services is required, provided that such clearing is not undertaken outside the minimum clearing extents required by the relevant Authority;

D. native vegetation clearing for fencing, including boundary fencing is required, provided that such clearing complies with the extents required by the Reference Document 'RTA Biodiversity Guidelines Protecting and

Managing Biodiversity on RTA Projects (Sept 2011)' and RMS D&C R201 of Appendix 7 of the Scope of Works and Technical Criteria; and

E. native vegetation clearing for Property Works does not extend further than 2 metres beyond the design footprint of the Property Works;

(iii) The Contractor must identify the location of exclusion zones with temporary fencing or flagging tape to indicate the limits of clearing (in accordance with the Roads and Maritime Biodiversity Guidelines (RTA, 2011)); and

(iv) The Contractor must ensure all relevant staff are inducted and informed of the limits of vegetation clearing and the areas of vegetation to be retained.

1.7 Pre-Clearing and Clearing Procedures

(a) Further to the Review of Environmental Factors and the Reference Document 'RTA Biodiversity Guidelines Protecting and Managing Biodiversity on RTA Projects (Sept 2011)', the Contractor must implement the procedures to minimise direct and indirect impacts upon flora and fauna.

(b) **Fauna rescue during clearing**

(i) The Contractor must prepare and implement a fauna rescue procedure to minimise the impacts on fauna, including threatened and protected fauna, caused by the Contractor's Work. This procedure must be developed as part of the Design Documentation and must be included in the Flora and Fauna Management Plan.

(ii) The fauna rescue procedure must identify all species that are likely to be affected by the Contractor's Work and must identify species description, locations, population sizes, likely impacts, required searches and rescue procedures.

(iii) The procedure must be reviewed by and address the requirements of the OEH and Department of Primary Industries (DPI) (Fishing and Aquaculture) prior to finalisation and subsequent implementation.

(c) **Project Ecologist**

(i) The Contractor must employ a project ecologist, who must be degree qualified, suitably experienced and with expertise in fauna rescue. The project ecologist must manage and supervise all fauna rescue tasks to minimise the impacts on fauna. Wildlife rescue organisations may be used to assist in rescue, but must not manage the process.

(d) **Clearing Procedures**

(i) The fauna rescue procedure must address the control of all clearing operations to minimise fauna injury and must include procedures to reduce risks from vehicle impacts to fauna in newly cleared areas.

(ii) The fauna rescue procedure must address, as a minimum, the following requirements:

A. The contact details for the project ecologist must be identified and kept at a convenient location on the Construction Site and must be available to the relevant Contractor's management and supervisory personnel at all locations where clearing is being undertaken, to enable quick contact and access with the project ecologist.

B. Prior to undertaking clearing at any location or time, a pre-clearing assessment must be undertaken by the project ecologist to identify the presence or evidence of the presence (including fresh scats, scratches and remains of prey) of fauna, including threatened species. The assessment must include processes and actions to protect or rescue the identified fauna including bat colonies and roosts, glider dens and frogs.

C. All hollow bearing trees, potential hollow bearing trees and all other fauna containing habitat trees, including trees with nests, dreys and termitaria likely to be occupied by fauna, must be marked at least 7 days prior to the commencement of clearing in a manner which clearly identifies and demarcates the trees.

D. The Contractor must implement a two stage approach to clearing. Non-habitat trees must be removed at least 48 hours before habitat trees are removed, unless otherwise agreed with the OEH and DPI (Fishing and Aquaculture), to allow fauna an opportunity to move from habitat trees and allow time to concentrate rescue efforts on the trees that are most likely to be inhabited. All habitat trees must be felled under the supervision of the project ecologist. Felled trees must be left for a short period of time, determined by the project ecologist, on the ground to give any fauna trapped in the trees an opportunity to escape.

E. An assessment of habitat trees and the handling of the fauna affected by the clearing activities must be undertaken. The assessment must address all elements of the implementation, outcomes and effectiveness of the fauna rescue procedure, including:

   1. the identification and assessment of habitat trees affected by the clearing activities, including details on the checks by the project ecologist on trees for fauna, nests and the like, and the implementation of the fauna rescue procedure; and

   2. shocked and injured animal care and handling.

F. Procedures for the relocation of non-injured fauna from clearing areas and operations, including the identification of appropriate locations, timings and weather conditions for the relocation of non-injured fauna.

G. Procedures for handling injured fauna from clearing areas and operations, including details on liaison with wildlife rescue groups, veterinary surgeons and any other appropriate organisations or individuals.

1.8 Ecological Monitoring

(a) Further to the Review of Environmental Factors and the Reference Document 'RTA Biodiversity Guidelines Protecting and Managing Biodiversity on RTA Projects (Sept 2011)', the Contractor shall develop and implement an ecological monitoring program consistent with the management measures identified in the REF.

(b) The Contractor's Flora and Fauna Management Plan must address timeframes for the conceptual development of the program, implementation and monitoring post-REF and REF Determination.

1.9 Waterway Crossing Requirements

(a) Further to the Review of Environmental Factors and other requirements of the Scope of Work and Technical Criteria:

(i) all requirements with respect to waterway crossings only apply to those waterway crossing that are a part of the Project Works and the Temporary Works;

(ii) waterway crossings must also be designed and constructed in consultation with OEH and DPI (Fishing and Aquaculture) and all affected stakeholders;

(iii) waterway crossings that are a part of the Temporary Works must also be designed and constructed in accordance with requirements of clause 3.6 of RMS D&C G38;

~~(iv)~~ Temporary waterway crossings must wherever practicable be located immediately upstream or downstream of the proposed bridge alignment so as to minimise clearing of riparian habitat~~;~~

(v) To minimise loss of aquatic habitat, large woody debris in streams must wherever practicable be lopped or relocated rather than removed; and

(vi) Refuelling of plant and equipment must not take place within 50m of waterways.

1.10 Structures

(a) The Contractor must assess and inspect all bridges, culverts and associated structures that are to be demolished or removed for the presence of native fauna, including fauna such as bats that may be present in gaps in structures or scuppers. If native fauna are found, the Fauna Handling and Rescue Procedure as detailed in the Reference Document 'RTA Biodiversity Guidelines Protecting and Managing Biodiversity on RTA Projects (Sept 2011)' must be implemented.

1.11 Reporting

(a) Following the completion of clearing operations and any demolition or removal of bridges, culverts and associated structures, the Contractor, in consultation with the project ecologist, must prepare a report that:

(i) details the assessment of habitat trees and the handling of the fauna affected by the clearing activities undertaken in accordance with the requirements of sections 1.6 and 1.7 of this Appendix 4;

(ii) details the clearing and structures removal operations, including procedures, dates, areas and information on the fauna specialist(s) present during the clearing and structures removal operations;

(iii) details any live animals that were sighted, captured, released, injured or shocked;

(iv) details dead animals that were found as a result of clearing and structures removal operations and fauna rescue;

(v) details trees being used for breeding or roosting by fauna, including their species, locations, sizes, heights and depths of hollows in trees;

(vi) details any bridge or culvert structure being used for breeding or roosting by fauna, including their species, locations, sizes, gap heights and depths;

(vii) includes photo images of rescued fauna;

(viii) includes records of road kill during the clearing period;

(ix) includes an analysis of the effectiveness of the clearing methods and fauna rescue procedures adopted by the Contractor; and

(x) includes recommendations for future pre-clearing assessments and/or fauna rescue procedures.

1.12 Water Quality Monitoring

(a) Further to the Review of Environmental Factors the Contractor must prepare and implement a Surface and Groundwater Quality Monitoring Program as part of its Construction Soil and Water Quality Management Plan.

1.13 Construction Water Quality Monitoring

(a) Further to the Review of Environmental Factors, the Contractor must prepare and implement a Construction Water Quality Monitoring Program as part of its Construction Soil and Water Quality Management Plan.

1.14 Aboriginal Heritage

(a) Further to the Review of Environmental Factors, the Contractor must implement all measures required by the Aboriginal Heritage Impact Permit and, generally, to minimise and manage impacts on Aboriginal heritage sites within the Construction Site including those measures detailed in the Review of Environmental Factors; and

(b) Further to the Review of Environmental Factors, the Contractor must implement measures to protect Aboriginal heritage sites near or adjacent to the project including those measures detailed in the Review of Environmental Factors.

1.15 Non-Aboriginal Heritage

(a) Further to the Review of Environmental Factors, the Contractor must implement measures to minimise and manage impacts on Non-Aboriginal heritage sites within the Construction Site due to the Contractor’s Work including those measures detailed in the Review of Environmental Factors;

(b) Further to the Review of Environmental Factors, the Contractor must implement measures to protect Non-Aboriginal heritage sites near or adjacent to the project including those measures detailed in the Review of Environmental Factors; and

(c) Further to the Review of Environmental Factors, the Contractor must establish temporary exclusion areas prior to commencement of construction and implement any management and mitigation measures required to ensure that there are no additional impacts to the Non-Aboriginal heritage items.

1.16 Nest Boxes, Bush Rocks and Hollow Logs

(a) Further to the Review of Environmental Factors and the Reference Document 'RTA Biodiversity Guidelines Protecting and Managing Biodiversity on RTA Projects (Sept 2011)' and notwithstanding the requirements of other Environmental Documents, the Contractor must conduct a survey prior to construction to determine the distribution density of hollow bearing trees and prepare a Nest Box Plan, in consultation with OEH, to replace hollow-bearing trees that are removed. The survey must include stag watching to identify the number and type of nest boxes required and the locations to be installed.

(b) Prior to clearing activities, the Contractor must undertake a survey of bush rocks for the identification of natural and artificial habitat features to limit injury to fauna and damage to existing flora.

(c) The Contractor must install 70% of nest boxes prior to construction and 30% after clearing is complete.

(d) The Contractor must comply with the relevant requirements of the Biodiversity Guidelines (RTA 2011).

1.17 Bats and Micro-Bats

(a) In the event that any assessments and inspections of structures undertaken under section 1.10 of this Appendix 4 indicates the presence of roosting bats, including micro-bats, in the structures, the Contractor must prepare and implement a Bat Management Plan and comply with the requirements of the Reference Document 'RTA Biodiversity Guidelines Protecting and Managing Biodiversity on RTA Projects (Sept 2011)'.

(b) The Bat Management Plan must be compatible with the Fauna Handling and Rescue Procedure prepared under clause 1.7 of this Appendix 4.

1.18 *Alternanthera philoxeroides* (Alligator Weed) & Other Noxious Weeds

(a) Prior to the commencement of construction in any waterway area, the Contractor must:

(i) inspect the site and waterway within the Site for the presence of Alligator Weed and other noxious weeds; and

(ii) if Alligator Weed or other noxious weeds are found, report the find to RMS Representative and the relevant local government council.

(b) In accordance with RMS Biodiversity Guidelines: Guide 10 – Aquatic habitats and Riparian Zones (RTA 2011), the Contractor must:

(i) train its personnel and its subcontractors personnel in the identification and disposal of Alligator Weed; and

(ii) inspect plant and equipment regularly to ensure that the species is not spread to uninfested areas.

1.19 Scour Protection

(a) Further to requirements of other Environmental Documents, the design must include:

(i) appropriate works that provide a controlled overland flow path; and

(ii) scour protection complying with Appendix 10 of the Scope of Works and Technical Criteria to prevent erosion and scour.

1.20 Stockpiles

(a) Stockpile sites must not result in any clearing of native vegetation beyond that which is otherwise required for the Project and which is permitted under the deed.

(b) The Contractor must locate, plan and manage vegetation stockpiles so as to minimise the impact of tannins leaching into the surrounding environment, in accordance with the requirements of Environmental Guidance – Management of Tannins from Vegetation Mulch (RMS, 2012).

(c) Stockpiles and stockpile sites must comply with D&C G36 and D&C G38.

1.21 Climate Change

(a) The Contractor must design the Project to take into account predicted climate change related rainfall increases.

(b) The climate changes assumptions adopted must be documented in the Design Documentation.

1.22 Automatic Weather Station

(a) The Contractor must install and operate an automatic weather station in accordance with the requirements of RMS Specification D&C R272 Automatic Weather Stations for the duration of the period of the Contractor's Work.

(b) The automatic weather station must be located within the Contractor's compound unless an alternative location is agreed with RMS representative.

1.23 Noise Mitigation

(a) The Contractor must, as a minimum, achieve the construction noise criteria detailed in the Environmental Documents.

1.24 At-Residence Operational Noise Treatment

(a) Further to and as a consequence of the Project, and the Review of Environmental Factors:

(i) The Contractor must provide 223 at-residence treatments for the properties listed in Appendix M (Receivers requiring at-property treatments), of Appendix E (Noise and Vibration Assessment Report), of Exhibit E (Review of Environmental Factors) ("**Appendix M**"), unless otherwise directed by the RMS Representative.

(ii) The Contractor must engage a consultant from the RMS Panel of Architectural Advisory Consultants to assist in the implementation of at-residence treatments.

(iii) The Contractor must engage a sub-contractor from the RMS Panel of Acoustic Treatment Contractors to undertake all at-residence treatments

(iv) Not Used.

(v) The Contractor (working with the Architectural Advisory Consultant) must consult with the owners of all properties identified in Appendix M to determine, in consultation with the owners, the scope and extent of noise mitigation and treatments to be applied as a minimum to residences based on the Concept Design and the Environmental Documents.

(vi) The operational at-residence noise treatments must be provided in accordance with the Reference Document "RTA Environmental Noise Management Manual (December 2001)". Note that any references to the Reference Document "RTA Environmental Noise Management Manual (December 2001)"includes the Reference Document "RMS Noise Criteria Guideline (April 2015)" (which supersedes the "RTA Environmental Noise Management Manual (December 2001)" Practice Note 1) and the Reference Document "RMS Noise Mitigation Guideline (April 2015)" (which supersedes the "RTA Environmental Noise Management Manual (December 2001)" Practice Notes 4a and 4c).

(vii) Notwithstanding the requirements of Practice Note ii of the ENMM, noise mitigation measures are not required at commercial or industrial premises.

1.25 Operational Noise Review

(a) Not Used

1.26 Urban Design

(a) The Contractor's design must be developed with reference to the urban and landscape design requirements in Appendix 15 of the Scope of Works and Technical Criteria. For the avoidance of doubt, the urban design and landscape requirements of Appendix 15 of the Scope of Works and Technical Criteria shall take precedence over the requirements of the Environmental Documents.

1.27 Ancillary Facilities

(a) Further to the requirements of the Review of Environmental Factors, and in addition to the requirements of some of the other Environmental Documents the Contractor must prepare a dilapidation report prior to first use of any ancillary facilities and access points. The dilapidation reports must comply with the requirements set out in Section 1.28.

1.28 Dilapidation Reports

(a) Further to the requirements of the Review of Environmental Factors, and in addition to the requirements of some of the other Environmental Documents, every dilapidation report prepared by the Contractor must be prepared in accordance with AS 4349.0 2007. In addition to the requirements of AS 4349.0 2007, every dilapidation report must document and contain:

(i) The type of construction(s).

(ii) Site conditions and their propensity to contribute to environmental damage (for example, presence of reactive soils).

(iii) A full record of every visible defect including description, photos with crack gauge, size and extent.

(iv) Categorisation of each defect as either a “Major Defect” or “Minor Defect” and “cosmetic” or “structural”.

(v) An assessment on whether the defect is likely to alter due to environmental movement of the building or structure.

(vi) Identification of poor building practice that may be exacerbated by environmental movement.

(b) Post-construction inspections must take place within one month of completion of the Project Works.

1.29 Template Construction Environmental Management Plan

(a) RMS has prepared a template Construction Environmental Management Plan (“Template CEMP”) including associated sub-plans.

(b) The Template CEMP and supporting documentation are contained in the electronic files Appendix 4.1 entitled “SWTC Appendix 4.1 (Additional Environmental Requirements) - Template CEMP.zip”.

(c) The Template CEMP contains generic construction management systems and processes and management and mitigation measures.

(d) The Contractor must use the Template CEMP as the basis of preparation of its CEMP, amended and expanded to suit Project and Site specific conditions and details.

(e) The Contractor must highlight all sections in the Template CEMP that have been changed from the original document.

(f) Preparation and submission of the CEMP must be undertaken in accordance with the requirements of section 3 of D&C G36.

1.30 Template Consistency Assessment & Addendum Review of Environmental Factors

(a) The Contractor may be required to undertake a consistency review and Addendum Review of Environmental Factors environmental assessment on proposed design refinements where they differ from the Concept Design described in the REF.

(b) Further to the Contractor's obligations under clause 9.5(a)(i)(B) of the deed, RMS has prepared a template Consistency Assessment as a base to facilitate:

(i) consistency of post-Approval environmental assessment of Extra Land;

(ii) consistency and standardisation of wording and environmental management practices;

(iii) consistency in the management of construction impacts on Extra Land;

(iv) consistency in the application of mitigation and management measures; and

(v) a consistent and streamlined approval process for Consistency Assessments.

(c) The template Consistency Assessment and supporting documentation are contained in the electronic files Appendix 4.2 entitled "SWTC Appendix 4.2 (Additional Environmental Requirements) - Template REF Consistency Review.docx".

(d) The template Addendum Review of Environmental Factors and supporting documentation are contained in the electronic files Appendix 4.3 entitled "SWTC Appendix 4.3 (Additional Environmental Requirements) - Template Addendum REF.docx".

(e) The appropriate template must be:

(i) used as the base for the preparation of any Consistency Assessment or Addendum Review of Environmental Factors for the Project; and

(ii) amended to suit Project and Site specific conditions and details.

(f) The Contractor must consult with RMS prior to using the templates to determine which template is appropriate in the circumstances.

(g) Draft versions of the Consistency Assessments and Addendum Review of Environmental Factors must be presented to RMS and relevant Authorities for their information, review, or comment, prior to submitting the final versions to RMS for approval.

Transport
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Exhibit A –
Scope of Works and Technical Criteria
Appendix 5 – Not Used
for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

November 2016

Document Author: Roads & Maritime Services

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About this document

Project data

Project name:	Western Sydney Infrastructure Plan, The Northern Road Upgrade - Stage 3 North Project
Contract type:	Design and Construction
Contract number:	15.3662.2254
Location:	Penrith, New South Wales
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Document name:	WSIP The Northern Road Upgrade - Stage 3 North Project Exhibit A – SWTC Appendix 5
Version and date:	Contract Execution V1
Prepared by:	Roads & Maritime Services
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Table of Contents

1 Not Used

Exhibit A –
Scope of Works and Technical Criteria
Appendix 6 – RMS General Specifications for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade – Stage 3 North Project

Penrith, New South Wales

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Table of Contents

1 RMS General Specifications

(a) This Appendix contains the following RMS general D&C specifications.

(b) Identified changes to the RMS General D&C model specifications for this Project are listed in Table 6-1.

(c) The documents identified in Table 6-2 are included as electronic files. The electronic files are provided on the disc titled:

Design and Construction of
The Northern Road Upgrade – Stage 3 North Project
Contract No: 15.3662.2254
Exhibit F - Electronic Files

Table 6-1 Identified changes to RMS General D&C model specifications

Specification	Clause/Section
RMS D&C Q6	Annexure Q/A
RMS D&C G4	Annexure G4/A
RMS D&C G7	3.3 , 4.1.2 , 6.3 , 7 , 8
RMS D&C G10	Annexure G10/A
RMS D&C G22	1.3 , 2.2 , 3.2.2 , 4.2 , 4.3.1 , 4.3.2 , 4.8.3 , 6 , Annexure G22/A
RMS D&C G36	3.1 , 3.2.1 , 3.2.2 , 3.6 , 3.7.2.2 , 3.7.2.4 , 4.2.1 , 4.5 , 4.17 , Annexure G36/A , Annexure G36/E
RMS D&C G38	2.2.2 , 2.3 , 3.2 , 3.7.4 , 3.75 , Annexure G38/A
RMS D&C G40	Annexure G40/A
RMS D&C G71	1.3 , 1.4.1 , 2.1 , 3.2 , Annexure G71/D

Table 6-2 List of RMS General Specifications

Specification	Title	Electronic File Reference
RMS D&C Q6	Quality Management System (Type 6)	D&C Q6.pdf
RMS D&C G4	RMS Site Facilities	D&C G4.pdf
RMS D&C G7	Services Works (Utility Adjustments)	D&C G7.pdf
RMS D&C G10	Traffic Management	D&C G10.pdf
RMS D&C G22	Work Health and Safety (Construction Works)	D&C G22.pdf
RMS D&C G36	Environmental Protection (Management System)	D&C G36.pdf
RMS D&C G38	Soil and Water Management (Soil and Water Management Plan)	D&C G38.pdf
RMS D&C G40	Clearing and Grubbing	D&C G40.pdf
RMS D&C G71	Construction Surveys	D&C G71.pdf
RMS G73	Detail Survey in CADD Format	G73.pdf

Exhibit A –
Scope of Works and Technical Criteria
Appendix 7 – RMS Technical Specifications for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade – Stage 3 North Project

Penrith, New South Wales

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Table of Contents

1 General

(a) This Appendix contains the RMS D&C specifications.

(b) Identified changes to the RMS Technical D&C model specifications for this Project are listed in Table 7-1.

(c) The documents identified in Table 7-2, Table 7-3, Table 7-4, Table 7-5, below are included as electronic files. The electronic files are provided on the disc titled:

Design and Construction of
The Northern Road Upgrade – Stage 3 North
Contract No: 15.3662.2254
Exhibit F - Electronic Files

Table 7-1 Identified changes to RMS Technical D&C model specifications

Specification	Clause/Section
D&C R24	Annexure R24/A
D&C R44	1.6.2 , 2.4.1 , 2.8.4 , 4.6 , Annexure R44/A
D&C R57	Annexure R57/A
D&C R90	Annexure R90/A
D&C R179	Annexure R179/A
D&C 3051	Annexure 3051/A
D&C 3071	5.1 , Annexure 3071/A
D&C 3151	Annexure 3151/A
D&C 3152	Annexure 3152/A
R155	Multiple changes have been made to the RMS Technical D&C model specification as a result of: (a) conversion of the construct only model specification to a D&C specification for the Project; and (b) updates to the model specification to align with Project requirements within SWTC Appendix 18 (Intelligent Transport Systems).
TS104	Multiple changes have been made to the RMS Technical D&C model specification as a result of:

Specification	Clause/Section
	(a) conversion of the construct only model specification to a D&C specification for the Project; and (b) updates to the model specification to align with Project requirements within SWTC Appendix 18 (Intelligent Transport Systems).
TS105	Multiple changes have been made to the RMS Technical D&C model specification as a result of: (a) conversion of the construct only model specification to a D&C specification for the Project; and (b) updates to the model specification to align with Project requirements within SWTC Appendix 18 (Intelligent Transport Systems).
TS106	Multiple changes have been made to the RMS Technical D&C model specification as a result of: (a) conversion of the construct only model specification to a D&C specification for the Project; and (b) updates to the model specification to align with Project requirements within SWTC Appendix 18 (Intelligent Transport Systems).
TS107	Multiple changes have been made to the RMS Technical D&C model specification as a result of: (a) conversion of the construct only model specification to a D&C specification for the Project; and (b) updates to the model specification to align with Project requirements within SWTC Appendix 18 (Intelligent Transport Systems).
TS020	Multiple changes have been made to the RMS Technical D&C model specification as a result of: (a) conversion of the construct only model specification to a D&C specification for the Project; and (b) updates to the model specification to align with Project requirements within SWTC Appendix 18 (Intelligent Transport Systems).

2 RMS D&C Specifications

2.1 Roadworks Specifications

Table 7-2 List of RMS Roadworks Specifications

Specification	Title	Electronic File Reference
D&C R11	Stormwater Drainage	D&C R11.pdf
D&C R15	Kerbs and Gutters	D&C R15.pdf
D&C R16	Precast Reinforced Concrete Box Culverts	D&C R16.pdf
D&C R23	Plastic Flexible Pipes	D&C R23.pdf
D&C R24	Precast Concrete Arches	D&C R24.pdf
D&C R31	Vertical Wick Drains	D&C R31.pdf
D&C R33	Trench Drains	D&C R33.pdf
D&C R37	Intra-pavement Drains	D&C R37.pdf
D&C R38	Edge Drains	D&C R38.pdf
D&C R40	Horizontal Drains	D&C R40.pdf
D&C R44	Earthworks	D&C R44.pdf
D&C R50	Stabilisation of Earthworks	D&C R50.pdf
D&C R53	Concrete (For General Use), Mortar and Grout	D&C R53.pdf
D&C R55	Rock Filled Gabions and Mattresses	D&C R55.pdf
D&C R57	Design of Reinforced Soil Walls	D&C R57.pdf
D&C R58	Construction of Reinforced Soil Walls (Contractor's Design)	D&C R58.pdf
D&C R63	Geotextiles (Separation and Filtration)	D&C R63.pdf
D&C R64	Soil Nailing	D&C R64.pdf
D&C R67	High Strength Geosynthetic Reinforcement	D&C R67.pdf

Specification	Title	Electronic File Reference
D&C R68	Shotcrete Work Without Steel Fibres	D&C R68.pdf
D&C R71	Construction of Unbound and Modified Pavement Course	D&C R71.pdf
D&C R73	Construction of Plant Mixed Heavily Bound Pavement Course	D&C R73.pdf
D&C R75	Insitu Pavement Stabilisation Using Slow Setting Binders	D&C R75.pdf
D&C R82	Lean-Mix Concrete Subbase	D&C R82.pdf
D&C R83	Concrete Pavement Base	D&C R83.pdf
D&C R90	Roller Compacted Concrete Subbase	D&C R90.pdf
D&C R93	Diamond Grinding of Concrete Pavement	D&C R93.pdf
D&C R101	Cold Milling of Road Pavement Materials	D&C R101.pdf
D&C R106	Sprayed Bituminous Surfacing (With Cutback Bitumen)	D&C R106.pdf
D&C R107	Sprayed Bituminous Surfacing (With Polymer Modified Binder)	D&C R107.pdf
D&C R109	Bituminous Slurry Surfacing	D&C R109.pdf
D&C R110	Coloured Surface Coatings for Bus Lanes and Cycleways	D&C R110.pdf
D&C R111	Sprayed Bituminous Surfacing (With Bitumen Emulsion)	D&C R111.pdf
D&C R116	Heavy Duty Dense Graded Asphalt	D&C R116.pdf
D&C R117	Light Duty Dense Graded Asphalt	D&C R117.pdf
D&C R118	Crumb Rubber Asphalt	D&C R118.pdf
D&C R119	Open Graded Asphalt	D&C R119.pdf
D&C R121	Stone Mastic Asphalt	D&C R121.pdf

Specification	Title	Electronic File Reference
D&C R131	Guide Posts	D&C R131.pdf
D&C R132	Safety Barrier Systems	D&C R132.pdf
D&C R142	Retroreflective Raised Pavement Markers	D&C R142.pdf
D&C R143	Signposting	D&C R143.pdf
D&C R145	Pavement Marking (Performance-Based)	D&C R145.pdf
D&C R151	Street Lighting	D&C R151.pdf
D&C R152	Roadside Emergency Telephone Pillars	D&C R152.pdf
D&C R153	Tunnel and Underpass Main Switchboard, Distribution Boards and Control Panels	D&C R153.pdf
D&C R154	Tunnel and Underpass Electrical Services Works	D&C R154.pdf
D&C R155	Design and Construction of ITS Cableways (Ed2 Rev 0)	D&C R155.pdf
D&C R158	Road Tunnel and Underpass Lighting	D&C R158.pdf
D&C R173	General Concrete Paving	D&C R173.pdf
D&C R178	Vegetation	D&C R178.pdf
D&C R179	Landscape Planting	D&C R179.pdf
D&C R201	Fencing	D&C R201.pdf
D&C R204	Property Adjustments	D&C R204.pdf
D&C R271	Design and Construction of Noise Walls	D&C R271.pdf
D&C R272	Automatic Weather Stations	D&C R272.pdf
DS2012/000293	Bicycle Path Design Plans and Details	RMS Pavement Standard Drawings – Bicycle Path Design Plan and Details – DS2012 000293.pdf

2.2 Bridgeworks Specifications

Table 7-3 List of RMS Bridgeworks Specifications

Specification	Title	Electronic File Reference
D&C B30	Excavation and Backfill for Bridgeworks	D&C B30.pdf
D&C B50	Driven Reinforced Concrete Piles	D&C B50.pdf
D&C B51	Driven Prestressed Concrete Piles	D&C B51.pdf
D&C B53	Driven H-Section Steel Piles	D&C B53.pdf
D&C B54	Driven Tubular Steel Piles	D&C B54.pdf
D&C B57	Driven Cast-in-Place Concrete Piles	D&C B57.pdf
D&C B58	Bored Cast-in-Place Reinforced Concrete Piles (With Permanent Casing)	D&C B58.pdf
D&C B59	Bored Cast-in-Placed Reinforced Concrete Piles (Without Permanent Casing)	D&C B59.pdf
D&C B61	Driven Composite Piles	D&C B61.pdf
D&C B63	Concrete Injected (CFA) Piling	D&C B63.pdf
D&C B80	Concrete Work for Bridges	D&C B80.pdf
D&C B82	Shotcrete Work	D&C B82.pdf
D&C B110	Supply of Pretensioned Precast Concrete Members	D&C B110.pdf
D&C B113	Post-Tensioning of Concrete	D&C B113.pdf
D&C B114	Ground Anchors	D&C B114.pdf
D&C B115	Precast Concrete Members (Not Pretensioned)	D&C B115.pdf
D&C B150	Erection of Pretensioned Precast Concrete Members	D&C B150.pdf
D&C B152	Incrementally Launched Prestressed Concrete Girders	D&C B152.pdf
D&C B153	Erection of Precast Concrete Members (Not Pretensioned)	D&C B153.pdf
D&C B170	Supply and Installation of Void Formers	D&C B170.pdf

Specification	Title	Electronic File Reference
D&C B200	Fabrication of Major Steel Structural Members	D&C B200.pdf
D&C B204	Welding of Bridges and Other Road Structures	D&C B204.pdf
D&C B220	Protective Treatment of Bridge Steelwork	D&C B220.pdf
D&C B240	Supply of Bolts, Nuts, Screws and Washers	D&C B240.pdf
D&C B241	Manufacture and Supply of Minor Steel Items	D&C B241.pdf
D&C B242	Manufacture and Supply of Aluminium Barriers	D&C B242.pdf
D&C B245	Fabrication of Aluminium Structural Members	D&C B245.pdf
D&C B246	Manufacture and Supply of Minor Aluminium Items	D&C B246.pdf
D&C B260	Erection of Structural Steelwork	D&C B260.pdf
D&C B261	Erection of Structural Aluminium	D&C B261.pdf
D&C B264	Erection of Barrier Railings and Minor Components	D&C B264.pdf
D&C B280	Unreinforced Elastomeric Bearing Pads and Strips	D&C B280.pdf
D&C B281	Laminated Elastomeric Bearings	D&C B281.pdf
D&C B282	Pot Bearings – Structural Steel	D&C B282.pdf
D&C B283	Pot Bearings – Stainless Steel	D&C B283.pdf
D&C B284	Installation of Bridge Bearings	D&C B284.pdf
D&C B310	Compression Seal Expansion Joints	D&C B310.pdf
D&C B312	Cold Applied Elastomeric Joint Sealants	D&C B312.pdf
D&C B315	Elastomeric Strip Seal Expansion Joints	D&C B315.pdf
D&C B316	Modular Bridge Expansion Joints	D&C B316.pdf
D&C B318	Bonded Metal-Elastomer Expansion Joints	D&C B318.pdf
D&C B319	Proprietary Aluminium Expansion Joints	D&C B319.pdf
D&C B341	Demolition of Existing Structure	D&C B341.pdf

Specification	Title	Electronic File Reference
D&C B343	Waterproofing & Liquid Applied Membrane Systems	D&C B343.pdf
D&C B344	Sprayed Bituminous Waterproofing Membrane	D&C B344.pdf
D&C B345	Supply of Bridge Nameplates	D&C B345.pdf
D&C B349	Supply of Precast Concrete Noise Walls (Not Pretensioned)	D&C B349.pdf
D&C B381	Design, Supply and Installation of Pedestrian Bridge Lifts	D&C B381.pdf

2.3 Materials Specifications

Table 7-4 List of RMS Materials Specifications

Specification	Title	Electronic File Reference
D&C 3051	Granular Base and Sub-base Materials for Surfaced Road Pavements	D&C 3051.pdf
D&C 3071	Selected Material for Formation	D&C 3071.pdf
D&C 3151	Cover Aggregate for Sprayed Bituminous Surfacing	D&C 3151.pdf
D&C 3152	Aggregates for Asphalt	D&C 3152.pdf
D&C 3153	Reclaimed Asphalt Pavement Material	D&C 3153.pdf
D&C 3154	Granulated Glass Aggregate	D&C 3154.pdf
D&C 3202	Wax Emulsion Concrete Curing Compound	D&C 3202.pdf
D&C 3204	Preformed Joint Fillers for Concrete Road Pavements and Structures	D&C 3204.pdf
D&C 3211	Cements, Binders and Fillers	D&C 3211.pdf
D&C 3221	Roller Compacted Concrete	D&C 3221.pdf
D&C 3222	No Fines Concrete (For Subsurface Drainage)	D&C 3222.pdf
D&C 3252	Polymer Modified Binder for Pavements	D&C 3252.pdf
D&C 3253	Bitumen for Pavements	D&C 3253.pdf
D&C 3254	Bitumen Emulsion	D&C 3254.pdf
D&C 3256	Comminuted Scrap Rubber	D&C 3256.pdf
D&C 3258	Aggregate Precoating Agent (For Bitumen)	D&C 3258.pdf
D&C 3259	Bitumen Adhesion Agent (For Bitumen)	D&C 3259.pdf
D&C 3261	Cutback Bitumen	D&C 3261.pdf
D&C 3263	Hot Poured Elastomeric Joint Sealant for Roads	D&C 3263.pdf
D&C 3268	Aggregate Precoating Agent (For Polymer Modified Bitumen)	D&C 3268.pdf

Specification	Title	Electronic File Reference
D&C 3269	Bitumen Adhesion Agent (For Polymer Modified Bitumen)	D&C 3269.pdf
D&C 3351	Road Marking Paint	D&C 3351.pdf
D&C 3352	Fluorescent Plastic Traffic Cones	D&C 3352.pdf
D&C 3353	Glass Beads (For Application to Road Marking Materials)	D&C 3353.pdf
D&C 3354	Adhesives for Raised Pavement Marker Installation	D&C 3354.pdf
D&C 3356	Waterborne Road Marking Paint	D&C 3356.pdf
D&C 3357	Thermoplastic Road Marking Material	D&C 3357.pdf
D&C 3359	Profile Thermoplastic Road Marking Material	D&C 3359.pdf
D&C 3360	Two Part Cold Applied Road Marking Material	D&C 3360.pdf
D&C 3368	Skid Resistant Friction Coating for Temporary Steel Road Plates	D&C 3368.pdf
D&C 3385	Barrier Boards	D&C 3385.pdf
D&C 3400	Manufacture and Delivery of Road Signs	D&C 3400.pdf
D&C 3411	Supply Of Guide Posts – (Timber)	D&C 3411.pdf
D&C 3412	Supply Of Guide Posts (Non-Timber)	D&C 3412.pdf
D&C 3552	Subsurface Drainage Pipe (Corrugated Perforated and Non-perforated Plastic)	D&C 3552.pdf
D&C 3553	Seamless Tubular Filter Fabric	D&C 3553.pdf
D&C 3555	Subsurface Drainage Pipe (Slotted and Unslotted Fibre-Reinforced Concrete)	D&C 3555.pdf
D&C 3556	Rigid Strip Filter Drains	D&C 3556.pdf
D&C 3557	Flexible Strip Filter Drains	D&C 3557.pdf
D&C 3580	Aggregate Filter Materials for Subsurface Drainage	D&C 3580.pdf
D&C 3651	Paints and Thinners for Steelwork	D&C 3651.pdf
D&C 3851	Steel Tapered Lighting Columns	D&C 3851.pdf

2.4 Other Specifications (Traffic / Communications)

Table 7-5 List of Other RMS Specifications

Specification	Title	Electronic File Reference
TSI-SP-012	General Requirements for Roadside Equipment Housing	TSI-SP-012.pdf
TSI-SP-016	General Requirements for Outdoor Electrical Equipment	TSI-SP-016.pdf
SI_TCS_8	Installation and Reconstruction of Traffic Light Signals	SI_TCS_8.pdf
SI_TCS_8 Appendix A	Specification SI_TCS_8 Appendix A	SI_TCS_ App A.pdf
SI_TCS_8 Appendix B	Specification SI_TCS_8 Appendix B	SI_TCS_App B.pdf
TS020	ITS Communications System	QA specification TS020.pdf
TS104	ITS Vehicle Detection Site (Ed1 Rev3)	QA TS104 Ed1 Rev3.pdf
TS105	ITS Electronic Message Sign Site	QA specification TS105.pdf
TS106	ITS Video Surveillance Camera Site	QA specification TS106.pdf
TS107	ITS Emergency Telephone Site	QA specification TS107.pdf
TS200	Register of ITS Field Equipment	QA Specification TS200.pdf
TS201	Approval of ITS Field Equipment	QA Specification TS201.pdf

Transport
Roads & Maritime Services

Exhibit A –
Scope of Works and Technical Criteria
Appendix 8 – Reference Documents
for

Design and Construction of

Western Sydney Infrastructure Plan -The Northern Road Upgrade – Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

November 2016

Document Author: Roads and Maritime Services

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About this document

Project data

Project name:	Western Sydney Infrastructure Plan, The Northern Road Upgrade - Stage 3 North Project
Contract type:	Design and Construction
Contract number:	15.3662.2254
Location:	Penrith, New South Wales
Road name:	The Northern Road and M4 Motorway
Local government area(s):	Penrith City Council

Data for this document

Document name:	WSIP The Northern Road Upgrade - Stage 3 North Project Exhibit A – SWTC Appendix 8
Version and date:	Contract Execution V2
Prepared by:	Roads & Maritime Services
Objective document ID and Version No.	qA1764323

Table of Contents

1 Reference Documents

(a) Reference Documents are identified in the tables below in the following categories:

(i) Listing of Reference Documents in Table 8-1;

(ii) Bridge Technical Directions in Table 8-2; and

(iii) RMS Technical Directions in Table 8-3.

(b) The documents identified in Table 8-1, Table 8-2 and Table 8-3 below are included as electronic files.

(c) The electronic files are provided on the disc titled:

Design and Construction of
The Northern Road Upgrade – Stage 3 North
Contract No: 15.3662.2254
Exhibit F - Electronic Files

1.1 Listing of Reference Documents

Table 8-1 Standards Australia Codes, Standards and Guidelines

Reference Doc. No.	Document Title	Electronic File
1	Australian Standard AS 5100 Set Bridge Design Set	Tenderer to obtain
2	NAASRA Explosives in Roadworks Users Guide 1982	Tenderer to obtain
3	Acid Sulfate Soil and Rock – Victorian EPA Publication 655.1 – July 2009	Tenderer to obtain
4	RMS Bridge Technical Direction Manual	ref_doc_004.pdf
5	Bridge Waterway Manual – RTA, October 1994 (Revised September 2000)	ref_doc_005.pdf
6	Waterway Design (A Guide to the Hydraulic Design of Bridges, Culverts and Floodways) – AUSTROADS – 1994	Tenderer to obtain
7	Structural Drafting and Detailing Manual – May 2011	ref_doc_007.pdf
8	Austroads Guide to Traffic Management	Tenderer to obtain
9	Guide Specification for Bridge Construction – NAASRA (1987); and Guide to Bridge Construction Practice – Austroads 1991	Tenderer to obtain
10	The Design and Construction of Incrementally Launched Bridges – DMR, August 1986	ref_doc_010.pdf
11	RTA Noise Management and Night Works, Environmental Fact Sheet 02	ref_doc_011.pdf
12	RTA Bridge Inspection Procedure Manual, Second Edition June 2007	ref_doc_012.pdf
13	RMS Bridge Standard Drawings	ref_doc_013.pdf
14	RTA Heritage Guidelines, Version 2 March 2004	ref_doc_014.pdf
15	Roads and Maritime Services Procedure for Aboriginal Cultural Heritage Consultation and Investigation –November 2011	ref_doc_015.pdf
16	Guide to Slope Risk Classifications RTA Draft	ref_doc_016.pdf
17	RTA Environmental Noise Management Manual, –December 2001	ref_doc_017.pdf
18	Road Noise Policy, EPA 2011	ref_doc_018.pdf
19	RTA Technical Guideline, Environmental Management of Construction Site Dewatering, Issue 2 April 2011	ref_doc_019.pdf
20	Managing Urban Stormwater: Soils and construction, Volume 2D Main road construction June 2008 (DECC)	ref_doc_020.pdf
21	Managing Urban Stormwater- Soils and Construction, Volume 1 4th Edition, March 2004 (Landcom)	ref_doc_021.pdf
22	Policy and Guidelines for Habitat Conservation and Management (update 2013) – NSW Fisheries	ref_doc_022.pdf

Reference Doc. No.	Document Title	Electronic File
23	RMS - Model Road Drawings	Tenderer to obtain
24	Transport for NSW Use of Social Media Policy 2013	ref_doc_024.pdf
25	Constructed Wetlands Manual – DLWC	Tenderer to obtain
26	NSW Wetlands Policy – DECC&W – March 2010	ref_doc_026.pdf
27	RMS Standard Pavement Subsurface Drainage Details Ed3 Rev2 (Volumes 1 to 6)	Register of Standard Pavement Subsurface Drainage Details.pdf SPSDD Volume 1.pdf SPSDD Volume 2.pdf SPSDD Volume 3.pdf SPSDD Volume 4.pdf SPSDD Volume 5.pdf SPSDD Volume 6.pdf technicalguide.pdf
28	AS/RMS 5100.5 Rev 2 May 2015	ref_doc_028V1.pdf
29	Hazardous Industry Planning Advisory Paper No. 3 Risk Assessment – NSW Planning January 2011	ref_doc_029.pdf
30	Technical Note: Investigation of Service Station Sites, 2004 (replaces EPA Guidelines for assessing service station sites, 1994)	ref_doc_030.pdf
31	Stockpile Site Management Guideline – RMS, May 2015	ref_doc_031.pdf
32	Guide to Slope Risk Analysis – RMS, Version 4 April 2014	ref_doc_032.pdf
33	AUSTROADS Guide to Geotextiles Technical Report – January 1990	Tenderer to obtain
34	Alkali Aggregate Reaction – Guidelines on Minimising the Risk & Damage to Concrete Structures in Australia – Cement and Concrete Association of Australia/Standards Australia – 1996	Tenderer to obtain
35	Acid Sulphate Soils Concrete Structures – Advice for Design and Construction – Review Report, RTA, Edition 3 May 2008	ref_doc_035.pdf
36	Acid Sulfate Soil Manual, NSW Acid Sulfate Soils Management Advisory Committee, August 1998	ref_doc_036.pdf
37	RMS Management of Special Events on State Roads, Issue 1.0 January 2012	ref_doc_037.pdf
38	Installation and Maintenance of Signs. RTA 2010	ref_doc_038.pdf
39	Guidelines for the Management of Acid Sulfate Materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze– RTA April 2005	ref_doc_039.pdf
40	Concrete Pavement Manual Design and Construction – RTA, Edition 2 April 1992	ref_doc_040.pdf

Reference Doc. No.	Document Title	Electronic File
41	AUSTROADS (2012) – Guide to Pavement Technology. Part 2: Pavement Structural Design (Austroads Publication No. AGPT02-12)	Tenderer to obtain
42	RMS Austroads Guide. Austroads Guide to Pavement Technology Part 2: Pavement Structural Design Version 2.2, january 2015	ref_doc_042.pdf
43	CIRCLY – Computer Program for the analysis of Multiple Complex Circular Loads on Layered Anisotropic Media (Wardle 1977) Geomechanics Computer Program Version 5 or later	Tenderer to obtain
44	Concrete Roundabout Pavements. A guide to their design and construction - RTA March 2004	ref_doc_044.pdf
45	Guide for the Measurement and Interpretation of Skid Resistance using SCRIM – RTA, February 1996	ref_doc_045.pdf
46	Sprayed Sealing Guide – RTA, February 1997 (including Section 4, Design Edition 2 – April 2002 (Interim)	ref_doc_046.pdf
47	Interim Guide to the Maintenance of Concrete Pavements – RTA, June 2000	ref_doc_047.pdf
48	RMS Standard Drawings – Rigid Pavement – Standard Details – Maintenance	Plain Concrete Pavement - PCP.pdf Volume MC - Continuously Reinforced Concrete Pavement - CRCP.pdf Volume MJ - Jointed Reinforced Concrete Pavement - JRCP.pdf
49	RTA Rigid Pavements Standard Details – Construction	Bicycle_Path_Design.pdf Series CC_CRCP.pdf Series CJ_JRCP.pdf SFCP_for roundabouts.pdf Volume_CP.pdf
50	Roads & Maritime Noise Criteria Guideline	ref_doc_050.pdf
51	Roads & Maritime Noise Mitigation Guideline	ref_doc_051.pdf
52	NSW Government Training Management Guidelines Feb 2009	ref_doc_052.pdf
53	RTA CADD Manual June 2005	ref_doc_053.pdf
54	Road Model Drawings – RMS	ref_doc_054.pdf
55	Austroads Guide to Road Design	Tenderer to obtain
56	NSW Speed Zoning Guidelines – RTA Version 4 April 2011	ref_doc_056.pdf
57	Austroads National Strategic Research Program The collection and discharge of stormwater from road infrastructure Research report ARR 368	Tenderer to obtain

Reference Doc. No.	Document Title	Electronic File
58	Road Medians – NAASRA – 1984	Tenderer to obtain
59	Concrete Pipe Selection and Installation (Concrete Pipe Association 1990)	Tenderer to obtain
60	Roundabouts – Geometric Design Method – RTA, Version No. 1.1 January 1997	ref_doc_060.pdf
61	Australian Rainfall and Runoff – The Institution of Engineers, Australia. 1987 edtion.	Tenderer to obtain
62	Model Analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings – DMR, 1979 (including types SO and SH)	ref_doc_062.pdf
63	Roads and Maritime Services Editorial Style Guide March 2014	ref_doc_063.pdf
64	RTA/ Tourism NSW Tourist Signposting – February 2012	ref_doc_064.pdf
65	Delineation RTA Version 1.1 – (Various dates)	ref_doc_065_register.pdf delineationappendixaa_i.pdf delineationfoldercovers_i.pdf delineationsect1v11_i.pdf delineationsect2a_i.pdf delineationsect3a_i.pdf delineationsect4v11_i.pdf delineationsect5v15_i.pdf delineationsect6v12_i.pdf delineationsect7v13_i.pdf delineationsect8_i.pdf delineationsect9v11_i.pdf delineationsect10v11_i.pdf delineationsect11v11_i.pdf delineationsect12v11_i.pdf delineationsect13v11_i.pdf delineationsect14a_i.pdf delineationsect15v13_i.pdf delineationsect16a_i.pdf delineationsect17a_i.pdf delineationsect19a_i.pdf
66	Guide to Road Safety Part 6: Road Safety Audit. Austroads	Tenderer to obtain
67	Guidelines for Road Safety Audit Practices. RTA July 2011	ref_doc_067.pdf
68	Roads & Maritime, Work Health and Safety – Policy Statement	ref_doc_068.pdf
69	Traffic Control at Work Sites Version 4.0 – RTA, June 2010	ref_doc_069.pdf
70	Seepage, Drainage and Flow Nets – HR Cedergren – 1989	Tenderer to obtain
71	Pavement Sub-Surface Drainage Systems – HH Ridgeway – 1982	Tenderer to obtain

Reference Doc. No.	Document Title	Electronic File
72	Accident Reduction Guide – Part 1 – Accident Investigation and Prevention – RTA	ref_doc_072.pdf
73	Standard Management Procedure Unexpected Archaeological Finds RMS July 2012	ref_doc_073.pdf
74	Guide to Traffic Generating Developments – RTA, Version 2.2 October 2002	ref_doc_074.pdf
75	Interim Construction Noise Guideline DECC July 2009	ref_doc_075.pdf
76	Erosion and Sedimentation Management Procedure – RTA, November 2008	ref_doc_076.pdf
77	Beyond the Pavement, RTA urban design policy, procedures and design principles, July 2014	ref_doc_077.pdf
78	Bridge Aesthetics – Design Guidelines to Improve the Appearance of Bridges in NSW – RMS, July 2012	ref_doc_078.pdf
79	Noise wall design guideline – Design guideline to improve the appearance of noise walls in NSW – RMS, March 2016	ref_doc_079_v1.pdf
80	NSW Government Social Media Policy and Guidelines, version 1 May 2013	ref_doc_080.pdf
81	RTA Guideline for Construction Water Quality Monitoring	ref_doc_081.pdf
82	Procedure for Selecting Treatment Strategies to Control Road Runoff Version 1.1 – RTA, June 2003	ref_doc_082.pdf
83	RTA Community Involvement and Communications Draft Resource Manual for Staff, June 2008	ref_doc_083.pdf
84	RMS Technical Directions	REF_doc_084_register.pdf and Refer to Section 1.3
85	Economic Analysis Manual – RTA, Version 2.0 1999 (amended 2009)	Abbrevs.pdf Appendix A.pdf to Appendix E.pdf Chapter 1.pdf to Chapter 13.pdf EAM Foreword.pdf EAM Foreword.pdf ref_doc_085_register.pdf
86	RMS Guideline for the Management of Contamination September 2013	ref_doc_086.pdf
87	NSW Bicycle Guidelines – RTA, Version 1.2 July 2005	ref_doc_087.pdf
88	US National Cooperative Highway Research Program – Report Number 350 (NCHRP350)	ref_doc_088.pdf
89	Austroads Traffic Engineering Practice. Series	Tenderer to obtain
90	Shotcrete design guideline – Design guideline to improve the appearance of shotcrete in NSW – RMS, March 2016	ref_doc_090_v1.pdf

Reference Doc. No.	Document Title	Electronic File
91	Roads & Maritime Kit of Tools – March 2014	ref_doc_091.pdf
92	NSW Government Advertising Guidelines – The NSW Government Branding Style Guide, September 2015	ref_doc_092.pdf
93	NSW EPA Waste Classification Guidelines 2014	Tenderer to obtain
94	RTA Corporate Policy PN148 Roadside Tributes Policy 2008	ref_doc_094.pdf
95	Guidelines for Treatment of Stormwater runoff from the Road Infrastructure – AUSTROADS, 2003	Tenderer to obtain
96	RTA Landscape Guideline Landscape design and maintenance guidelines to improve the quality, safety and cost effectiveness of road corridor planting and seeding, RTA, April 2008.	ref_doc_096.pdf
97	RTA Water Policy	ref_doc_097.pdf
98	Guide to Retaining Wall Design. 1993, Hong Kong Government	Tenderer to obtain
99	Guidance Note. Environmental Inspection Reporting June 2015	ref_doc_099.pdf
100	Environmental Incident Classification and Reporting Procedure – RMS, June 2014	ref_doc_100.pdf
101	Guidance for Environmental Incident Classification and Management. February 2009	ref_doc_101.pdf
102	RTA Environmental Direction No. 18 Pesticide Use – Compliance with Pesticides Act 1999, 12 july 2005	ref_doc_102.pdf
103	RTA Environmental Direction No. 19 Use of Reclaimed Water, 8 december 2006	ref_doc_103.pdf
104	RTA Environmental Direction No. 20 Legal Offsite Disposal of Bulk RTA Project Wastes, 23 april 2007	ref_doc_104.pdf
105	RTA Environmental Direction No. 21 Coal Tar Asphalt Handling and Disposal, 23 april 2008	ref_doc_105.pdf
106	RMS Supplements to Austroads Guides (Version 1.0)	ref_doc_106v1.zip
107	Rms Austroads Guide Supplements. Austroads Guide to Road Safety: Version 2-October 2011	ref_doc_107.pdf
108	RMS Austroads Guide Supplements. Austroads Guide to Traffic Management	Part 1.pdf Part 2.pdf Part 3.pdf Part 4.pdf Part 5.pdf Part 6.pdf Part 7.pdf Part 8.pdf Part 9.pdf

Reference Doc. No.	Document Title	Electronic File
		Part 10.pdf Part 11.pdf Part 12.pdf Part 13.pdf
109	RMS Australian Standard Supplements. Australian Standard – AS1742 Manual of Uniform Traffic Control Devices Parts 1 – 15	ref_doc_109.pdf
110	RMS Australian Standard Supplements. Australian Standard – AS1743 Road Sign - Specifications	ref_doc_110.pdf
111	RMS Australian Standard Supplements. Australian Standard – AS2890 Parking Facilities Parts 1 – 6	ref_doc_111.pdf
112	Road Safety & Traffic Management Directorate Policy 97M1454 Significant Roadside environment Area Signs	ref_doc_112.pdf
113	RMS Environmental Direction No. 25 Management of Tannins from Vegetation Mulch, January 2012	ref_doc_113.pdf
114	RTA Towards Best Practice, Concrete Slab Replacement – Review of Current Practice May 2011	ref_doc_114.pdf
115	RTA Biodiversity Guidelines, Protecting and Managing Biodiversity on RTA Projects, 2011	ref_doc_115.pdf
116	RMS Guide for the Preparation of a Durability Plan, June 2013	ref_doc_116.pdf
117	RMS Guideline for Batter Surface Stabilisation Using Vegetation, April 2015	ref_doc_117.pdf
118	RMS - Project Communications Templates	Tenderer to obtain
119	RMS Standard Details – Typical Pavement Profiles	Technical Guide - Typical Pavement Profiles.pdf Typical Pavement Profile.pdf
120	(Not used)	ref_doc_120.pdf
121	RMS Community Engagement and Communications, a Resource Manual for Staff, October 2012	ref_doc_121.pdf
122	Australian Steel Institute, Steel Construction Journal, Volume 39 No 2 Are you getting the bolts you specified, A Discussion Paper – December 2005	ref_doc_122.pdf
123	RMS Traffic Control Training, Factsheets July 2015	traffic-control-training-blue-card-training.pdf traffic-control-training-orange-card-training.pdf traffic-control-training-red-card-training.pdf traffic-control-training-yellow-card-training.pdf

Reference Doc. No.	Document Title	Electronic File
124	RMS Specification Geographical Information System (GIS) Datasets from External Providers, Pacific Highway Office, Ver 01 (Oct 2015)	ref_doc_124.pdf
125	RMS Concrete Pavement Maintenance Specifications	M212.pdf M213.pdf M214.pdf M215.pdf M231.pdf M232.pdf M258.pdf
126	AASHTO LRFD Bridge Design Specification	Tenderer to obtain
127	Hydraulic Engineering Circular No 18 – Evaluating Scour at Bridges, fifth edition, April 2012 (Publication No FHWA HIF-12-003)	Tenderer to obtain
128	Australian Building Codes Board - Building Code of Australia	Tenderer to obtain
129	Austroads - AP-R341/09 Austroads Research Report Freeway Design Parameters for Fully Managed Operations	Tenderer to obtain
130	Austroads - Austroads Research Report AP-R374/11 Guidance for the Development of Policy to Manage Skid Resistance	Tenderer to obtain
131	Austroads - Bridge Design Code, 1992	Tenderer to obtain
132	Austroads - Design Vehicles and Turning Path Templates Guide	Tenderer to obtain
133	Austroads - Guide to Bridge Technology Part 5: Structural Drafting	Tenderer to obtain
134	Austroads - Guide to Pavement Technology Part 5: Pavement Evaluation and Treatment Design	Tenderer to obtain
135	Austroads Technical Report AP-T60/06 Automatic Vehicle Classification by Vehicle Length	Tenderer to obtain
136	Department of Environment, Climate Change and Water NSW - Waste Classification Guidelines Part 1: Classifying Waste, December 2009	ref_doc_136.pdf
137	National Road Transport Commission, Federal Office of Road Safety - Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code), Sixth Edition, January 1998	Tenderer to obtain
138	RMS - Signs Database	Tenderer to obtain
139	RMS - Test Methods - Volumes 1, 2 and 3	Tenderer to obtain
140	RMS Vendor Accessibility Fact Sheet	Tenderer to obtain
140	NSW Government - Environmental Management Systems Guidelines, Third Edition, August 2013	Tenderer to obtain
141	NSW Government - Implementation Guidelines to the New South Wales Code of Practice for Procurement: Building and Construction, July 2013	ref_doc_141.pdf

Reference Doc. No.	Document Title	Electronic File
142	RMS - Code of Conduct and Ethics, September 2012	ref_doc_142.pdf
143	RMS - Guide to QA Specification R44 Earthworks	Tenderer to obtain
144	RMS - RMS visual identity - Interim visual identity guidelines, November 2012	Tenderer to obtain
145	RMS - Social Media Guidelines For community dialogue for RMS infrastructure projects, March 2013	Tenderer to obtain
146	RMS - Traffic Modelling Guidelines, February 2013	ref_doc_146.pdf
147	RTA Austroads Guide Supplements - Austroads Guide to Road Design Supplements (8 parts)	Tenderer to obtain
148	RTA - Bridge Engineering Policy and Specifications - Acid Sulfate Soils Concrete Structures Advice for Design and Construction, Edition 3, May 2008	Tenderer to obtain
149	RTA - Children's Crossings A Guide to Promoting Correct Use	Tenderer to obtain
150	RTA - Code of Practice for Water Management Road Development and Management, April 1999	ref_doc_150.pdf
151	RTA - Delineation Guidelines	Tenderer to obtain
152	RTA - Designing to Minimise Vandalism, Final Draft, November 2008	Tenderer to obtain
154	RTA - Guidelines for the Management of Acid Sulfate Materials: Acid Sulfate Rock and Monosulfidic Black Ooze, April 2005	Tenderer to obtain
155	RTA - Interim Guide to Signs and Markings Manual	Tenderer to obtain
156	RTA - Road environment safety - A practitioner's reference guide to safer roads, January 2006	Tenderer to obtain
157	RTA - Guide to the Geometry of Single Lane Entry and Exit Freeway Ramps S.D. 6323	Tenderer to obtain
158	RTA - RTA Waste Reduction and Purchasing Policy, 2009	Tenderer to obtain
159	RTA - Traffic signal design guidelines	Tenderer to obtain
160	RTA Occupational Health & Safety Policy Manual	Tenderer to obtain
161	Web Content Accessibility Guidelines Working Group (WCAG WG) - Web Content Accessibility Guidelines (WCAG), Version 2.0	Tenderer to obtain
162	RTA - Road Safety Audits Fact Sheet - December 2010	ref_doc_162.pdf
163	Australian Road Research Board (ARRB) - Storm drainage design in small urban catchments, a handbook for Australian practice Special Report 34, 1987	Tenderer to obtain
164	Australian Road Research Board (ARRB) - Subsurface Drainage of Road Structures Special Report 35, 1987	Tenderer to obtain
165	Department of Conservation and Land Management - Urban Erosion and Sediment Control Handbook, 1992	Tenderer to obtain

Reference Doc. No.	Document Title	Electronic File
166	Environment Protection Authority, Victoria - Information Publication 655 - Acid Sulphate Soil and Rock, July 2009	Tenderer to obtain
167	NSW Government Department of Environment, Climate Change and Water NSW - Action for Air, 2009	Tenderer to obtain
168	NSW Environment Protection Authority - Assessing and Managing Acid Sulphate Soils, June 1995	Tenderer to obtain
169	NSW Government - Advertising Handbook, December 2015	ref_doc_169.pdf
170	Unexpected Heritage Items Heritage Procedure 02 November 2015	ref_doc_170.pdf
171	RMS TIS-003 Loop Loop Classifier Installation	ref_doc_171.pdf
172	RMS VC005-33 Installation of Loop Detectors at traffic detector stations for use with the NSW ITS	ref_doc_172.pdf
173	RMS ME15551C Type B Region A cantilever electronic variable message sign	ref_doc_173.pdf
174	RMS ME16349C Type C Region A&B cantilever electronic variable message sign structure with walkway and service platform	ref_doc_174.pdf
175	RMS ME16466A Ladder with cage for VMS Type B&C region A&B cantilever electronic variable message	ref_doc_175.pdf
176	RMS Policy Number: PN 028i, RMS Core Business Policy, Strategic location and placement of variable message signs	ref_doc_176.pdf

1.2 RMS Bridge Technical Directions

(a) RMS Bridge Technical Direction Manual, which is Reference Document Number 4 in Table 8-1, comprises the following RMS bridge technical directions listed in Table 8-2.

Table 8-2 List of RMS Bridge Technical Directions

Number	Title	Electronic File
2014/03 Rev1	Release of Secure Bridge Plans	Tenderer to obtain
2014/02	Durability Plan for Bridges and Other Structures	Tenderer to obtain
2014/01	Traffic Loading for Bridges	Tenderer to obtain
2013/01	Design of Precast Reinforced Concrete Box Culverts	Tenderer to obtain
2012/01	Provision of Safety Screens on Bridges	Tenderer to obtain
2011/08	Testing of Cast-in-Place Concrete Piles	Tenderer to obtain
2011/07	RMS (RTA) Interim Code for Concrete Design	Tenderer to obtain
2011/06	Provisions for the Design of Super - T Girder Bridges	Tenderer to obtain
2011/05	Minimum Restraint Capacity for Superstructures	Tenderer to obtain
2011/04	Re-issue of Standard Bridge Drawings	Tenderer to obtain
2011/03	Skid-Resistant Treatments for Bridge Deck Joints	Tenderer to obtain
2011/02	Use of CFA Piles on Bridges	Tenderer to obtain
2011/01	Use of Proprietary Precast Reinforced Concrete Modular Bridge Deck Systems	Tenderer to obtain
2010/04	Issue of New Standard Bridge Drawing No RTAB100 – Design and Construction and Alliance Team Project Drawing Sheet	Tenderer to obtain
2010/03	Pretensioned Bridge Members – Concrete Transfer Strength Requirements	Tenderer to obtain
2010/02	Timber Bridge Design – Adoption of AS 1720.1-2010	Tenderer to obtain
2009/02	Management of Bridge Rehabilitation Design Projects	Tenderer to obtain
2009/01 Rev1	Design of Sign Structures	Tenderer to obtain
2008/17	Changes to Standard Bridge Drawings - RC Link Slab for Super T Girder Decks	Tenderer to obtain
2008/16	Timber Bridge Manual	Tenderer to obtain
2008/15	Concrete Parapets on Pedestrian Overbridges	Tenderer to obtain
2008/14	Changes to Standard Bridge Drawings– Spaced Planks Standard Drawings	Tenderer to obtain

Number	Title	Electronic File
2008/13	Provisions for Future Cathodic Protection of Reinforced Concrete Bridges	Tenderer to obtain
2008/12	Provisions for Concrete Structures in Acid Sulfate Soils	Tenderer to obtain
2008/11	Lists of RMS (RTA) Approved Bridge Components and Systems	Tenderer to obtain
2008/10	Bridge Deck Joints	Tenderer to obtain
2008/09	Link Slabs for Precast Pretensioned Concrete Girder Bridges	Tenderer to obtain
2008/08	Provision of Conduits in Bridge Traffic Barriers	Tenderer to obtain
2008/07	Design of Bridge Supports for Collision Load from Road Traffic	Tenderer to obtain
2008/06	Joints in Precast Concrete Barrier Elements on a Grade	Tenderer to obtain
2008/05	Splicing of Steel Girders Using Bolts	Tenderer to obtain
2008/03	Use of Profiled Steel Sheeting in Bridges and Minor Structures	Tenderer to obtain
2008/02	Access for Inspection, Monitoring and Repair or Replacement of Bridge Components	Tenderer to obtain
2008/01	Changes to Standard Bridge Drawings – Bridge Traffic Barrier Termination Details	Tenderer to obtain
2007/13	Durability of Steel Piles in Contact with Acid Sulfate Soils	Tenderer to obtain
2007/12	Design for Replacement of Bridge Bearings	Tenderer to obtain
2007/11	Horizontal Reinforcement for Crack Control in Walls and Wall Type Piers	Tenderer to obtain
2007/10	Restraint of Longitudinal Reinforcement in Columns	Tenderer to obtain
2007/09	Soil-Arch Structures	Tenderer to obtain
2007/08 Rev1	Design of Replacement Traffic Barriers on Existing Bridges	Tenderer to obtain
2007/07	Vertical Clearances on Bridges	Tenderer to obtain
2007/06	RMS (RTA) Structural Drafting and Detailing Manual	Tenderer to obtain
2007/05	Design of Integral Bridges	Tenderer to obtain
2007/04	Changes to Standard Bridge Drawings Steel Traffic Barrier Railing Joints	Tenderer to obtain
2007/03	Changes to Standard Bridge Drawings Quarterly Update Revised Australian Standards	Tenderer to obtain
2007/02	Changes to Standard Bridge Drawings Installation of Elastomeric Bearings for PSC Girders	Tenderer to obtain
2007/01	Changes to Standard Bridge Drawings Revision of Standard Bridge Drawings	Tenderer to obtain

Number	Title	Electronic File
2006/13	Changes to Standard Bridge Drawings – Revision of Three Standard Bridge Drawings – Nos RTAB032; RTAB041; RTAB042C	Tenderer to obtain
2006/09	Changes to Standard Bridge Drawings – Reinforcement Nomenclature Changed on All Bridge Standard Drawings Containing Reinforcement	Tenderer to obtain
2006/07	Changes to Standard Bridge Drawings – Revision of Standard Bridge Drawing No RTAB029 – Standard Notes	Tenderer to obtain
2006/05	Pipes and Conduits for Bridgeworks	Tenderer to obtain
2006/04	Changes to Standard Bridge Drawings – Bridge Traffic Barriers – Standard Cross Sections	Tenderer to obtain
2006/03	RMS (RTA) Approval of Proprietary Bridging Systems	Tenderer to obtain
2005/10	Reissue of Standard Bridge Drawings	Tenderer to obtain
2005/09	Provision of Disabled Access for Pedestrian Bridges	Tenderer to obtain
2005/08	Welding of Bridges	Tenderer to obtain
2005/06	Bird Nesting in Bridge Abutments & Box Girders	Tenderer to obtain
2005/05	Use of Steel Fibre Reinforced Reactive Powder Concrete ('Ductal') in RTA Works	Tenderer to obtain
2005/04 Rev1	Pot Bearing Attachment Plates	Tenderer to obtain
2005/03	Installation of Elastomeric Bearings for Pretensioned Concrete Girders – Standard Drawings	Tenderer to obtain
2004/11	Strategies for Enhancing the Durability of Post-Tensioned Concrete Bridges	Tenderer to obtain
2004/10	Bridge Approach Slabs - Standard Drawings	Tenderer to obtain
2004/09	Policy circulars made redundant by AS 5100:2004	Tenderer to obtain
2004/08	Inspection of modular bridge expansion joints and control of noise	Tenderer to obtain
2003/08	Bridge Screens	Tenderer to obtain
2003/07	Bridge Maintenance Piling Works	Tenderer to obtain
2003/06	Timber Truss Cross Girder Replacements	Tenderer to obtain
2003/04	Use of Proprietary Expanded Metal Construction Joints and Shear Keys	Tenderer to obtain
2003/03	Bituminous Surfacings for Timber Bridge Decks	Tenderer to obtain
2003/02	Waterproofing Membranes for Concrete Bridge Decks	Tenderer to obtain
2002/05	Bridge Concept	Tenderer to obtain

Number	Title	Electronic File
2002/03	Standard Connector – Thrie-Beam to Old Three Rail RHS Traffic Barrier	Tenderer to obtain
2002/02	Maximum Concrete Strengths for Use in RTA Works	Tenderer to obtain
2001/01	Replacement of Chief Bridge Engineer's Circulars	Tenderer to obtain
2000/09	Geotechnical Information for Bridges	Tenderer to obtain
2000/08	Bar Shapes and Steel Lists for Precast Concrete Members	Tenderer to obtain
2000/05	Compaction of Concrete in Solid and Non-circular Bridge Columns	Tenderer to obtain
1999/15	Timber/Concrete Composite Bridge Modules Test Loading of Module - Design Criteria	Tenderer to obtain
1998/15	Multi Span Plank Bridges with Link Slabs Guidelines for Bearing Selection	Tenderer to obtain
1998/12	Tech CulvertTM	Tenderer to obtain
1998/08	Bridge Bearings - Design for Maintenance or Replacement	Tenderer to obtain
1997/10	Use of Brand Names	Tenderer to obtain
1997/05	Design of Bearings for Durability	Tenderer to obtain
1997/01	Variability of Concrete Properties	Tenderer to obtain
1996/05	Registration and Standard of Bridge Designs and Drawings for Bridge Works Funded by the Authority on Main Roads	Tenderer to obtain
1996/04	Driven Piles	Tenderer to obtain
1995/03	Information to be shown on Drawings for Driven Piles	Tenderer to obtain
1995/02	Stress Laminated Timber Bridges	Tenderer to obtain
1994/07	Mass of Girders	Tenderer to obtain
1994/05	Drainage of Voids in Bridge Deck	Tenderer to obtain
1993/03	Socket Inserts for Precast Concrete Girders	Tenderer to obtain
1991/11	Bridges over Roads. Horizontal Clearances and Visual Perceptions	Tenderer to obtain
1991/06	Permanently Cased Piles - Driving Shoe Details	Tenderer to obtain
1990/10	Reinforcement detailing	Tenderer to obtain
1990/09	Weld Category - Fabricated Steelwork	Tenderer to obtain
1990/07	Cast-in Angle Details - Amendments to Sketch Number 89-D-1	Tenderer to obtain

Number	Title	Electronic File
1989/10	Detailing Steel Members	Tenderer to obtain
1988/08	Provision of Curtain Walls	Tenderer to obtain
1986/02	Design for Continuous Superstructures	Tenderer to obtain
1985/07	Anchor Bolts	Tenderer to obtain
1985/06	Bent on Site Reinforcing Bars	Tenderer to obtain
1984/06	Provision of Drainage on Bridge Kerb	Tenderer to obtain
1980/11	Provision of Lifting Lugs on Steel Girders	Tenderer to obtain
1980/03	Bearing Levels	Tenderer to obtain

1.3 RMS Technical Directions

(a) Reference Document No 84 comprises the following RMS Technical Directions listed in Table 8-3.

Table 8-3 List of RMS Technical Directions

Number	Title	Electronic File
ATD 2015/01	Prequalified Retroreflective Raised Pavement Markers	ATD 2015-01.pdf
TTD 2014/002	Signposting for Contra-Flow Bicycle Facilities	TTD 2014-02.pdf
TTD 2013/08	Approved Retroreflective Sheeting Materials for Road Signs	TTD 2013-08.pdf
TDT 2013/07	Bus Layover Parking	TDT 2013_07.pdf
TDT 2013/06	Provision for Variable Message Signs On Motorways for On-Road Presentation of Real Time Travel Time Information	TDT 2013_06.pdf
TDT 2013/05	Continuous Footpath Treatments	TD 2013_05.pdf
TDT 2013/04a	Guide to Traffic Generating Developments Updated Traffic Surveys	TDT 2013-04a.pdf
TDT 2013/03	Revised Traffic Signal Cable Installation and Connection	TDT 2013_03.pdf
TDT 2013/02	Management of Changes to the Alphanumeric (Mab) Route Marking System In NSW	TDT 2013_02.pdf
TDT 2013/01	Management of Changes to a Road Name for a State Road In NSW	TDT 2013-01.pdf
TDT 2012/10	Energy Management for New Traffic Assets	TD 2012_10.pdf
TDT 2012/09	Pavement Depth for Vehicle & Bicycle Loop Detectors	TD 2012-9.pdf
TDT 2012/08	Approved Requirements for New Traffic Assets	TD 2012-8.pdf
RTD 2012/002	Safety Barriers – Twin Rail Aluminium Road Barrier Withdrawn	RTD 2012_002.pdf
RTD 2011/001	Plastic Water Filled Devices	RTD 2011_001.pdf
TDT 2011/07	Attachment Of Equipment to Traffic Facilities Assets	TDT 2011-07.pdf
TDT 2011/06	Use of Uninterrupted Power Supply for Traffic Signals	TDT 2011-06.pdf
TDT 2011/04	Implementation of Revised Pavement Marking Layouts	TDT 2011-04.pdf
TDT 2011/03	Communication Modems for Traffic Control Signals	TDT 2011-03.pdf
TDT 2011/02	Use of Portable Speed Hump Devices	TDT 2011-02.pdf
TDT 2011/01a	Pedestrian Refuges	TDT 2011-01a.pdf
TDT 2010/07	Use of Variable Message Signs (VMS) RTA Policy	TDT 2010-07.pdf

Number	Title	Electronic File
TDT 2010/06	Use of Ground Mounted Controllers for Pedestrian or Small Traffic Signal Sites	TDT 2010-06.pdf
TDT 2010/05	Signposting of Truck Parking Areas and Bus Parking Areas on Freeways/Motorways	TDT 2010-05.pdf
TDT 2010/04	Guidelines for the Selection of Bus Priority Enforcement Camera Sites	TDT 2010-04.pdf
TDT 2010/03	Traffic Control at Worksites	TDT 2010-03.pdf
TDT 2010/02	Use of Prefabricated Detector Loops	TDT 2010-02.pdf
TDT 2010/01	Traffic Control at Worksites Training	TDT 2010-01.pdf
TDT 2009/07	Police Speed Enforcement or Presence on RTA Work Sites	TDT 2009-07.pdf
TDT 2009/06	Bicycle Storage Areas and Advance Bicycle Stop Lines	TDT 2009-06.pdf
TDT 2009/04	Use of Type Approved Illuminated Flashing Arrow Signs	TDT 2009-04.pdf
TDT 2009/03b	Implementation of New Intersection Layout at Traffic Signals	TDT 2009-03b.pdf
TDT 2008/06	Guidelines for the Use of 'No Stopping Taxis Excepted 1 Minute Limit' Zones and Signposting	TDT 2008-06.pdf
TDT 2008/04a	Land Use Development Assessment – RTA Guidelines	TDT 2008-04a.pdf
TDT 2008/03	Use of Traffic Management Equipment on Multi-Function Poles	TDT 2008-03.pdf
TDT 2008/01	Use of Portable Variable Message Signs With Radar Speed Indicators	TDT 2008-01.pdf
TDT 2007/01	Use of Fluorescent Materials for Road Signs	TDT 2007-01.pdf
TDT 2006/05	Signposting for Temporary Rural Road Closures	TDT 2006-05.pdf
TDT 2006/01	Design Vehicles and Turning Path Templates	TDT 2006-01.pdf
TDT 2005/02b	Guidelines for Location and Placement of Variable Message Signs	TDT 2005-02b.pdf
TDT 2005/01	Planning Guidelines for Walking and Cycling	TDT 2005-01.pdf
TDT 2004/01a	Use of Class 1 Retroflective Sheeting on Roadworks Signs	TDT 2004-01a.pdf
TDT 2004/02	Motor Bike Parking	TDT 2004-02.pdf
TDT 2003/05	Restricted Parking Access	TDT 2003-05.pdf
TDT 2002/12c	Stopping And Parking Restrictions at Intersections and Crossings	TDT 2002_12c.pdf
TDT 2002/04	How to Prepare a Pedestrian Access and Mobility Plan - An Easy Three Stage Guide	TDT 2002-04.pdf
TDT 2001/06a	RTA Policy Autoturn Swept Path Computer Program	TDT 2001-06a.pdf

Number	Title	Electronic File
2004/RS02	Non-Reflective Raised Pavement Markers for Lane Lines on Freeways and Dual Carriageways	TD 2004-RS02.pdf
2003/RS03 Ver 2	Policy for Road Safety Audits of Construction and Reconstruction Projects	TD 2003-RS03.pdf
2002/ RS01	Motorcyclist Risk Area Identification Signs	TD 2002-RS01.pdf
2002/ RS02	Policy for Safety Screening Of Bridges	TD 2002-RS02.pdf
RTD 2009/001	Restriction on the Installation of New Steel Culverts	RTD 2009-001.pdf
TD 2010-SR02	Pedestrian Fencing	TD 2010-SR02.pdf
TD 2010-SR01	Colour of Wire Rope Safety Barrier Posts	TD 2010-SR01.pdf
TD 2006/06	Surface Friction - Bituminous Specifications Options (Asphalt and Bituminous Surfacings)	TD 2006-06.pdf
TD 2006/05	Revised RTA Form 395K - Seal or Reseal Design Calculation Sheet (Bituminous Surfacings)	TD 2006-05.pdf
TD 2006/04	Bitumen Specification RTA 3253 – Upgrade (Bituminous Surfacing)	TD 2006-04.pdf
TD 2006/03	Use of Rhyolite Aggregate in Asphalt	TD 2006-03.pdf
TD 2006/02	Restoration of Core Holes in Asphalt Pavement	TD 2006-02.pdf
TD 2006/01	Slip Formed Slotted Road Drainage. Temporary Suspension Of All Installations	TD 2006-01.pdf
TD 2005/07	Design of Geotextile Seals and Reseals	TD 2005-07.pdf
TD 2005/06	Increased Proportion of Reclaimed Asphalt Pavement (RAP) In Dense Graded Asphalt	TD 2005-06.pdf
TD 2005/05	Monitoring of Cement Quality (Initial and Ongoing)	TD 2005-05.pdf
TD 2005/02	Maintaining the Integrity of the State Control Survey on RTA Construction Projects in Accordance with the Surveying Act 2002	TD 2005-02.pdf
TD 2004/16	Wire Rope Safety Barriers	TD 2004-16.pdf
TD 2004/15	Rest Area Toilets. Effluent Treatment Systems – Access Restrictions	TD 2004-15.pdf
TD 2004/14	Rest Area Toilets. Effluent Disposal Systems – Exclusion Zones	TD 2004-14.pdf
TD 2004/13	Rest Area Toilets. Underground Tanks – Anchoring Requirements	TD 2004-13.pdf
TD 2004/12	Rest Area Toilets. Securing Tank Access Openings	TD 2004-12.pdf
TD 2004/11	Rest Area Toilets - Portable Toilet Units - Locking Requirements	TD 2004-11.pdf
TD 2004/10	Drainage Interlayers for Asphalt Pavements	TD 2004-10.pdf

Number	Title	Electronic File
TD 2003/05	Layering of Asphalt Pavement	TD 2003-05.pdf
TD 2000/06	Shared Zone Signs	TD 2000-06.pdf
TD 1999/26	Keep Clear Pavement Markings	TD 1999-26.pdf
TD 1998/09	Pavement Investigation Requirements for Hot In-Place Asphalt Recycling	TD 1998-09.pdf
TD 1998/07	The Use of Waterborne Paints with Large Glass Beads	TD 1998-07.pdf
TD 1997/11	Use of Vibrating Steel Drum Rollers Incorporating a Mechanical Gearbox in the Drive Train	TD 1997-11.pdf
TD 1997/02	Geostrips	TD 1997-02.pdf
TD 1994/04	Stormwater Drainage Design, Access and Inspection Covers, Grates and Frames - Road Design Guide	TD 1994-04.pdf
TD 1993/21	Road Lighting Installations, Requirements For Design Of RTA	Tenderer to obtain
PTD 2015/002	Minimum Cement and FA Content For Concrete Pavements	PTD-2015-002.pdf
PTD 2015/001	Foamed Bitumen Stabilisation	PTD-2015_01.pdf
PTD 2014/004	C240 Bitumen and Sprayed Sealing	PTD-2014_004.pdf
PTD 2013/004	Selection of Surface Treatments to Improve Skid Resistance	PTD 2013-004.pdf
PTD 2013/003	Layering of Asphalt Pavements	PTD-2013-003.pdf
PTD 2013/002	Rhyolite Aggregate for use In Skid Resistant Asphalt Mixes	PTD-2013-002.pdf
PTD 2013/001	Stabilisation of Road Materials Using Cementitious Binders With Additives	PTD-2013-001.pdf
PTD 2012/003	Packing Coat Treatment for Sprayed Seals	PTD-2012-003.pdf
PTD 2012/002	Concrete Roundabouts – Surface Texture	PTD-2012-002.pdf
PTD 2012/001	Asphalt Overlay of Concrete Pavements	PTD-2012-001.pdf
TDT 2012/07	Installation of LED traffic signals lantens	TD 2012-7.pdf
TDT 2012/06	Approved retroflective sheeting materials for road signs	TD 2012-06.pdf
TDT 2011/08	Use of type approved portable variable message signs	TDT 2011-08.pdf
TDT 2008/05a	Installation of light emitting diode (led) traffic signal lanterns	TDT 2008-05a.pdf
TDT 2007/04	Guidelines for the implementation of on-street car share parking	TDT 2007-04.pdf
GTD 2015/01	Use of new geotechnical products or techniques on RMS Projects	GTD 2015-01.pdf

Number	Title	Electronic File
TD 2003 RS01	Signposting of Rest Areas, Driver Reviver Sites and other Rest Stops	TD 2003-RS01.pdf
TD 2004 RS01	Accident Reduction Guide, Part 1	TD 2004-RS01.pdf
TDT 2009/08	Approved retro-reflective sheeting materials for road signs	TDT 2009-08.pdf
TDT 2009/09	Prequalified retro-reflective raised pavement markers	TDT 2009-09.pdf
TDT 2011/05	Approval requirements for new traffic assets	TDT 2011-05.pdf
TDT 2011/10	Prequalified retro-reflective raised pavement markers	TDT 2011-10.pdf
TTD 2014/001	Providing a Clearway Service on a State Road	TTD 2014-01.pdf
TTD 2014/004	Off-road parking provision on narrow roads	TTD 2014-004.pdf
TTD 2014/005	Statutory 10 m No Stopping at unsignalised intersections review checklist	TTD 2014-005.pdf
TTD 2014/006	Variable speed limit signs	TTD 2014-006.pdf
TDT 2014/002	Signposting for Contra flow Bicycle Facilities	TD 2014-02.pdf
TDT 2012/05	Pedestrian Bridge Eligibility & Prioritisation Assessment	TD 2012_05.pdf
TDT 2012/01	Economic Analysis of Traffic Management Projects when using Sidra or Paramics	TD 2012_01.pdf
TDT 2006/07	A Guide to the Delegation to Councils for the Regulation of Traffic (including the operation of Traffic Committees)	TD 2006_07.pdf
TD 2004 RS01	Accident Reduction Guide, Part 2: Road Safety Audits	Tenderer to obtain
TDT 2003/04	Traffic Facilities Inventory - RTA Policy	TDT 2003_04.pdf
TDT 2003/03	Traffic Light Inventory - RTA Policy	TDT 2003_03.pdf
TD 2001/04a	Use of Traffic Calming Devices as Pedestrian Crossings	TD 2001_04a.pdf
TM P00/1	Bicycle Policy (Grates), RTA	TM P00-1.pdf
TM P99/4	Bicycle Policy (Maintenance Work), RTA	TM P99-4.pdf
P99/2	Advertising on RTA Infrastructure (Nov 2014)	P99_02 - Nov 2014.pdf
TD 98/13	Route Assessment for 14.5 metre Buses	TD 1998_13.pdf

Exhibit A –

Scope of Works and Technical Criteria

Appendix 9 – Geometric Performance and Design Requirements

for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

November 2016

Document Author: Roads & Maritime Services

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About this document

Project data

Project name:	Western Sydney Infrastructure Plan, The Northern Road Upgrade - Stage 3 North Project
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Contract number:	15.3662.2254
Location:	Penrith, New South Wales
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Prepared by:	Roads & Maritime Services
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Table of Contents

1 General

(a) The Project Works, Temporary Works and the Landscaping Maintenance must be designed to comply with the requirements identified in this Appendix 9.

(b) Reference in this Appendix to a "Point" corresponds to the unique ID number in Table 2-2 of Appendix 2 (Site, Local Road Works Areas and Temporary Works Areas) of this SWTC set out in the column titled "Point".

(c) Reference in this Appendix to a "Chainage" corresponds with the location of Chainage 0 as identified in Section 1.5 of the SWTC.

(d) References and measurements from any roads are to be interpreted as being measured from the centre of the carriageway corresponding to the road being referenced.

(e) The Project Works must as a minimum include the following configuration requirements as shown in Table 9-1.

(f) The prescriptive requirements in Table 9-1 may not achieve the performance requirement for Level of Service specified in Table 9-8. In such case, the performance requirement to achieve the Level of Service in Table 9-8 shall take precedence.

Table 9-1 Minimum Configuration Requirements

Item	Location	Requirements
1	The Northern Road (**TNR**) – North of Jamison Road	North of the Jamison Road/TNR intersection, the Main Carriageway must transition to the existing: a) northbound carriageway, consisting of three (3) lanes; and b) southbound carriageway, consisting of three (3) lanes and one (1) dedicated right turn lane into Jamison Road westbound.
2	Jamison Road/TNR intersection	The Jamison Road intersection with TNR must include: a) three (3) lanes along TNR northbound through the intersection; b) three (3) lanes along TNR southbound through the intersection; c) one (1) dedicated right turn lane from TNR northbound into Jamison Road eastbound; d) one (1) shared bus/left turn lane from TNR northbound into Jamison Road westbound; e) one (1) dedicated right turn lane from TNR southbound into Jamison Road westbound; f) one (1) lane along Jamison Road westbound through the intersection; g) one (1) dedicated right turn lane from Jamison Road westbound into TNR northbound; h) one (1) dedicated left turn lane from Jamison Road westbound into TNR southbound; i) minimum three (3) lane western approach including: 1. at least one (1) dedicated right turn lane from Jamison Road eastbound into TNR southbound; and 2. at least one (1) shared straight/left turn lane from Jamison Road eastbound into TNR northbound.

Item	Location	Requirements
3	TNR – Jamison Road to Smith Street	Between the Jamison Road/TNR intersection and Smith Street/TNR intersection, TNR must consist of: a) one (1) northbound carriageway along TNR consisting of four (4) lanes; and b) one (1) southbound carriageway along TNR consisting of three (3) lanes, which tapers to four (4) lanes southbound (to accommodate a kerbside bus lane) commencing at least 200m north of Smith Street.
4	Smith Street/TNR intersection	The Smith Street intersection with TNR must include: a) three (3) lanes along TNR northbound through the intersection; b) three (3) lanes along TNR southbound through the intersection; c) one (1) dedicated right turn lane from TNR northbound into Smith Street eastbound; d) one (1) shared bus/left turn lane from TNR northbound into Smith Street westbound; e) one (1) dedicated right turn lane from TNR southbound into Smith Street westbound; f) one (1) shared bus/left turn lane from TNR southbound into Smith Street eastbound; g) one (1) shared straight/right turn lane from Smith Street Road westbound into TNR northbound; h) one (1) shared straight/left turn lane from Smith Street westbound into TNR southbound; i) one (1) shared straight/right turn lane from Smith Street Road eastbound into TNR southbound; and j) one (1) dedicated left turn lane from Smith Street eastbound into TNR northbound.
5	TNR – Smith Street to Maxwell Street/Bringelly Road	Between the Smith Street/TNR intersection and Maxwell Street/Bringelly Road/TNR intersection, TNR must consist of one (1) northbound and one (1) southbound carriageway, each of four (4) lanes.

Item	Location	Requirements
6	Maxwell Street/Bringelly Road/TNR intersection	The Maxwell Street intersection with TNR must include: a) four (4) lanes (including the kerbside bus lane) along TNR northbound through the intersection; b) four (4) lanes (including the kerbside bus lane) along TNR southbound through the intersection; c) two (2) dedicated right turn lanes from TNR northbound into Bringelly Road eastbound; d) one (1) dedicated left turn slip lane from TNR northbound into Maxwell Street westbound; e) one (1) dedicated right turn lane from TNR southbound into Maxwell Street westbound; f) one (1) dedicated left turn slip lane from TNR southbound into Bringelly Road eastbound; g) two (2) lanes along Bringelly Road westbound through the intersection; h) one (1) shared straight/right turn lane from Bringelly Road westbound into TNR northbound; i) one (1) dedicated right turn lane from Bringelly Road westbound into TNR northbound; j) two (2) dedicated left turn slip lanes from Bringelly Road westbound into TNR southbound; k) two (2) dedicated lanes along Maxwell Street eastbound through the intersection; l) three (3) dedicated right turn lanes from Maxwell Street eastbound into TNR southbound; m) one (1) dedicated left turn slip lane from Maxwell Street eastbound into TNR northbound; and n) widening of Maxwell Street to provide at least two (2) lanes eastbound commencing at least 150m west of Tania Avenue. o)
7	Maxwell Street/Fragar Road Roundabout	Not Used.

Item	Location	Requirements
8	Maxwell Street/Aspen Street/Tania Avenue/Hiliger Road	The Maxwell Street intersection roundabout with Aspen Street and Tania Avenue must include: a) two (2) lanes for the western approach, as an unsignalised leg of the intersection roundabout b) two (2) lanes for the eastern approach, as an unsignalised leg of the intersection roundabout c) two (2) lanes for the southern approach, as the signalised leg of the intersection roundabout d) one (1) lane for the northern approach, as an unsignalised leg of the intersection roundabout
9	Maxwell Street/Tania Avenue (unsignalised)	Not Used.
10	Castle Road/TNR intersection (unsignalised)	The Castle Road intersection with TNR must include: a) four (4) lanes (including the kerbside bus lane) along TNR southbound through the intersection; b) one (1) dedicated left turn lane from TNR southbound into Castle Road eastbound; and c) one (1) dedicated left turn lane from Castle Road westbound into TNR southbound.
11	Aspen Street/TNR intersection (unsignalised)	The Aspen Street intersection with TNR must include: a) four (4) lanes (including the kerbside bus lane) along TNR northbound through the intersection; b) one (1) dedicated left turn lane from TNR northbound into Aspen Street westbound; and c) one (1) dedicated left turn lane from Aspen Street eastbound into TNR northbound.
12	TNR - Maxwell Street/Bringelly Road to Frogmore Road/Tukara Road	Between the Maxwell Street/Bringelly Road/TNR intersection and the Frogmore Road/Tukara Road/TNR intersection, TNR must consist of one (1) northbound and one (1) southbound carriageway, each of four (4) lanes.

Item	Location	Requirements
13	Frogmore Road/Tukara Road/TNR intersection	The Frogmore Road intersection with TNR must include: a) four (4) lanes (including the kerbside bus lane) along TNR northbound through the intersection; b) four (4) lanes (including the kerbside bus lane) along TNR southbound through the intersection; c) one (1) dedicated right turn lane from TNR northbound into Frogmore Road eastbound; d) one (1) dedicated left turn slip lane from TNR northbound into Tukara Road westbound. Sufficient geometric separation must be achieved to independently phase the respective TNR northbound through traffic and left turn traffic into Tukara Road. TNR northbound through traffic must be allowed to always flow, without stop, except in the instance of the pedestrian crossing phase across TNR; e) one (1) dedicated left turn slip lane from TNR southbound into Frogmore Road eastbound; f) one (1) dedicated right turn lane from Frogmore Road westbound into a dedicated TNR northbound acceleration lane; g) one (1) dedicated left turn slip lane from Frogmore Road westbound into TNR southbound; h) one (1) dedicated left turn slip lane from Tukara Road eastbound into TNR northbound; i) one (1) median side acceleration lane along TNR northbound for at least 280m before tapering into the TNR northbound carriageway; and j) physical restrictions to prevent traffic: 1. turning right from TNR southbound into Tukara Road westbound; 2. turning right from Tukara Road eastbound onto TNR southbound; and 3. proceeding straight through the intersection between Frogmore Road and Tukara Road.
14	Frogmore Road roundabout	The Frogmore Road roundabout (located on Frogmore Road, west of Simeon Road, adjacent to Point 753 and 754) must be provided.

Item	Location	Requirements
15	TNR - Tukara Road to M4 Motorway interchange	Between the Tukara Road/TNR intersection and M4/TNR interchange, TNR must consist of one northbound and one southbound carriageway, each of four (4) lanes.
16	M4/TNR interchange	The M4 Motorway interchange with TNR must include: a) four (4) lanes (including the kerbside bus lane) along TNR northbound through the interchange; b) four (4) lanes (including the kerbside bus lane) along TNR southbound through the intersection; c) two (2) dedicated right turn lanes from TNR northbound to the M4 eastbound entry ramp; d) two (2) dedicated left turn lanes from TNR northbound to the M4 westbound entry ramp; e) two (2) dedicated right turn lanes from TNR southbound to the M4 westbound entry ramp; f) two (2) dedicated left turn lanes from TNR southbound to the M4 eastbound entry ramp; g) three (3) dedicated right turn lanes from M4 westbound exit ramp into TNR northbound; h) three (3) dedicated left turn lanes from M4 westbound exit ramp into TNR southbound; i) three (3) dedicated right turn lanes from M4 eastbound exit ramp into TNR southbound; j) three (3) dedicated left turn lanes from M4 eastbound exit ramp into TNR northbound; k) no more than one (1) set of traffic control signals; l) two (2) lanes diverging for the M4 Motorway carriageway to the eastbound exit ramp; m) two (2) lanes diverging from the M4 Motorway carriageway to the westbound exit ramp; n) four (4) lanes between TNR and the M4 eastbound entry ramp Smart Motorways stop line without any merge of the southbound left turn traffic and the northbound right turn traffic lanes; o) M4 eastbound entry ramp storage capacity of no less than 1,100 lane metres between TNR and the M4 eastbound entry ramp stop line; p) At least three (3) lanes between TNR and the M4 westbound entry ramp Smart Motorways stop line without any merge of the southbound right turn traffic; and
16 cont.		

Item	Location	Requirements
		q) M4 westbound entry ramp storage capacity of no less than 1,100 lane metres between TNR and the M4 westbound entry ramp stop line.
17	Homestead Road/TNR intersection (unsignalised)	The Homestead Road intersection with TNR must include: a) four (4) lanes (including the kerbside bus lane) along TNR southbound through the intersection; b) one (1) dedicated bus/left turn lane from TNR southbound into Homestead Road eastbound; and c) one (1) dedicated left turn lane from Homestead Road westbound into TNR southbound.
18	Garswood Road/TNR intersection (unsignalised)	The Garswood Road intersection with TNR must include: a) four (4) lanes (including the kerbside bus lane) along TNR northbound through the intersection; b) one (1) dedicated left turn lane from TNR northbound into Garswood Road westbound; and c) one (1) dedicated left turn lane from Garswood Road eastbound into TNR northbound.
19	TNR - M4 to Glenmore Parkway/Wentworth Road	Between the M4/TNR interchange and Glenmore Parkway/Wentworth Road/TNR intersection, TNR must consist of one (1) northbound and one (1) southbound carriageway, each of 4 (four) lanes.
20 20 cont.	Glenmore Parkway/Wentworth Road/TNR intersection	The Glenmore Parkway/Wentworth Road intersection with TNR must include: a) four (4) lanes (including the kerbside bus lane) along TNR northbound through the intersection; b) four (4) lanes (including the kerbside bus lane) along TNR southbound through the intersection; c) two (2) dedicated right turn lanes from TNR northbound into Wentworth Road eastbound; d) one (1) dedicated left turn slip lane from TNR northbound into Glenmore Parkway westbound; e) two (2) dedicated right turn lanes from TNR southbound into Glenmore Parkway westbound; f) one (1) dedicated left turn slip lane from TNR southbound into Wentworth Road eastbound; g) one (1) lane along Wentworth Road westbound through the intersection; h) two (2) dedicated right turn lanes from Wentworth

Item	Location	Requirements
		Road westbound into TNR northbound; i) one (1) dedicated left turn slip lane from Wentworth Road westbound into TNR southbound; j) one (1) lane along Glenmore Parkway eastbound through the intersection; k) two (2) dedicated right turn lanes from Glenmore Parkway eastbound into TNR southbound; and l) three (3) dedicated left turn slip lanes from Glenmore Parkway eastbound into TNR northbound.
21	Glenmore Parkway/ Penrith Golf Club access road intersection	A U-turn facility on the northern side of Glenmore Parkway to allow westbound traffic to return eastbound on Glenmore Parkway. The facility must also connect to a new service road for Penrith Golf Club. Penrith Golf Club traffic must also be permitted to exit the site in a westbound direction.
22	Glenmore Parkway/ Fairwater Court intersection	A U-turn facility along Glenmore Parkway to allow eastbound traffic (and traffic originating from Fairwater Court) to return westbound on Glenmore Parkway. The facility must be located between Fairwater Court and Configuration item 21 above. Notwithstanding the requirements of Table 9-7 of this Appendix and those in Item 21 above. Items 21 and 22 can be combined at a single location on Glenmore Parkway.
23	TNR/Glenmore Parkway intersection to Wentworth Road/Carolyn Chase intersection	Between TNR/Glenmore Parkway intersection and Wentworth Road/Carolyn Chase intersection, Wentworth Road must be widened to transition to the upgraded TNR/Glenmore Parkway intersection.
24	Cross Road	Cross Road must be upgraded and extended to connect Homestead Road to Wentworth Road.

Item	Location	Requirements
25	TNR – Glenmore Parkway to southern extent of Main Carriageway	Between the Glenmore Parkway/TNR intersection and Chainage 0 of the Main Carriageway, TNR must be designed and constructed to accommodate one (1) northbound and one (1) southbound carriageway, each of 4 (four) lanes. Between Chainage 0 and the southern extent of the site as defined in this SWTC, TNR must transition to the existing northbound and southbound carriageways, each of one (1) lane.

2 Main Carriageway

2.1 Design Requirements

(a) The Main Carriageway must be designed to comply with the criteria and requirements in Table 9-2, except where these requirements, widths and details conflict with requirements in other sections of this Appendix 9, in which case the requirements in the other sections of this Appendix 9 take precedence.

Table 9-2 Main Carriageway design criteria and requirements

Design Criteria	Requirements
Main Carriageway	
Horizontal and vertical alignment - design speed - North of M4 Motorway interchange - The M4 Motorway interchange to Chainage 50 at the southern extent of the Main Carriageways (including sight distance to the southbound stop line of the northern extent of the M4 Motorway interchange) - Chainage 50 to the southern extent of the Main Carriageway including the tie in to the existing The Northern Road	 80km/h 90km/h 80km/h
Horizontal alignment – absolute minimum horizontal curve radius for any travel lane	R475
Crest "K" for stopping sight distance - South of and including M4 Motorway interchange - North of M4 Motorway interchange Crest "K" for approach sight distance - South of and including M4 Motorway interchange - North of M4 Motorway interchange Minimum K values are subject to grade correction as per note 1 in table 3.1 of Part 4a in Austroads and RMS supplement	 minimum 35.5 minimum 23.9 minimum 72.3 minimum 48.5
Sag "K" - South of and including M4 Motorway interchange	 minimum 13 (where lit) minimum 27.9 (unlit)
- North of M4 Motorway interchange	minimum 10 (where lit)

Design Criteria	Requirements
	minimum 21.7 (unlit)
Driver reaction time (R_T)	1.5 sec
Stopping sight distance - South of and including M4 Motorway interchange - North of M4 Motorway interchange	 minimum 126 m minimum 103 m
Number of lanes on Main Carriageway (incl. bus lane):	4
Effective Lane widths General Traffic: - Between Chainage 0 and Maxwell Street/Bringelly Road - Between Maxwell Street/Bringelly Road and Jamison Road	 3.5 m minimum 3.25 m
Bus Lanes: - Between Chainage 0 and Maxwell Street/Bringelly Road - Between Maxwell Street/Bringelly Road and Jamison Road	 4.0m minimum 3.5 m
Auxiliary Lanes: - Right turn lanes between Chainage 0 and Smith Street - Right turn lanes between Smith Street and Jamison Road - Left turn lanes	 3.3 m minimum 3.0 m minimum 3.5 m
Median width	Desirable minimum 2.4m Absolute minimum 1.5m
Median width at two-stage pedestrian crossing locations	minimum 2.4 m
Nearside verge width (adjacent to 4 to 1 or flatter batters) Nearside verge width adjacent to a: - Type F barrier - Wire Rope Safety Barrier (WRSB) and W Beam (except as allowed by section 3.1(d) of this Appendix 9)	minimum 1.0 m minimum 1.0 m minimum 1.5 m
Main Carriageways footway width (measured from face of kerb to property boundary)	minimum 5.0m

Design Criteria	Requirements
Main Carriageway footway width over the M4 Interchange Bridge (measured from face of kerb to back of barrier, with a shared path of minimum 3.0m in width with no obstruction) Footway width on eastern side of TNR between Bringelly Road and Jamison Road and any Other Roads	minimum 5.0m minimum 3.5m
Shared path width	minimum 3.0m
Footpath width	minimum 1.5m
New M4 Interchange Bridge	
Barrier Location	Behind Footways
M4 Interchange Ramps	
Design Speed	90km/h
Nearside shoulder width	minimum 2.0 m
Offside shoulder width	minimum 1.0 m
Stopping sight distance – reaction time (R_T)	1.5 sec
Lane widths	minimum 3.5 m
Shoulder width adjacent to SO Gutter Verge width behind SO Gutter	minimum 1.0 m minimum 1.0m
Clearance from edge of travel lane to safety barrier - nearside - offside	 minimum 2.0 m minimum 2.0 m
Nearside verge width (adjacent to 4 to 1 or flatter batters) Nearside verge width adjacent to a: - Type F barrier - WRSB and W Beam	minimum 1.0 m minimum 1.0 m minimum 1.5 m
Offside verge width	minimum 0.5 m
Cutting berm width (adjacent to SO gutter)	minimum 1.0 m

(b) Shoulder widths on bridges must be designed to comply with sight distance requirements.

(c) The surfaces in the areas from edges of travel lanes to 0.5m behind safety barriers must be traversable. Where these areas do not comprise pavement or gutters, the surface must be sealed to provide a maintenance free surface.

(d) The verge width behind Wire Rope Safety Barrier (WRSB) may be reduced to a minimum of 1.0 metre, subject to:

(i) An RMS approved 4 rope system being provided;

(ii) The depth of barrier footings being increased to comply with the manufacturer's specifications; and

(iii) A maintenance free area being provided under the wire rope barrier. Where a seal is provided under wire rope barrier, it must extend to the hinge point of the embankment cross section.

(e) Not Used.

(f) Minimum Main Carriageway horizontal alignment radius R475 will not require any lane widening.

(g) Stopping Sight Distances shown in Table 9-2 are to be corrected for grade where required, to meet the minimum requirements of the Austroads: Guide to Road Design and RMS supplements.

(h) Refer to Table 9-9 for a schedule of the proposed bus stop locations.

(i) Lane widths between Smith Street and Jamison Road may need to vary to tie into existing carriageway width and align with the existing lanes north of the intersection. However the minimum's stated within Table 9-2 must be complied with.

2.2 Horizontal Alignment

(a) Superelevation transitions must not have overlaps causing "gull wing" or "butterfly pavements" where water can pond.

(b) Compound curves and broken back curves must be avoided wherever possible. Where compound curves are unavoidable, the design speed criteria, and not curve ratio, must be satisfied.

(c) The minimum length measured between tangent spiral points on adjacent reverse horizontal curves must be equal to or greater than the design speed expressed as metres.

(d) Wherever possible the horizontal alignment of the carriageways must not be independent of each other.

2.3 Vertical Alignment

(a) The vertical alignment grade on the Main Carriageway must be no greater than:

(i) 4.0% north of and including the M4 Interchange; and

(ii) 5.0% south of the M4 Motorway.

(b) The lengths of sag vertical curves must as a minimum meet the ride and appearance criteria and the lengths of vertical crest curves should be minimised to improve pavement drainage on relatively level sections of the pavements.

2.4 Cross Section

(a) Vertical clearances across the full widths of the Main Carriageway and Other Roads including shoulders, must be a minimum of 5.4m, except where specified otherwise in this Appendix 9.

(b) Table 4.10 of "Austroads Guide to Road Design Part 3" is amended to read as shown in Table 9-3 below:

Table 9-3 Amendment to Table 4.10 of Austroads Guide to Road Design Part 3

Grade change A (%)	Verge rounding	Verge width
0 to 10	Not required in median. Nominal width beside shoulder.	1 m
10 to 20	Nominal 1 m	1 m
20 to 25	1 m + 1 m	1 m
26 to 35	2 m + 2 m	2 m
35+	3 m + 3 m	3 m

(c) The horizontal distance between the edge of formation and the Site boundary for the Main Carriageways must be a minimum of 3.5 metres. RMS will consider reducing this requirement subject to boundary constraints, access, drainage and utilities requirements.

(d) North of Maxwell Street/Bringelly Road the footways must shed water towards the adjacent carriageway's kerb and channel.

2.5 Other Roads

(a) The Works which relate to Other Roads which adjoin the Main Carriageway and are within the Site must comply, as a minimum, with the requirements of this Appendix 9, including Table 9-6.

(b) Plan transitions are not required on Other Roads when the radial shift is less than 0.15m.

(c) The verge widths of the roads listed in Table 9-6 must be designed to comply with the requirements in Table 9-4.

(d) Minimum median widths for local roads are 1.2m.

(e) The numbers of lanes provided must at least match the existing number of lanes.

(f) Except at tie in locations, all travel lanes must be at least 3.3m wide.

Table 9-4 Verge widths on Other Roads

Type of Formation	Minimum Verge Width (m)	Function
Embankment	0.5 0.75 1.0 1.0 to 3.0	Allows for guide posts Allows for non-rigid safety barrier (special cases only) Allows for safety barrier Allows for safety barrier flare and anchor
Cutting	2.0 1.5	Table drain Concrete lined drain

(g) The roads listed in Table 9-6 must be designed to comply with the sight distance criteria in the "*RMS Supplements*" and "*Austroads Guide to Road Design*", utilising a stopping sight distance reaction time (R_T) of 1.5 seconds where the design speed is 90km/h or less and a longitudinal coefficient of friction of 0.36.

Table 9-6: Requirements for Other Roads within Site

Road	Minimum Design Speed
Jamison Road - West	70km/h
Jamison Road - East	60km/h
Smith Street	60km/h
Maxwell Street	60km/h
Bringelly Road	60km/h
Castle Road	70km/h
Frogmore Road	70km/h
Simeon Road	Not Used.
Tukara Road	60km/h
Homestead Road	80km/h
Garswood Road	60km/h
Glenmore Parkway	60km/h
Wentworth Road	80km/h
Cross Road	60km/h

2.6 M4 Smart Motorway Entry Ramps

(a) Entry ramps must be designed using the following criteria:

(i) Merge/diverge design speed (non-metered operation): 120km/h; and

(ii) Merge/diverge design speed (metered operation): 100km/h.

(b) The M4 Motorway eastbound entry ramp must be designed from the M4 Smart Motorway stop line location to the M4 Motorway merge as follows:

(i) Taper merge length from 4 lanes to 2 lanes: 80m;

(ii) Parallel length of lanes 1 and 2: 260m;

(iii) Length of lane 2 merge taper: 120m (merge taper 1 from Table 9-5);

(iv) Length of lane 1 (parallel to M4 Motorway carriageway): 220m;

(v) Length of lane 1 merge taper: 120m (merge taper 2 from Table 9-5); and

(vi) Minimum ramp length from stop line to end of mainline merge taper: 800m.

(c) The M4 Motorway westbound entry ramp must be designed from the M4 Smart Motorway stop line location to the M4 Motorway merge as follows:

(i) Taper merge length from 3 lanes to 2 lanes: 70m;

(ii) Taper merge length from 2 lanes to 1 lane: 100m;

(iii) Length of lane 1 (non-parallel to M4 Motorway carriageway): 110m;

(iv) Length of lane 1 (parallel to M4 Motorway carriageway): 150m;

(v) Length of lane 1 merge taper: 120m (merge taper 1 from Table 9-5); and

(vi) Minimum ramp length from stop line to end of mainline merge taper: 800m.

(d) Stopping sight distance (SSD) must be achieved for the Smart Motorways stop line locations on both entry ramps using the ramp design speed in Table 9-2.

(e) Heavy vehicle speeds must achieve or exceed the requirements in Table 9-5 using the Austroads truck acceleration rates for a 19m single articulated vehicle laden at 42.0 tonnes gross mass:

Table 9-5 M4 Smart Motorway Entry Ramp speeds at merges

M4 Entry Ramp	Vehicle speed at ramp stop line	Vehicle speed at start of merge taper 1	Vehicle speed at start of merge taper 2
Eastbound Entry Ramp	0km/h	65km/h	91km/h
	5km/h	66km/h	92km/h
	10km/h	67km/h	92km/h
	20km/h	68km/h	93km/h

M4 Entry Ramp	Vehicle speed at ramp stop line	Vehicle speed at start of merge taper 1	Vehicle speed at start of merge taper 2
Westbound Entry Ramp	0km/h	82km/h	N/A
	5km/h	83km/h	N/A
	10km/h	83km/h	N/A
	20km/h	85km/h	N/A

(f) A maintenance bay must be provided on each entry ramp for the purposes of enabling maintenance activities on Smart Motorway assets. Each maintenance bay must be in the vicinity of the stop line on the entry ramps. The maintenance bays must be of dimensions suitable for vehicles and personnel to safely access the Smart Motorway assets to undertake maintenance activities similar to arrangement shown in Figure 9-1 in Annexure 1 to this Appendix 9.

2.7 M4 Smart Motorway Exit Ramps

(a) Exit ramp lanes must be designed to ensure stopping sight distance is provided from the exit ramp gore point to the back of the maximum modelled 2041 peak period queue length, as indicated and verified by the RMS AIMSUN model.

(b) Stopping sight distance for exit ramp design must be calculated using the design speed in section 2.6 a(i) of this Appendix.

(c) Diverge exit lane geometry must be designed in accordance with Austroads: Guide to Road Design and RMS Supplements

2.8 M4 Motorway Breakdown Bays

(a) All existing breakdown bays on the M4 Motorway impacted by the Project Works must be reinstated including the associated emergency telephones. The breakdown bays must:

(i) provide for maintenance activities;

(ii) be reinstated on the same side as the existing impacted breakdown bay and be located between the new M4 Motorway Interchange bridge and the commencement of the merge of the associated on or off ramp (whichever is closest to the impacted breakdown bay);

(iii) be of dimensions suitable for vehicles and personnel to safely approach and access;

(iv) be designed in accordance with Figure 9-1 in Annexure 1 (Figures) to this Appendix 9; and

(v) include a motorist emergency telephone in accordance with RMS Specification D&C R152 and TS107.

3 Roadside Furniture

3.1 Clear Zone

(a) Clear zones at a minimum must comply with Austroads Part 6 including RMS Supplements. All roadside furniture and landscaping in the clear zone must be frangible. Where it is not cost effective for this requirement to be met, a safety barrier must be erected.

3.2 Safety Barrier

(a) Safety barriers must be accepted safety barrier products in accordance with RMS D&C R132 and must comply with the design criteria in Table 9-2. Wire Rope Safety Barriers (WRSB) must be four wire systems.

(b) The ends of concrete barriers and railings, bridge piers and other solid objects within the clear zone must be protected by barriers or terminals

(c) The protection of bridge abutments and piers from road traffic collision loads must comply with section 2.1(f) of Appendix 13 of this SWTC.

(d) Solid safety barriers must not be used where they could have adverse impacts on the effects of floods.

3.3 Pedestrian Fencing

(a) The pedestrian fencing provided must be Type 1 and comply with the requirements of RMS Model (Road) Drawings.

4 Intersections and Interchanges

(a) Intersections and roundabouts must be designed to provide a minimum Level of Service, in accordance with "*Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis*", for design year 2041 and Table 9-8 of this Appendix 9.

(b) Intersections and roundabouts must be designed with layouts and permitted manoeuvres that are clearly indicated to motorists, including those required to enter and exit the Main Carriageway. The design of intersection layouts must consider and address:

(i) the maintenance of simplicity and consistency with regard to the local road network;

(ii) traffic volumes and characteristics;

(iii) existing and future road network requirements;

(iv) adjacent developments;

(v) compatibility with the topography of the sites;

(vi) environmental factors;

(vii) staging requirements;

(viii) costs of implementation and maintenance;

(ix) headlight glare;

(x) the avoidance of the potential for wrong way movements; and

(xi) All permissible movements at intersections and roundabouts must be designed for a design vehicle as indicated in Table 9-7.

Table 9-7 Design Vehicle at Intersections and Roundabouts

Location	Design Vehicle	Check Vehicle
The Northern Road/Jamison Road	19.0m Semi Trailer (Right turns into and out of Jamison Road from TNR) 14.5m bus (TNR northbound left turn into Jamison Road) 12.5m Single Unit Truck (Left turns into and out of Jamison except above)	26.0m B Double, all movements between Jamison Road (west) and The Northern Road 19.0m Semi Trailer all other movements
The Northern Road/Smith Street	19.0m Semi Trailer (Right turns into and out of Smith Street) 12.5m Single Unit Truck (left turns into and out of Smith Street)	19.0m Semi Trailer where not used as design vehicle
The Northern Road/Maxwell Street	19.0m Semi Trailer	26m B Double
The Northern Road / Bringelly Road	19.0 Semi Trailer	
The Northern Road/Aspen Street	19.0m Semi Trailer	26m B Double
The Northern Road/Castle Road	12.5m Single Unit Truck	19.0m Semi Trailer
Maxwell Street/Aspen Street/Tania Avenue/Hiliger Road	8.8m Service Vehicle (Right turns into Aspen Street from Maxwell Street) 19.0m Semi Trailer (except above)	26m B Double (Right turn into Maxwell Street from Aspen Street, and U-Turn from Maxwell Street westbound to Maxwell Street Eastbound)
Maxwell Street/Fragar Road	Not Used.	Not Used.
The Northern Road/Frogmore Road/Tukara Road	19.0m Semi Trailer (Right turns into and out of Frogmore Road and left turns out of both side roads) 12.5m Single Unit Truck (Left turns into side streets)	19.0m Semi Trailer for the left turn into Tukara Road only 26.0m B-Double for all other movements
Frogmore Road roundabout	19.0m semi-trailer	26.0m B-Double (U-Turn from Frogmore Road

Location	Design Vehicle	Check Vehicle
		eastbound to Frogmore Road westbound)
The Northern Road/M4 Motorway	26.0m B-Double	
The Northern Road/Homestead Road	8.8m Service Vehicle	19.0 Semi Trailer
The Northern Road/Garswood Road	8.8m Service Vehicle	19.0 Semi Trailer
Homestead Road/Cross Road	8.8m Service Vehicle	19.0 Semi Trailer
Wentworth Road/Cross Road	8.8m Service Vehicle	19.0 Semi Trailer
The Northern Road/Glenmore Parkway/Wentworth Road	19.0m Semi Trailer	26m B-Double into and out of Glenmore Parkway
Glenmore Parkway/Penrith Golf Club U-turn area (Item 21 of Table 9-1 of this Appendix)	19.0m Semi Trailer	
Glenmore Parkway U-turn area for Fairwater Court traffic (Item 22 of Table 9-1 of this Appendix)	8.8m service vehicle	26.0m B-Double

(c) At intersections:

(i) deceleration lengths for auxiliary right turn and left turn lanes must be provided in accordance with "*RMS Supplements*" and "*Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections*"; and

(ii) acceleration lengths must be provided in accordance with "RMS Supplements" and "Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections".

(d) Interchanges must be designed in accordance with the requirements "*Austroads Guide to Road Design Part 4C: Interchanges*" and "*RMS Supplements*".

(e) Interchange deceleration lanes must be designed to have all of the deceleration occurring in the deceleration lanes with no deceleration taking place in the adjacent carriageway through lanes.

(f) The rate of deceleration adopted in the design of deceleration lanes must be no greater than $2.5m/s^2$.

5 Pedestrian and Cycle Paths

(a) Shared pedestrian and cycle paths must be provided along the Main Carriageway for the length of the Site, except on the eastern side of the Main Carriageway between Bringelly Road and Jamison Road where a footpath of at least 1.5m wide is to be provided in the footway.

(b) Shared pedestrian and cycle paths must be a minimum of 3.0m in width.

(c) The path design must take into consideration the likely level of use and the "*Austroads guide to Road Design – Part 6A: Pedestrian and Cyclist Paths*" and tie into any existing shared user facilities.

(d) Signalised pedestrian crossings must be provided in accordance with Table 9-10.

6 Traffic Performance for Geometric Design

(a) RMS has cause to have prepared a traffic model in Aimsun Version 8.1.0 (Build R35251) for the Project. The model is included as electronic files which are provided on the disc titled:

Design and Construction of

The Northern Road Upgrade – Stage 3 North Project

Contract No: 15.3662.2254

Exhibit F - Electronic Files

(b) The Contractor is responsible for satisfying the traffic performance requirements specified in Appendix 9. RMS warrants the traffic model, however it does not accept any risks or liability for information or input data entered into the traffic model by others. The traffic model provided in Attachment B.3 (Electronic Information for SWTC) of the Request for Tender can be relied on as factual data.

(c) Notwithstanding any other requirements of this Appendix, RMS will, using the RMS AIMSUN model, verify that the contractor's design achieves the traffic performance requirements in Table 9-8 as a minimum for all the geometric design of the Main Carriageway, Other Roads within the Site, and Temporary Works. The traffic requirements identified in Table 9-8 are for Levels of Service (LOS) at intersections only.

(d) Where an approach LOS has not been prescribed in Table 9-8, it is subject to the Contractors's discretion to optimise.

(e) For the reference against some Austroads design requirements and notwithstanding the values nominated in Appendix 12 of the SWTC (Pavement Performance and Design Requirements), The Northern Road design AADT is 82,000 and heavy vehicles comprise 9% of this volume.

(f) For Other Roads within the Site (listed in Table 9-6), the AADT is per the values in Appendix 12 of the SWTC.

(g) All auxiliary lane lengths must be designed to ensure all queued vehicles are fully contained within the lane during the maximum modelled 2041 peak period queue length, as indicated and verified by the RMS AIMSUN model.

(h) For traffic movements which require more than one lane, the shortest lane provided for each movement must be no less than 0.75 times the length of the longest lane provided.

(i) At intersections and for the purpose of clause (h) above, lane lengths are measured between the intersection stop line and beginning of taper.

(j) Bus stop locations in Table 9-9 are measured from the front of a stopped bus or the coinciding bus shelter location.

(k) Bus shelters and accompanying infrastructure must satisfy Penrith City Council's requirements and not obstruct path clearances in Table 9-2 and Section 6 of this Appendix.

(l) To optimise traffic performance, signalised pedestrian crossings with more than one stage of crossing may have independent phasing for each crossing stage.

(m) The number of stages in each crossing in Table 9-10 does not include the crossing of left turn slip lanes.

Table 9-8 Minimum Intersection LOS Performance Requirements

Intersection	Approach	AM Peak Period LoS	Max. sec of delay	PM Peak Period LoS	Max. sec of delay
TNR/Jamison Road	Northern	B		C	
	Eastern	D		F	78*
	Southern	C		D	52
	Western	F	85*	E	
	Overall Intersection	C		D	
TNR/Smith Street	Northern	D		F	90*
	Eastern	C		B	
	Southern	B		B	
	Western	C		C	
	Overall Intersection	C		B	
TNR/Bringelly Road/ Maxwell Street	Northern	F	86*	D	
	Eastern	C		C	
	Southern	C		C	36
	Western	F	86*	D	
	Overall Intersection	D		C	
TNR/Frogmore Road/ Tukara Road	Northern	B		C	
	Eastern	D		D	
	Southern	A		A	
	Western	A		A	
	Overall Intersection	B		B	
TNR/M4 Motorway	Northern	C		C	
	Eastern	C		C	
	Southern	C		C	
	Western	D		C	31
	Overall Intersection	C		C	
TNR/Glenmore Parkway/ Wentworth Road	Northern	C		C	
	Eastern	E		F	80*
	Southern	D		C	
	Western	E		C	
	Overall Intersection	D		C	

* 10% variance on the Maximum Seconds of Delay is permitted.

Table 9-9 Bus Stop Locations

Carriageway	Location	Stop Type
TNR Northbound	Within 100m north of Smith Street	In bus lane
TNR Northbound	Within 50m north of Castle Road	In bus lane
TNR Northbound	Within 120m north of Tukara Road	In bus lane
TNR Northbound	Within 120m north of Glenmore Parkway	In bus lane
TNR Southbound	At least 100m north of Smith Street	In bus lane
TNR Southbound	Within 100m south of Smith Street	In bus lane
TNR Southbound	Within 150m of Bringelly Road	In bus lane
TNR Southbound	Within 100m of Frogmore Road	In bus lane
TNR Southbound	Within 100m south of Wentworth Road	In bus lane

Table 9-10 Pedestrian Crossing Locations

Intersection	Approach	Crossing	Stage(s)
TNR/Jamison Road	Northern	Yes	Single
	Eastern	Yes	Single
	Southern	Yes	Single
	Western	Yes	Single
TNR/Smith Street	Northern	Yes	Single
	Eastern	Yes	Single
	Southern	Yes	Single
	Western	Yes	Single
TNR/Maxwell Street/ Bringelly Road	Northern	Yes	Two
	Eastern	Yes	Single
	Southern	Yes	Two
	Western	Yes	Single
TNR/Frogmore Road/Tukara Road	Northern	No	-
	Eastern	Yes	Two
	Southern	Yes	Two
	Western	Yes	Single
TNR/M4 Motorway	Northern	Yes	Two
	Eastern	Yes	Multiple single crossings stages permitted
	Southern	Yes	Two
	Western	Yes	Multiple single crossings stages permitted
TNR/Wentworth Road/Glenmore Parkway	Northern	Yes	Two
	Eastern	Yes	Single
	Southern	Yes	Two
	Western	Yes	Single

7 Noise Modelling

(a) Not Used

(b) Not Used

(c) Not Used

8 Noise Treatment

(a) Without limiting the Contractor's obligations under the deed, noise treatment provided by the Contractor must include noise walls in accordance with Table 9-11 and the Environmental Documents as a minimum.

Table 9-11 Noise Wall Requirements

Location	Minimum Longitudinal Extent	Minimum Height	Maximum separation between edge of adjacent carriageway and front of noise wall
On the western side of the Main Carriageway between Tukara Road and Aspen Street	From at least Point 304 to Point 321 (Approximately 460m)	5.0m	7m
On the northern side of the M4 Motorway eastbound exit ramp and continuing north along TNR	From at least Point 778 to Point 297 (Approximately 838m)	5.0m	7m

(b) The minimum noise wall height is to be measured as the height above the design ground level in front of or behind the noise wall, whichever is the lesser.

(c) Not Used

Annexure 1 - Figures

Figure 9-1: Minimum Dimensions and Arrangement for Maintenance Bays

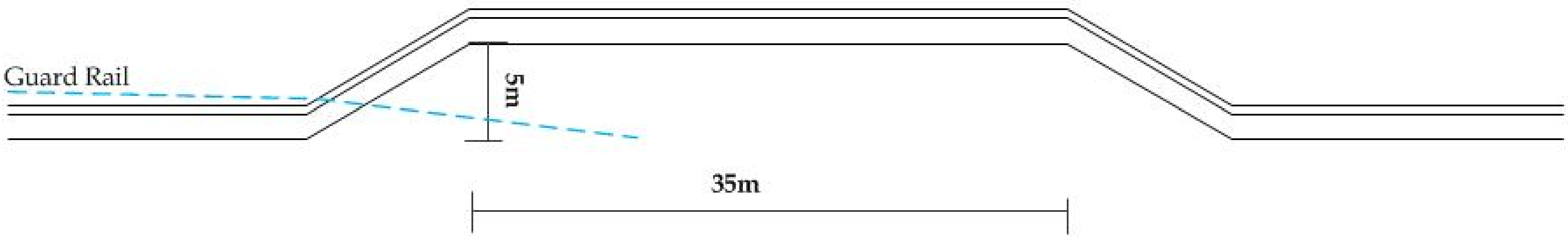

Exhibit A –

Scope of Works and Technical Criteria

Appendix 10 – Drainage Performance and Design Requirements

for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

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Table of Contents

1 Drainage General

(a) "Australian Rainfall and Runoff", Institution of Engineers Australia must be used as the basis of drainage design. The drainage design must include hydraulic modelling of watercourses that are crossed by the Project Works to determine flooding and associated impacts, including assessment for 1 in 20 year, 1 in 50 year and 1 in 100 year average recurrence interval (ARI) events and probable maximum flood (PMF) events and to identify required flood mitigation measures. The hydraulic modelling must include an assessment and identification of the impacts of the 1 in 100 year ARI event on properties and infrastructure at the site boundary. Details of these assessments and impacts must be included in the Design Documentation. The Contractor must provide all flood mitigation measures identified by the hydraulic modelling.

(b) The storm model used for all drainage design must be the storm model that produces the largest peak flows and discharges.

(c) The drainage system must separate cross drainage systems from pavement drainage systems

(d) The drainage system must be designed so that the Project Works do not increase inundation levels to greater than those identified in the Environmental Documents.

(e) Runoff from turning roadways, ramps and intersections must not flow beyond the turning roadway noses and across the carriageways on the Main Carriageway for flows generated by 1 in 10 year ARI events.

(f) The drainage network must be self cleaning. For the purpose of this Appendix self cleaning is defined as being achieved when the water velocity in pipes is ≥ 0.6m/s for the 1 in 6 month ARI event. All drainage pipes must be designed and constructed with a minimum gradient of 0.5%.

(g) Pavement drainage must include retention of polluted runoff in accordance with the Environmental Documents. The drainage system, including the transverse drainage system, and the pavement and subpavement drainage system, must have pipe outlet inverts at levels that discharge either at or above the existing surrounding natural surface levels or into the surface drainage system. Where the drainage system outlets into a basin, the invert of the outlet must be located at or above the basin spillway level.

(h) The drainage design must result in minimal disruption to the existing natural surface and ground water hydrological regime and must not divert flow onto or into adjoining catchments. Any drainage diversions must be designed to avoid any impacts on downstream morphology of the waterways.

2 Average Recurrence Intervals

(a) Drainage infrastructure must be designed to comply, as a minimum, with the ARIs specified in Table 10-1.

Table 10-1 Drainage Infrastructure ARI requirements

Item	Drainage Infrastructure	ARI
1	Open drains (surface drains including channels, table drains, bench drains, catch drains, contour banks, drop downs, basin inflows and basin outflows.)	5 years
2	Piped systems (including pits)	10 years
3	Culverts and structures designed for surcharge	50 years (1)
4	Culverts and structures not designed for surcharge	100 years
5	Pavement (including pavement wearing surfaces) - Maximum width of flow spread onto traffic lanes: 1. Where there is no shoulder or a shoulder less than 1m: 1m including width of the kerb and channel. 2. Where a shoulder of 1m or greater has been provided: Nil	10 years
6	Gross pollutant traps	1 year
7	Cycleways including Shared Paths	1 year

NOTE: (1) Where the Main Carriageways are being designed for 100 year ARI level of flood immunity, Item 3 of Table 10-1 is not applicable.

(b) Drainage infrastructure must be designed to prevent damage to:

(i) properties outside the Site in 1 in 100 year ARI events;

(ii) the Project Works, except for structures and bridges, in 1 in 100 year ARI events; and

(iii) structures and bridges forming part of the Project Works in 1 in 2000 year ARI events.

3 Drainage Design Modelling

(a) Drainage design hydraulic modelling must be undertaken using a design program that provides a routed reach outlet hydrograph and models, and must include details of:

(i) pit entry capacities;

(ii) pit losses;

(iii) bypass flows to next pits;

(iv) culvert sizing;

(v) detention basins;

(vi) overland flow times;

(vii) pervious and impervious areas and percentages;

(viii) rainfall lossess;

(ix) infiltration rates; and

(x) provide a routed reach outlet hydrograph.

(b) Pipes that will flow full must be analysed to determine their hydraulic performance. As a minimum, the analysis must include the identification of flow types and the production of hydraulic grade lines.

(c) Pit entry and exit losses must be considered and addressed as part of the drainage design hydraulic modelling.

(d) Catchment drawings must be provided within the Design Documentation and must include details on:

(i) existing and designed contours;

(ii) catchment areas;

(iii) drainage pits, headwalls and culverts; and

(iv) extents of proposed drainage work.

4 Surface Drainage

(a) Surface drainage must be provided where the Project Works intercept surface runoff, floodplains, watercourses, depressions and drainage lines.

(b) Drainage of the pavement wearing surface of the Works must be designed for a 10 year ARI event, except in unrelieved sag sections where drainage of the pavement wearing surface must be designed for a 100 year ARI event. Drainage of road pavement surfaces outside the Works must be designed to match or improve existing drainage standards.

(c) All outlets of the surface drainage system must incorporate energy dissipation and erosion and sediment control measures, where required.

(d) Design of the surface drainage system must consider and address the impacts of potential acid sulphate soils (PASS) and acid sulphate soils (ASS).

(e) Design of the surface drainage system must consider and address the effects of settlement on the drainage infrastructure.

(f) Batter catch drains must be provided up-slope of all cutting batters and at the foot of fill embankments where the ground slopes towards the embankment. Batter catch drains must be connected to the surface drainage system.

(g) Notwithstanding the requirements for lining in specification RMS D&C R11, open drains may be lined with the types of treatment identified in Table 10-2. The use of the types of treatments identified in Table 10-2 must comply with the gradient constraints identified in Table 10-3.

Table 10-2 Types of Treatment for Lining Open Drains

Treatment Number	Type of Treatment
1	Organic fibre matting - Jute mesh / bitumen emulsion (or similar) / vegetation
2	Organic fibre matting - Jute mesh / vegetation
3	Rip rap (rock lined)
4	Synthetic geotextile
5	Reinforced turf lining
6	Hydro-seed or hydro-mulch
7	Concrete
8	Segmental units or piped
9	Rock Mattress

Table 10-3 Types of Treatment and Open Drain Gradient Constraints

Open Drain Gradient	< 1%	1% to 5%	>5%
Types of treatment (Treatment Numbers are as identified in Table 10-2)	1; 3; 3 & 4 combined; 3 & 6 combined; 4; 5; or 7.	1; 2; 3 & 4 combined; 7; 8; or 9 & 4 combined.	3 & 4 combined; 7; 8; or 9 & 4 combined.

(h) Organic fibre matting treatment, as identified in treatment numbers 1 and 2 in Table 10-2, must include topsoiling and vegetation by seeding. Topsoiling and seeding must be undertaken in accordance with RMS D&C R178, prior to the application of organic fibre matting.

(i) Spacing and size of rock in rip rap must be determined by a soil conservation specialist registered under RMS Registration Scheme 'S'.

(j) All pipe and box culverts must be provided with concrete headwalls, wingwalls and aprons at both the inlets and outlets of the culverts.

5 Pavement Drainage

(a) In addition to the design requirements for pavement wearing surfaces in Table 10-1, pavement wearing surfaces must be modelled for a 1 in 100 year ARI event to assess and determine flow levels and to ensure that at least one traffic lane is trafficable in each direction on The Northern Road in the 100 year ARI storm event.

(b) Bridge drainage must be connected to the pavement drainage system.

(c) The pavement drainage system must be designed to collect all pavement water.

(d) Pavement drainage must be designed to prevent concentrations of water and long surface flow paths on pavements in superelevated and superelevation transition areas.

(e) Pavement wearing surface flows must be modelled through each superelevation transition.

(f) Pavement wearing surfaces on the Main Carriageway and Other Roads must be designed so that for the 50 mm per hour rainfall design event:

  (i) water depths in the through lanes at any point on the pavement must be less than 4 millimetres;

  (ii) the water depths at any point on the pavement wearing surfaces are not greater than 4 mm on the travel lanes, at intersections and on auxiliary lanes on the approaches to interchanges and intersections; and

  (iii) changes in the depth of flow at any point on the pavement wearing surfaces must not increase at a rate greater than 0.4 mm/m.

(g) A macrotexture depth of 0.5 mm must be used for modelling of water depths for all concrete and asphaltic pavement surfaces. The macrotexture depth for spray sealed surfaces must be determined for each spray seal design used.

(h) Verge crossfalls:

  (i) must be:

    A. where the adjacent carriageway has 3% normal crossfall, at least 5%; and

    B. where the adjacent carriageway has 3% adverse crossfall, at least 3%;

  (ii) nearside and offside verges must be sealed from the edge of the shoulder to beyond the hinge point;

  (iii) verges must be constructed in accordance with RMS D&C R49;

  (iv) batters must be protected during construction with a temporary berm and temporary batter chutes until the batter has vegetated sufficiently to prevent the occurrence of rill erosion;

  (v) dirty water from pavements must not be mixed with clean water flowing through transverse structures.

6 Drainage System

The design of drainage pipes and pipe systems must:

(a) comply with the requirements of specification RMS D&C R11;

(b) comply with the pipe classifications in AS 4058 and pipe installation type requirements in AS 3725, with installation types of no lesser requirement than HS3;

(c) consider and address the impacts of all soil conditions, including PASS and ASS;

(d) consider, address and provide details on inlet and outlet treatments;

(e) consider and address the impacts of blockages in transverse drainage and allow for a minimum of 50% blockage in cross drainage transverse pipes that are less than or equal to 600 mm diameter or box culverts that are less than or equal to 600 mm in height;

(f) provide a minimum clearance of 300 mm from the tops of pipes and box culverts to the underside of the selected material zone;

(g) provide drainage pipe and pit depths that enable the connection of subsoil drainage systems to the drainage pits;

(h) use spigot and socket type pipes with rubber ring seals;

(i) use pipes with a minimum 375 mm diameter for longitudinal drainage pipes and a minimum 450 mm diameter for transverse drainage pipes, where the terms "longitudinal" and "transverse" in this subsection (i) mean parallel to and across the travel flow directions on the road alignment, repectively, and the term "transverse drainage pipes" in this subsection (i) includes all pipes in the cross drainage and pavement drainage systems;

(j) The design of the longitudinal pipe and pit drainage networks must incorporate a 20% blockage factor for drainage inlet pits on grade and 50% blockage factor for drainage inlet pits in sag;

(k) The drainage system must be designed is that a minimum amount of water flows across the bridge deck joints. The flow width across a deck joint must not exceed 1.0 m in a 20 year ARI storm event;

(l) provide pipe classes and cover requirements suitable for construction traffic and staging conditions;

(m) Grated trench drainage systems or longitudinal slotted drains are permitted on the surface road network, provided the system can be demonstrated to be fit for purpose and satisfies RMS maintenance requirements. The longitudinal slotted drain must be located away from the design vehicle wheel paths (including cycle wheel paths). Longitudinal slotted drains must not present a hazard to cyclists or be located so as to cause a cycle wheel to be deflected by or enter a slotted drain aperture. Any removable grate system needs to be secured by bolts or other fasteners such that it cannot come loose when traversed be vehicles.

(n) not increase the peak discharge into the existing drainage network by more than 3% at the Site extents. If the Contractor connects any element of the Project Works to the existing drainage network and proposes to increase the peak discharge by more than 3%, the Contractor must ensure that downstream capacities of existing pits and pipes are sufficient to avoid any surcharging of the existing drainage network;

(o) be at a depth to provide for connection of subsoil drainage systems and provide separation of the two systems other than at outlet connections;

(p) consider, address and provide details on inlet and outlet treatments, including inlet and outlet velocities and Froude Number. Inlet and outlet lining treatments must include a description, length, width and depth of the treatment;

(q) where box culvert systems are 20.0m or more in internal length, the minimum clear height shall be 1.5m with suitable access for maintenance;

(r) provide a minimum desirable pipe grade of 1% and an absolute minimum pipe grade of 0.5%;

(s) limit the maximum velocity of water in pipes to less than or equal to 6.0m/s except where marine grade reinforced concrete pipes are used, in which case the maximum velocity of water in pipes shall be limited to less than or equal to 8.0m/s;

(t) provide a maximum desirable pit spacing of 60m and an absolute maximum pit spacing of 120m;

(u) provide a minimum freeboard at pits of 150mm;

(v) provide box culverts that comply with the requirements of AS 1597.1 – 2010 and AS 1597.2 – 2010;

(w) not include steel culverts or box culverts with precast concrete invert slabs;

(x) where new drainage elements abuts or adjoins existing or retained infrastructure elements, the existing structure shall be inspected, recorded and reported as to its adequacy, structural integrity and ongoing fit-for use to achieve the design standards outlined within Appendix 7 of the SWTC.

7 Subsurface Drainage

(a) The drainage infrastructure must be designed and constructed to comply with the typical cross sections and standard details contained in "RMS Standard Drawings – Pavements" including the "RMS Typical Pavement Cross Sections and Standard Subsurface Drainage Details (Volumes 1 to 6)". The typical cross sections and standard details contained in "RMS Typical Pavement Cross Sections and Standard Subsurface Drainage Details (Volumes 1 to 6)" are minimum requirements.

(b) Notwithstanding section 10(a) above, the Contractor may develop the typical cross sections and standard details contained in "RMS Typical Pavement Cross Sections and Standard Subsurface Drainage Details (Volumes 1 to 6)" to address project specific requirements and constraints.

(c) No change is to be made by the Contractor in the development of the typical cross sections and standard details contained in "RMS Typical Pavement Cross Sections and Standard Subsurface Drainage Details (Volumes 1 to 6)" to address project specific requirements and constraints that would:

(i) reduce the level of subsurface drainage performace;

(ii) modify the drainage paths identified in the typical cross sections and standard details;

(iii) provide less drainage capacity than indentified in the typical cross sections and standard details;

(iv) increase safety risks and hazards; or

(v) increase the level of maintenance required for pavements during the Design Life of the pavements.

(d) The subsurface drainage design must ensure the road formations and pavements are maintained in a relatively constant moisture condition and to provide for structural adequacy and uniformity.

(e) Subsurface drainage must be provided in all cuttings and shallow embankments, including false cuttings such as earth mounds.

(f) Subsurface drainage must be provided in fills where verge material is less permeable than the adjacent pavement layers.

(g) Trench drains must be provided on each side of the pavement on each carriageway in all cuttings. Except as required by section 7(f) of this Appendix 10, the inverts of trench drains must be the deepest of:

(i) 500mm below the designed cutting floor level;

(ii) 150mm below the ripped and loosened material in the cutting foundation; or

(iii) 200mm below the cutting foundation level.

(h) Subsurface drainage must comply with the following requirements:

(i) All pavements located in cuttings and false cuttings formed by earth mounds must have a trench drain with a 100 millimetre diameter perforated pipe installed on each side of the pavement. The trench drains must be installed to a minimum of 300 millimetres below the design floor level of the cutting and must be designed to drain the pavement and to intercept seepage from the cutting;

(ii) Rock cuttings and wet cuttings must be assessed by a qualified geotechnical engineer to determine the requirements for a drainage blanket as part of the subsurface drainage system. A drainage blanket must be provided if there is an existing drainage blanket. The drainage blanket must discharge into trench drains installed to a minimum depth of 150 millimetres below the underside of the drainage blanket. Outlets to the trench drains must be detailed in the Design Documentation;

(iii) The subsurface must be designed to drain pavement and to intercept seepage from cuttings and other ground water sources;

(iv) Foundation treatments in cuttings (including the need for drainage layers) must be assessed and designed in accordance with RMS Austroads Guide Supplement to Austroads Guide to Pavement Technology Part 2: Pavement Structural Design Version 2.2 – 2015. Where shale or siltstone is encountered in the floor of a cutting it must be treated as soft and expansive subgrade in accordance with section 3.14 and section 5 of RMS Austroads Guide Supplement to Austroads Guide to Pavement Technology Part 2: Pavement Structural Design Version 2.2 – 2015;

(v) Subsurface drainage must be provided in fill earthworks where material, including but not limited to landscaping and erosion control measures, placed adjacent to pavement layers and Select material Zone (SMZ) is less permeable than the adjacent pavement and SMZ layers;

(vi) Subsurface drains must be provided with a minimum clearance of 200mm to any other subsequently constructed item including, but not limited to safety barriers and utilities;

(vii) Subsurface drainage of bridge approach slabs must be incorporated in the pavement subsurface drainage system;

(viii) At points of superelevation change, trench and edge drains must be extended to the point where a 2% crossfall is developed; and

(ix) The subsurface drainage system is to be separated from the stormwater drainage system other than at outlet connections.

(i) In wet cuttings or in cuttings where the floor of the cutting is rock with an unconfined compressive strength greater than 6MPa, the subsurface drainage must include a drainage layer beneath the selected material zone. For the avoidance of doubt, a wet cutting is defined as a cutting where moisture is observed in the cut floors and/or batters during construction or where the geotechnical logs and/or groundwater monitoring data indicates the presence of water at or above the foundation level of the cutting. The drainage layer must:

(i) comply with requirements for Type C5 treatment of RMS R44;

(ii) be designed to be structurally sound, have adequate drainage capacity and to act as a filter to limit migration of fines from either the subgrade or selected material zones into the free draining rock layer;

(iii) be provided with transverse trench drains, where necessary, to intercept longitudinal flows. Where longitudinal grades are greater than 3%, transverse trench drains must be provided at a maximum spacing of 100m; and

(iv) discharge into trench drains installed to the depths required by section 7(e) of this Appendix B.7 and with a minimum cross sectional area of 0.25 m^2. Outlets for the trench drains must be detailed on the drawings in the Design Documentation.

(j) In cuttings that do not require a drainage layer in accordance with section 5(g) and where the floor of the cutting is rock with an unconfined compressive strength between 2MPa and 6MPa (inclusive), the subsurface drainage must include transverse trench drains provided at a maximum spacing of 50m. The transverse trench drains must be connected to the longitudinal trench drains provided in accordance with subsection (e) above.

(k) Edge drains must be provided on the low side of all rigid pavements to drain the interface between the base and subbase pavement layers. The edge drains may be connected to trench drains to facilitate removal of water. Edge drain outlets must be spaced no greater 80m apart.

(l) Pavement interface drains must be provided at all interfaces between different pavement types, including interfaces with existing pavements.

(m) Intra-pavement drainage must be provided in accordance with RMS D&C R37 (in conjunction with trench drains) to drain water from pavements layers on steep grades and sag curves where water flows are likely to be more parallel than transverse to the road alignment. Intra-pavement drains must also be provided at pavement interface joints where a less permeable pavement is downhill of an adjacent more permeable pavement or otherwise where there is a need to relieve moisture build-up at interface joints between different pavement types.

8 Temporary Drainage

(a) Longitudinal Drainage systems used in Temporary Works must be designed to the same criteria specified in this Appendix 10 for the greater of, a minimum 2 year ARI event or twice the expected construction time in years, except that the requirements of section 7.14(b) of the SWTC must also be met.

(b) All temporary drainage systems must satisfy the requirements of all relevant authorities.

9 Discharge into Council's Stormwater Drainage System

(a) Any new or increased stormwater discharge into Penrith City Council's stormwater drainage system must be approved by Penrith City Council.

(b) Requirements for operational water quality devices, detention basins and any gross pollutant traps must comply with Penrith City Council's maintenance requirements.

(c) Any stormwater detention basins or tanks that are required to comply with the Council's requirements must be designed and analysed for 2, 10, 20 and 100 year ARI storm events.

(d) All stormwater drainage basins must be designed with a Gross Pollutant Trap (GPT) upstream of all stormwater detention devices or basins that capture pollutants for a 1 year ARI event as listed in Table 10-4 (Annual Average Load Reduction). GPTs installed must:

(i) outlet into a basin where the invert of the outlet is at least at or above the basin spillway level; and

(ii) include a hardstand area for maintenance vehicle access.

10 Flooding

(a) The drainage works must be designed to minimise changes to existing flooding characteristics for flood events up to and including the 100 year ARI, and must not increase upstream/downstream inundation levels at the site boundary.

(b) The Project Works and Temporary Works must be designed such that the potential for flooding of any other property is not increased by the presence of the Project Works or the Temporary Works at the site boundary.

(c) The sensitivity of the drainage design to rainfall intensity increase as a result of climate change is to be quantified. Rainfall intensity increases of 10%shall be assessed.

(d) Transverse drainage must be designed to provide:

(i) Minimum 100 year ARI flood immunity to The Northern Road;

(ii) Maintain existing flood immunity to the local roads;

(iii) Maintain existing flood immunity to surrounding property.

(e) Where surcharge of a culvert is possible for a 100 year ARI event or less, the culvert inlet and surrounding inlet and outlet embankment must be designed for stability, piping failure and scour protection to accommodate the surcharge flow without damage to road embankment.

(f) The design of the culvert at chainage 40 (‘C40’) will need to comply with both the interim conditions when only TNR 3 (North) is constructed, and the ultimate conditions when both TNR 3 (North) and TNR 3 (South) are complete

(g) The existing culvert across Glenmore Parkway is to be designed to provide hydraulic capacity at least equal to its existing capacity.

(h) A peak flow of 35m3/s during a 100 year ARI flood event is to be assumed to combine with the outlet flows of the drainage easement at approximately Point 178 (as listed under the column titled “Point” in Appendix 2 (Site, Local Road Works Areas and Temporary Works Areas), section 1 (General), Table 2-2 (List of Site Boundary Coordinates)).

10.1 Interim Conditions

(a) The existing culvert south of the proposed culvert at C40 will contribute overflows to the culvert at C40 in the interim condition when only TNR 3 (North) is completed.

(b) The flood level increase upstream of the culvert at C40 under the interim conditions is to be no greater than 240mm and must not impact any existing dwellings.

(c) The flood immunity for The Northern Road in interim conditions must provide immunity against at least a 50 year ARI event.

(d) The registered drainage easement downstream of the culvert at C40 must be upgraded to completely contain flows under the interim conditions.

10.2 Ultimate Conditions

(a) The existing culvert south of the proposed culvert at C40 will be designed for the 100 year ARI event for the catchment directly contributing to that culvert with no bypass to the culvert at C40 in the future (ultimate conditions).

(b) The culvert at C40 is to be designed to ensure it has capacity for the 100 year ARI event for the catchment directly contributing to that culvert.

11 Scour Protection

(a) Scour protection must be provided in all areas susceptible to scouring, including, as a minimum, at upstream and downstream ends of drainage structures, batters and bridge abutments.

(b) Permanent scour protection must be designed as a flexible and adaptive measure to minimise maintenance requirements over a 50 year Design Life. The scour protection must be designed for a 50 year ARI event in accordance with RMS D&C G38.

(c) Temporary scour protection must, as a minimum, be designed for a 20 year ARI event in accordance with RMS D&C G38.

(d) Scour protection for waterway areas must be designed in consultation with the relevant Authorities and must address fauna access and fish friendly and passage requirements for water crossings.

(e) Where pipe culverts are laid on steep grades to match existing steep creek alignments, energy dissipaters must be provided to reduce flow velocities and protect against scour.

12 Water Quality Treatment Measures

12.1 Construction phase sediment basins

(a) The design of temporary sediment basins must comply with the requirements of *'Managing Urban Stormwater : Soils and Construction, Volume 1, 2004 and Volume 2D,2008 Main Road Construction', and RMS G38.*

(b) At locations where sediment basins are required but cannot be provided due to boundary constraints, the Contractor's Erosion and Sediment Controls Plans must contain additional controls to adequately mitigate against any potential impacts on downstream waterways or Council's drainage systems.

12.2 Operational phase water quality controls

(a) The design must include operational water quality controls that consist of swales, water quality basins or constructed wetlands to remove pollutants from road pavement surface runoff prior to discharge into environmentally sensitive areas that have been identified in the Environmental Documents. Gross Pollutant Traps (GPT) must be incorporated upstream of all stormwater detention devices or basins to screen inlet flows. Capture of gross pollutants/litter must achieve the load reduction listed in Table 10-4 (Annual Average Load Reduction).

(b) The design of water quality controls located upstream of the environmentally sensitive areas must achieve the water quality targets outlined in Table 10-4.

Table 10-4 Annual Average Load Reductions

Pollutant	Annual Average Load Reduction
Gross Pollutants/Litter (>50mm)	80%
Total Suspended Solids	80%
Total Phosphorus	45%

(c) The pollution load reductions must be demonstrated using appropriate water quality modelling, such as the latest version of the eWater MUSIC model, with all assumptions, inputs and results provided in the Design Documentation.

Exhibit A –

Scope of Works and Technical Criteria

Appendix 11 – Geotechnical Performance and Design Requirements

for

Design and Construction

Western Sydney Infrastructure Plan -The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

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Document Author: Roads & Maritime Services

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Table of Contents

1 Cuttings

(a) The geotechnical design must consider and address all the issues that will affect or be affected by the cuttings during the construction and operation, and over the design life of the Project Works, including, but not limited to:

(i) cutting heights and stability;

(ii) slopes adjacent to cuttings;

(iii) the presence of landslides including the existence of landslide debris;

(iv) weathering (both on the cutting surface and at depth);

(v) fracturing, slippage and rock falls;

(vi) repair provisions;

(vii) erosion, scour and scour protection;

(viii) maintenance requirements and access provisions;

(ix) drainage;

(x) traffic loads;

(xi) springs and groundwater (including stability of cuttings, water quality, drawdown effects, impacts on water resources and ground water recharge; and

(xii) traffic safety.

(b) The geotechnical design of cuttings must address:

(i) the impacts of subsurface conditions on the design of cutting batters and benches, including considerations and measures to minimise exposure of cutting batters to weathering, and the treatment of benches;

(ii) proposed cutting batter treatments, including the treatment of weathered and fractured zones;

(iii) the impacts of groundwater and springs on cutting batters and cutting floor treatments;

(iv) the impacts of the cutting floor properties on pavement support, including the identification and treatment of swelling clays;

(v) drainage around, into, within and out of the cuttings;

(vi) the construction techniques and resources required to excavate cuttings and subgrades to design lines and to prevent damage to in-situ remaining materials;

(vii) intervention levels and procedures for maintenance and repair of cutting batters;

(viii) access provisions for maintenance and the repair of cutting batters and drainage structures. Access must be provided to the final cutting batters for plant and equipment to enable the ready installation of any treatment measures which may become necessary and to facilitate the inspection of the faces of the cutting batters; and

(ix) measures and precautions required to keep drainage water from becoming contaminated.

(c) Cutting batters must be designed:

(i) for the overall cutting batter to be stable with no foreseeable possibility of a failure involving the whole slope or a major part of it;

(ii) so that material which may become detached from the batter face is prevented from reaching the road shoulder;

(iii) to comply with all requirements specified in Section 3.6 of Appendix 13 (Structural Performance and Design Requirements) of the SWTC;

(iv) to comply with landscaping and urban design requirements of Section 7.1(b) of Appendix 15 (Urban Design Performance and Design Requirements) of the SWTC.

(d) Benches must be provided on cut batter slopes to restrict the length of unbroken batter faces and to minimise erosion of soil and weathered materials. Bench widths on cutting batters must be designed to provide safe access for maintenance and maintenance plant items and to control water flows and runoff.

(e) Benches in cuttings in rock must be provided with a minimum 100mm thick concrete lining that extends, as a minimum, 100mm up the rock cutting batter slope above the bench. Each end of the concrete lining must be connected to a minimum 1m wide concrete lined drain that extends from the end of the bench to the toe of the slope and discharges into the drainage system.

(f) Benches on cutting batters must comply with the spacing and width requirements in Table 11-1:

Table 11-1 Bench Requirements on Cutting Batters

Batter Slope	Vertical Height of Batter	Bench Width
Steeper than 2:1 H:V	Maximum 7 m	Minimum 4.0 m
2:1 H:V or flatter	Maximum 10 m	Minimum 4.0 m

(g) Cutting batter designs must include:

(i) details on the rationale for selection and application of batter protection for:

A. soft seams;

B. shattered, fractured or jointed rock;

C. degradable, weathered or low strength rock;

D. soil material; and

E. stress release in rock cuts.

(ii) a schedule of estimated quantities for the various cutting batter protection systems; and

(iii) details on drainage provisions.

(h) Cutting batter designs must detail the required surface condition and roughness of cut batters and include:

   (i) details on measures to control water flow and runoff and to minimise erosion of soil and weathered materials; and

   (ii) methodologies to apply and retain topsoil and seed.

(i) Cutting batter designs must detail measures to prevent erosion of material from the seams in cuttings that are prone to rapid weathering.

(j) Except for transitions at the ends of cuttings, the slopes of cutting batters must not lie between 0.75:1 H:V and 1.5:1 H:V.

(k) A rock catch fence must be provided on the lowest bench in cuttings where the batter above the lowest bench is steeper than 1.5H:1V. Rock catch fences must not be installed in the verge or shoulder at the toe of cuttings.

(l) Cutting batters must be laid back and curved at the ends, for a minimum 50 m length, to reflect the influence of the subsurface profile and to blend in with adjacent slopes while still allowing access to benches for maintenance.

(m) The Contractor must undertake a survey of the completed batters within 4 weeks of the completion of construction of the adjacent section of pavement and provide a baseline batter profile to monitor batter profile changes against.

(n) In rock cuttings, presplitting or line drilling must be used to provide a neat and stable batter surface and cutting excavation.

(o) All batter slopes of 2H: 1V and flatter must be topsoiled and vegetated in accordance with Appendix 15 (Urban Design Performance and Design Requirements) of the SWTC. Maintenance of vegetation on slopes steeper than 3H:1V must be accounted for and documented by the Contractor in Appendix 31 (Contractor's Urban and Landscape Design) of the SWTC.

(p) Cutting batters must be designed so that localised deviations, movements and changes in the batter surfaces, over any area of less than 10 m2, do not exceed the limits detailed in Table 11-2 during the Design Life of the batters.

Table 11-2 Cutting Batter Limits

Year After the Date of Construction Completion	Limit of localised deviations, movements and changes in batter surfaces (relative to the baseline batter profile)
1	100mm
2	125mm
3	150mm
4	175mm
10	200mm
100	300mm

2 Embankments

(a) The geotechnical design must consider and address all the issues that will affect or be affected by the embankments during the construction and operation, and over the design life of the Project Works, including, but not limited to:

(i) embankment heights and stability;

(ii) slopes/structures adjacent to embankments;

(iii) springs and groundwater impacts;

(iv) embankment foundation conditions and settlements;

(v) embankment foundations and drainage on side slopes and cut to fill transitions;

(vi) materials and internal compression;

(vii) moisture conditions;

(viii) erosion, scour and scour protection;

(ix) maintenance requirements;

(x) construction loads;

(xi) traffic loads; and

(xii) surface drainage.

(b) The geotechnical design of embankments must address:

(i) batters and benches;

(ii) the settlement and lateral deformation of embankments, foundations and structures, including predictions of:

A. Total Settlement which is defined as the total amount of settlement of the embankment, at any location on the embankment, that occurs in the period from the commencement of embankment construction until the date which is the minimum Design Life of the pavement (as specified in Table 5.1 of the SWTC) after the Date of Construction Completion;

B. **Total Residual Settlement** which is defined as the total amount of settlement of the pavement, at any location on the pavement surface, that occurs in the period from the completion of pavement construction until the date which is the minimum Design Life of the pavement (as specified in Table 5.1 of the SWTC) after the Date of Construction Completion;

C. **Differential Settlement** which is defined as the total change in grade of the pavement over any distance, at any location on the pavement surface, that occurs in the period from the completion of pavement construction until the date which is the minimum Design Life of the pavement (as specified in Table 5.1 of the SWTC) after the Date of Construction Completion; and

D. Lateral deformation of embankments and foundations at the interface with all structures affected by embankments, including:

1. total lateral deformation which is defined as the total amount of lateral movement of the embankment or foundation, at the affected structure, that occurs in the period from the commencement of embankment construction until the date which is the minimum Design Life of the structure (as specified in Table 5.1 of the SWTC) after the Date of Construction Completion; and

2. total residual lateral deformation which is defined as the total amount of lateral movement of the embankment or foundation, at the affected structure, that occurs in the period from the commencement of structure construction until the date which is the minimum Design Life of the structure (as specified in Table 5.1 of the SWTC) after the Date of Construction Completion.

(iii) the assessment of options for limiting or accelerating settlement;

(iv) the methodology for verifying that predicted Total Residual Settlement, predicted Differential Settlements and predicted lateral deformations meet the requirements of this Appendix, and the process for regularly providing and updating the results of the implementation of this methodology to RMS;

(v) the stability of embankment foundations including requirements to key into side slopes and at cut to fill transitions, dewatering, drainage and pore pressure relief;

(vi) the methodology for monitoring and validation of ground movement, including settlements and lateral movements;

(vii) the impacts of embankment materials and embankment pore pressures;

(viii) surface, subsurface and batter drainage, including where embankments are designed to settle, measures and methodologies proposed to maintain drainage capacities and efficiencies;

(ix) erosion and scour protection and stabilisation;

(x) intervention levels for maintenance and / or repair activities; and

(xi) access provisions for maintenance and repair activities.

(c) Embankments must be designed:

(i) to be globally and locally stable with no foreseeable possibility of a failure involving the whole embankment or a major part of the embankment and must satisfy all requirements specified in Section 3.6 of Appendix 13 (Structural Performance and Design Requirements) of the SWTC. The design must detail the proposed methods for the treatment of all embankment foundations;

(ii) to limit post construction movements;

(iii) Not used;

(iv) to include measures to ensure that scour and erosion of embankment batters is minimised and / or that batters are protected;

(v) to provide batter slopes of 4H:1V or flatter on embankments up to and including 1.5m in height and to provide batter slopes of 2H:1V or flatter on all embankments greater than 1.5m in height, except where specific treatments are used. RMS will consider reducing this requirement subject to boundary constraints, property impacts and Local Council requirements.

(vi) except for rockfill batters or on rock-faced embankment batters, to provide benches on all embankment batters in accordance with the requirements of Table 11-3. The benches must be designed to satisfy the requirements of the proposed maintenance methodology;

Table 11-3 Bench Requirements on Embankment Batters

Batter Slope	Vertical Height of Batter	Bench Width
Steeper than 2:1 H:V	Maximum 7 m	Minimum 4.0m
2:1 H:V or flatter	Maximum 10 m	Minimum 4.0m

(vii) to have benches a minimum of 4.0 metres wide and to accommodate and provide safe access for maintenance and maintenance plant items; and

(viii) subject to Sections 2(d) and 2(e) below, to limit level changes in the pavements, including all those resulting from the settlements of the embankment foundations and changes in moisture and internal compression within the embankments:

A. to no increases after the construction of the pavements;

B. to decreases following the construction of the pavements of a maximum of 10 mm over any twelve month period; and

C. to levels that generate differential settlements, in any direction, of a maximum of 0.3%.

(d) **Compressible Foundation Materials** are defined as foundation materials below embankments where the requirements of Section 2(c)(viii) above cannot be met without the application of specific foundation improvement techniques. The use of preloads and / or surcharges to manage settlement and to limit level changes in embankments and pavements are specific foundation improvement techniques. The design of embankments and pavements above Compressible Foundation Materials must:

(i) include a strategy that optimises the pavement types and the maintenance strategy with the proposed embankment foundation improvement techniques and the predicted Total Residual Settlements; and

(ii) comply with requirements of Section 2(e).

(e) Bridge approach embankments, bridge approach slabs, Main Carriageway embankments and Main Carriageway pavements above Compressible Foundation Materials must be designed to comply with the performance requirements of the deed, including pavement drainage, road geometry and ride quality, and must:

(i) except as required by Section 2(e)(ii) below, limit the Total Residual Settlements as defined in Section 2(b)(ii)B to a maximum of 100mm for concrete pavements and 200mm for flexible pavements;

(ii) limit the Total Residual Settlements within 20m of bridge abutments to a maximum of 50mm;

(iii) limit the Differential Settlements as defined in Section 2(b)(ii)C, in any direction, to a maximum of 0.3% for concrete pavements and 0.5% for flexible pavements;

(iv) provide a smooth pavement transition between the settlement at any bridge approach slab and the settlement 20 m from the bridge approach slab; and

(v) where the length of pavement, including any bridge approach slab, above Compressible Foundation Materials in any location is less than 50 m, limit the Differential Settlements, in any direction, to a maximum of 0.3% and limit the Total Residual Settlements to a maximum of 50mm.

(f) The Design Documentation must include a monitoring plan (or framework) that details monitoring of the settlement of all embankments and pavements above Compressible Foundation Materials from the commencement of their construction and must use the monitoring data to review, confirm and amend, where necessary, the settlement predictions in the Design Documentation. Main Carriageway pavement construction above Compressible Foundation Materials must not commence until the:

(i) monitoring confirms that the predicted Total Residual Settlements and predicted Differential Settlements will comply with the requirements of Section 2(e) of this Appendix; and

(ii) the Project Verifier has released a Hold Point certifying compliance with the requirements of Section 2(f)(i) of this Appendix.

(g) Monitoring of the settlements of the embankments and pavements above Compressible Foundation Materials must be undertaken using instrumentation to measure the deformation of the embankments and pavements. Instrumentation must be provided at spacing intervals of less than 100 metres along the embankment axis and within 10 metres of structures. Instrumentation monitoring at each location must include:

(i) where predicted Total Settlement exceeds 100mm and/or predicted Total Residual Settlement exceeds 50mm, instrumentation to measure internal settlement, external settlement, pore water pressure and lateral movement, including at least three settlement plates and a horizontal profile gauge (HPG); or

(ii) where predicted Total Settlement is less than or equal to 100mm and predicted Total Residual Settlement is less than or equal to 50 mm, instrumentation to measure external settlement, including at least three settlement plates.

(h) In addition to the requirements of Section 2(g) above, the contractor must install survey measurement pins:

(i) at 10 m intervals along the edge lines of the Main Carriageway within 100m of bridge abutments; and

(ii) at each location where settlement plates are installed in accordance with Section 2(g) above.

(i) The Contractor must complete baseline surveys and measurements within 4 weeks of the completion of construction of the pavement above Compressible Foundation Materials and provide the results to RMS in a database in a form acceptable to the RMS

Representative. Survey and measurements must be undertaken thereafter at 6 monthly intervals until the Date of Construction Completion.

(j) Except for settlement plates, other instrumentation installed for monitoring of the settlements of the embankments and pavements above Compressible Foundation Materials in accordance with Sections 2(g) and 2(h) above must be maintained by the Contractor until the Date of Construction Completion. Prior to the Date of Construction Completion the Contractor must provide RMS with an up to date database containing monitoring results from instrumentation installed for monitoring of the settlements of the embankments and pavements above Compressible Foundation Materials.

(k) The Contractor must include in the Design Documentation all calculations associated with embankment stability and settlement, including those associated with the assessment of options for limiting or accelerating settlement and predictions of:

(i) Total Settlement;

(ii) Total Residual Settlement;

(iii) Differential Settlement; and

(iv) lateral deformations.

3 Structures

(a) Geotechnical studies for structures must be undertaken in accordance with Section 4.2 of Appendix 13 (Structural Performance and Design Requirements) of the SWTC.

4 Foundations of Structures

4.1 Design Requirements

The geotechnical study for geotechnical structures and their foundation design must provide and assess the following:

(a) Geotechnical structures and their foundations including bridges, culverts, retaining walls and other structures must be designed and constructed in accordance with AS5100.

(b) Be sufficient to identify and provide all the information required to design, construct and maintain each new structure and to preserve and protect existing structures.

(c) Encompass the structural adequacy, long term deformation and durability of the foundation, including the effects of the placement of fill in embankments near or adjacent to structures.

(d) Predict the insitu ground movement, structural movement and groundwater movement.

(a) Identify any aggressive ground or water conditions that may be potentially harmful for foundation and structural elements to achieve the required design life.

(b) Include sufficient surface drainage on the soil and soil-supporting structures to capture and discharge appropriately to avoid soil erosion. The drainage system should be designed to be self-cleaning with minimum maintenance.

(c) Where the soil and soil supporting structures are susceptible to damage by tree root actions, the design must eliminate the growth of such trees within the active zone of the structures.

(d) For each structure site, a separate geotechnical investigation report must be provided as part of the design documentation in accordance with Chief Bridge Engineer Circular, CBE 2000/09. The geotechnical investigation report must be prepared by a RMS recognised geotechnical and foundation expert and must contain assessment of foundation conditions, design criteria, design calculations, geotechnical models, and recommendations of design parameters for the design of foundations for geotechnical structures. The design strength parameters of soil and rock must be characteristic values as defined in AS5100.3.

(e) Instead of providing a separate geotechnical investigation report for each structure site, the geotechnical investigation report for each bridge site may be included as part of the bridge design report. The cover sheet of the bridgework set of drawings in the Design Documentation must cross reference the geotechnical investigation report.

4.2 Pile Foundation Analysis and Design

The pile foundation design report must list the design elements logically, including but not limited to:

(a) Calculation of Relevant Structural Loadings

These must be under both serviceability and ultimate limit state load conditions. The Contractor must comply with AS 5100-Part 2 for the calculation of design loads.

(b) Geotechnical Model

A geotechnical model at a foundation site is to be developed based on all available site investigations, field and laboratory tests. Both longitudinal models and cross-sectional models are to be developed encompassing all local investigations.

(c) Selection of Pile Type

The Contractor should nominate the most suitable pile type with due cognisance to the site conditions and the superstructure. The Contractor should consider a number of options and decide on the most economical option viable to satisfy the project requirements.

(d) Calculation of Pile Ultimate Capacity

For the nominated type of pile(s) and the available geological information, determine the ultimate geotechnical capacity for vertical load of a single isolated pile R_{ug} in the nomenclature of AS 5100, and $R_{d.ug}$ and AS 2159 -2009 (the Australian Piling Code). The appropriate value of $Ö_g$ can be calculated in accordance with AS 2159.

(e) Trial Pile or Pile Group Geometry

With consideration of the ultimate limit state design loads, the Contractor should recommend a suitable pile arrangement (unless agreed and specified by the Structural Engineers).

(f) Analysis of Pile or Pile Group

The Contractor must analyse the pile or pile group for the worst combination of ultimate limit state loads to assess pile structural actions. Subsequently, the Contractor must analyse the pile or pile group under serviceability load cases to assess expected deflections.

(g) Verification of Pile Cap Deflections under Serviceability Limit State

The Contractor must check calculated deflections under serviceability loads against allowable values. The Contractor must also consider the likelihood of differential settlements for the structure both longitudinally and transversely.

(h) Structural Assessment on Pile and Pile/Pile Cap Connection for Calculated Loads

The Contractor should provide their worst combination of calculated pile loads to assess the structural strength of the pile and to ensure that the piles can withstand the ultimate loads. Due consideration should be given to column effects for the piles that are to be subjected to scour or those which extend from the ground surface level to the crosshead level.

(i) Structural Design of Pile Cap

The Contractor should provide the worst combination of ultimate limit state pile loads obtained from analysis to the Structural Engineer to enable the structural design of the pile cap.

(j) Driveability Assessment of Pile – Driven Piles

Where driven piles are being considered, the Contractor must ascertain whether the piles can be driven and tested to ensure that the required ultimate geotechnical axial compression can be achieved for the proposed piling equipment.

(k) Pile Tests

For piles other than driven preformed piles, consideration should also be given to the need for pile testing to confirm pile capacity and/or integrity. Full details of the requirements for various types of pile load testing are given in AS 2159. Testing of bored cast-in-place concrete piles for integrity and geotechnical strength must comply with the requirements of Bridge Technical Direction BTD 2011/08.

(l) Other Considerations

In addition to the ultimate vertical load capacity of a pile(s) there are also a number of other vertical load effects that the Contractor must assess and discuss where applicable, such as design uplift capacity and, in relatively soft soils, potential negative friction and pile buckling.

4.3 Precast arch structures

(a) The design of precast arch structures must assess and address foundation stability, settlements, including differential settlements, and foundation treatment requirements.

(b) The design must also assess and address loads that will be induced during the construction of the precast arch structures, including varying staged backfill levels, and the effects of construction traffic.

4.4 Noise barrier design

(a) Noise barriers and support systems must comply with RMS D&C R271.

4.5 Other Considerations

(a) Type F safety barriers must not be used as a retaining structure.

(b) Where existing structures are affected, their stability and deformation must be assessed and documented, and where required, strengthening measures are to be designed to conform to the performance requirements of this Appendix.

(c) Unprotected gabion walls are not to be used within 4 m of the carriageway. The design must consider the need to restrict public access and prevent vandalism.

(d) The maximum deflection must be limited to 1/150 of the retaining wall height.

(e) The maximum foundation settlement must be limited to 50 mm for retaining walls.

5 Design Development

(a) Further to the requirements of clause 12.1(b) of the deed, and notwithstanding any conflicting requirements elsewhere in the SWTC, including the figures in Appendix 9 (Geometric Performance and Design Requirements), the Contractor must not provide cut and embankment batter slopes that are steeper than those detailed in the Concept Design in Appendix 30 (Contractor's Concept Design) of the SWTC. Any changes to batter slopes detailed in the Concept Design in Appendix 30 (Contractor's Concept Design)) of the SWTC must be made in accordance with the requirements of clause 12.1(b) of the deed. For the avoidance of doubt, the impact of increases in the slopes of batters reduces the durability and aesthetic value of batters and increases the maintenance costs of batters.

Transport
Roads & Maritime Services

Exhibit A –
Scope of Works and Technical Criteria
Appendix 12 – Pavement Performance Design Requirements
for

Design and Construction of

Western Sydney Infrastructure Plan – The Northern Road Upgrade Project – Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

November 2016

Document Author: Roads & Maritime Services

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About this document

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Table of Contents

1 General

(a) Pavements must be designed and constructed, as a minimum, to deliver the Design Lives required by section 5.5 of the SWTC, the performance requirements identified in the pavement maintenance diaries in this Appendix 12, the requirements of RMS D&C specifications and the other requirements of this Appendix 12.

(b) Design Documentation must include design calculations and methodologies and must include a separate developed maintenance diary for each Pavement Tag. Maintenance diaries must detail the proposed performance, maintenance, rehabilitation and reconstruction requirements for the full Design Life of each pavement.

(c) Pavement designs must include an assessment of durability of each pavement during the construction and maintenance of the pavements. This assessment must consider the impact of the insitu pavement layer strengths and layer thicknesses actually constructed. The Design Plan must include a methodology for the durability assessment.

(d) Where any pavement is used for traffic in any Temporary Works or opened to traffic for construction staging and traffic management, in other than the completed configuration, the traffic volumes specified for those pavements in this Appendix 12 must be increased by the volumes of traffic that will use the pavements for construction staging and traffic management in other than the completed configuration.

(e) Pavements must be designed and constructed and maintenance, rehabilitation and reconstruction treatments developed in the maintenance diaries to provide the pavement performance measures and conditions over the Design Life of the pavements required by section 5.5 of the SWTC.

(f) Single lane paving can only be used where it is not feasible to achieve multiple lane paving for construction of Main Carriageway through carriageways.

(g) Pavements on the Main Carriageway must comply with the performance measures and conditions detailed in Table 12-1. Pavement conditions must be determined by the methods of assessment detailed in Table 12-1.

(h) Bridge deck wearing surfaces, including bridge approach slabs, must comply with the design and performance requirements for pavement wearing surfaces in this Appendix 12. Roughness must be determined using RMS Test Method T187 with bridge joints addressed in accordance with clause 4.2.3(d) of RMS Test Method T187.

(i) The riding quality requirements of clause 4.4 of RMS D&C R121 or clause 4.5 of RMS D&C R116 apply to the bridge deck wearing surface on the Main Carriageway.

(j) The minimum designed pavement layer thicknesses must be adjusted as follows:

   (i) The design thickness of the critical layer for each pavement must be rounded up to the nearest 5 mm.

(ii) The construction tolerances as required by RMS Supplement to Austroads Part 2: Pavement Structural Design are to be added to the critical layer design thickness for each pavement.

(k) The total cover requirements over expansive subgrades must be determined in accordance with the "RMS Austroads Guide Supplement, Austroads Guide to Pavement Technology Part 2: Pavement Structural Design". For Other Roads the total cover requirements shall consist of an Impervious Capping Layer of 600mm as described in the "RMS Austroads Guide Supplement, Austroads Guide to Pavement Technology Part 2: Pavement Structural Design", and the designed pavement layers on top of the Impervious Capping Layer.

(l) Structural pavement and wearing surfaces layers must be provided for the full carriageway width, which includes all lanes, auxiliary lanes, shoulders, outside shoulders and median shoulders. In addition, the minimum pavement structural shoulder widths detailed in RMS Supplement to Austroads Part 2: Pavement Structural Design must be met by the design.

Table 12-1 Pavement Performance Measures and Conditions

Performance Measure		Pavement Condition at the Date of Construction Completion	Pavement Condition during Design Life	Method of Assessment
Roughness (IRI)		1.56 max	2.69 max	Equivalent measurement to International Roughness Index (IRI) roughness measured in all Main Carriageway lanes. Reported as reading for 100 m intervals - lengths <100m to be included in previous 100m length. (RMS Test Method T187).
Rutting (mm)		N/A	5 max	Multi-laser profilometer (using taut wire analogy) measured in all Main Carriageway lanes. Reported as average reading for 100m test intervals.
Skid Resistance		Skid resistance levels must exceed the investigatory skid resistance levels determined in accordance with "A guide for measurement and interpretation of skid resistance using SCRIM". (RMS Test Method T189).		
Texture depth (mm) where posted speeds are	Asphalt Wearing Surface	0.8 min	0.5 min	RTA Test Method T192, 1No Test of 10m randomly located every 100m of lane. An alternative test report, as approved by RMS, may be
	Concrete Wearing	0.45 min	0.35 min	

Performance Measure		Pavement Condition at the Date of Construction Completion	Pavement Condition during Design Life	Method of Assessment
greater than 80 km/h	Surface			more appropriate.

2 Pavement Reference Documents

(a) Pavement designs must comply with the following pavement related Reference Documents which, notwithstanding anything to the contrary in this SWTC, are listed in their order of precedence in the event of any inconsistency, ambiguity or discrepancy between them:

(i) “RMS Austroads Guide Supplement. Austroads Guide to Pavement Technology Part 2: Pavement Structural Design Version 2.2 (January 2015)”.

(ii) “CIRCLY - Geomechanics Computer Program Version 5” or later version.

(iii) RTA Rigid Pavements Standard Details Construction

A. “Steel Fibre Reinforced Concrete Pavement (SFCP) for Roundabouts.”

B. “Bicycle Path Design Drawing”

(iv) RMS Pavement Standard Drawings Asphalt

A. “Volume 1 – New Construction”

B. “Volume 2 – Maintenance”

(v) “RMS Standard Pavement Subsurface Drainage Details Volumes 1 to 6”

(vi) “RMS Pavements Standard Details Typical Pavement Profiles”

(vii) “Concrete Roundabout Pavements. A guide to their design and construction RTA March 2004” and Techncial Direction PTD2012/002 “Concrete roundabouts; surface texture”.

(viii) Austroads - "Guide to Pavement Technology. Part 2: Pavement Structural Design" (2012).

3 Pavement Wearing Surface

(a) The binder in asphalt wearing surfaces on the Main Carriageway, must be an A15E binder complying with RMS D&C 3252.

(b) Dense grade asphalt must not be provided as the wearing surface on the pavements where the design speed is greater than 90 km/h (Stone Mastic Asphalt (SMA) or Open Grade Asphalt (OGA) must otherwise be used).

(c) Concrete roundabouts must be provided with a lightly broomed and transverse tyned surface texture.

(d) Except as required to comply with the other requirements in this Appendix 12 of the SWTC, Other Road Works other than concrete surfacing must be provided with an asphalt wearing surface.

(e) Signalised intersections including approaches, vehicle braking and turning zones must be provided with A15E polymer modified binder asphalt wearing surfaces complying with RMS D&C 3252.

(f) As a requirement of the Southern Tie-in (refer Section 5.29, Scope of Works and Technical Criteria), the final wearing course shall not be placed between Chainage 0 and Chainage 150.

4 Pavement Design

(a) Flexible pavements for the Main Carriageway must be designed to comply with the following criteria:

(i) The minimum bound subbase layer thickness must be 170 mm.

(ii) Where a bound subbase is proposed the layer thickness to be no greater than 250mm.

(iii) The minimum lean mix concrete subbase layer thickness must be 150 mm.

(iv) The design modulus for subgrade materials (including capping layers, the upper zone of formation materials and selected subgrade material) must be not greater than 150 MPa.

(v) Asphalt modulus must be determined in accordance with section 6.5.3 of the "RMS Austroads Guide Supplement. Austroads Guide to Pavement Technology Part 2: Pavement Structural Design".

(vi) The nominal aggregate size of all asphalt pavement layers must be less than or equal to 20 mm.

(vii) A minimum 300 mm thickness of selected material zone, complying with the requirements of RMS D&C R44 must be provided beneath flexible pavements.

(viii) Not used;

(b) Rigid pavements on roundabouts must be designed to comply with the following criteria:

(i) The subbase must be lean mix concrete with a minimum thickness of 150mm.

(ii) A minimum 300mm thickness of selected material zone, complying with the requirements of RMS D&C R44, must be provided beneath the lean mix concrete subbase.

(iii) The jointing layout and structural design, including reinforcement, tiebars and dowels, must be in accordance with "RMS Pavements Standard Drawings – Rigid Pavement – Steel Fibre Reinforced Concrete Pavement (SFCP) for Rounndabouts".

(c) Not used.

(d) Pavements for the Other Roads must be designed to comply with the requirements of Penrith City Council (refer to Figure 1, under section 2.3.1, of the Scope of Works and Technical Criteria for the extend of 'Other Roads'), except for roundabouts located on Other Roads which must be design to comply with the following criteria:

(i) Roundabouts located on Other Roads must be designed to comply with the criteria for flexible or rigid pavements in section 4 (a) and (b) of this Appendix 12 only to the extent that these criteria relate to and are relevant to the type of pavement.

(ii) The selected material zone for roundabouts on Other Roads must be covered by a sprayed seal with a nominal aggregate size of 7 mm.

(iii) Not Used

(iv) Not used;

(v) Where Other Road traffic information is not available or sufficient, design traffic loadings for flexible and rigid pavements must be calculated using the axle group load distributions and the proportions of axle groups provided in Tables 12-3 and 12-4 of this Appendix 12.

5 Subsurface Drainage

(a) The subsurface drainage design must ensure that the pavement is maintained in a relatively constant moisture condition to ensure structural adequacy and uniformity. The design must be carried out in accordance with the Roads and Maritime model drawings and design reference documents, and the following criteria:

(i) A subsurface drainage system is to be provided for all pavements.

(ii) All subsurface drainage is to be drained into the stormwater drainage system.

(iii) Intercept ground water and/or springs that were identified from the geotechnical investigations.

(b) The longitudinal and transverse interfaces between existing and new pavements must have interface subsurface drainage, when the pavements are different in composition (layer types and thicknesses). Where the widening is less than a single lane width and the pavement type for the widening is the same as the existing, the longitudinal joint between the widening and existing pavement is to be constructed such that the layers are 'stepped' in 150 mm increments and an interface drain will not be required. Where different pavement types are proposed for a widening then an interface drain must be provided.

6 Pavement Drawings

Pavement design drawings are to include, but not be limited to:

(a) Diagrammatic representation of each pavement type with full layer (including inter layer) descriptions. For example, for an asphalt pavement, show the mix type and nominal aggregate sizes and binder type.

(b) Details of treatments at interface between different pavements and existing pavements.

(c) Pavement type layout plans.

(d) Pavement drainage layers and structures.

(e) Pavement edge details (including subsurface drains) for each pavement type in cut, fill and shallow embankments for relevant cross falls.

7 Existing Pavements

(a) Existing pavements and pavement materials must not be incorporated within the pavements in the Project Works, with the exception of tying Other Roads into the existing pavement and the Jamison Road/TNR intersection. Existing pavement materials may be utilised as select subgrade or fill material subject to their compliance with all the other requirements of the Scope of Works and Technical Criteria.

8 Footpath, Shared Path and Cycle Path Pavements

(a) Further pavements for footpath, shared path and cycle paths must comply, as a minimum, with the requirements of “RMSA Pavement Standard Drawings – Rigid Pavement –Bicycle Path Design – 2.5 m wide, 3.0 m wide and 4.0 m wide” drawings. Pavement thicknesses must be designed to accommodate maintenance vehicle access.

9 Traffic Criteria – Main Carriageway

The Main Carriageway pavements must be designed as a minimum:

(a) to achieve Project design reliability of 95%;

(b) for the Annual Average Daily Traffic (AADT) data at year 2021 identified in Table 12-2;

(c) to allow for a vehicle annual growth rate (compounded) of 2.3% for flexible pavements;

(d) to allow 2.49 Heavy Vehicle Axle Groups (HVAG) per heavy vehicle;

(e) to allow for the Axle Group Load Distributions as detailed in Table 12-3;

(f) to allow for the Proportions of Axle Groups identified in Table 12-4;

(g) to allow for Lane Distribution factor (LDF) of 1.0 for up to and including two lanes and 0.65 for sections of the Main Carriageway where there are three or more lanes; and

(h) The minimum 40 year design traffic loadings for flexible pavements on the Main Carriageway based on the criteria detailed in this Appendix 12 and expressed in terms of repetition of standard axles (SAR) for each failure mode must be as detailed in Table 12-5.

As a requirement of the southern tie-in (refer Section 5.29 of the Scope of Works and Technical Criteria), the median pavement between Chainage 0 and Chainage 100 must meet the minimum design requirements for Main Carriageway pavements as listed above.

Table 12-2 Traffic Volumes

Location	AADT (2021) vehicles per day both directions	Percent heavy vehicles
Main Carriageway & M4 Ramps	66,000	18%

Table 12-3 Axle Group Load Distribution

Axle group load	Axle group type					
	SAST	SADT	TAST	TADT	TRDT	QADT
(kN)	%	%	%	%	%	%
10	0.2804	3.473	0.0354	0.1444	0.0050	0
20	7.827	8.696	0.2377	0.5755	0.1568	0
30	15.46	23.46	0.2763	0.6242	0.3290	0
40	15.71	21.93	0.5755	1.977	1.317	0
50	29.94	16.8	2.889	6.496	4.167	0

Axle group load	Axle group type					
	SAST	SADT	TAST	TADT	TRDT	QADT
(kN)	%	%	%	%	%	%
60	23.29	9.606	10.27	9.511	7.419	0
70	6.502	6.5	16.81	10.94	9.777	0
80	0.7943	4.623	16.61	9.769	8.338	0
90	0.1087	2.969	15.95	7.611	6.15	0
100	0.0354	1.393	14.42	7.242	5.029	0
110	0.0174	0.4098	9.774	6.267	3.701	0
120	0.0174	0.1158	5.903	5.952	3.298	0
130	0.0174	0.0244	2.943	5.878	3.147	0
140	0	0	1.539	6.534	3.361	0
150	0	0	0.8439	8.030	4.008	0
160	0	0	0.4279	5.717	4.115	0
170	0	0	0.2308	3.554	4.819	0
180	0	0	0.1367	1.863	6.097	0
190	0	0	0.0723	0.8535	7.733	0
200	0	0	0.0555	0.3331	8.433	0
210	0	0	0	0.0801	5.136	0
220	0	0	0	0.0322	2.339	0
230	0	0	0	0.0160	0.7764	0
240	0	0	0	0	0.2503	0
250	0	0	0	0	0.0905	0
260	0	0	0	0	0.0080	0
270	0	0	0	0	0	0
280	0	0	0	0	0	0
290	0	0	0	0	0	0
300	0	0	0	0	0	0

Axle group load	Axle group type					
	SAST	SADT	TAST	TADT	TRDT	QADT
(kN)	%	%	%	%	%	%
310	0	0	0	0	0	0
320	0	0	0	0	0	0
330	0	0	0	0	0	0
340	0	0	0	0	0	0
350	0	0	0	0	0	0
360	0	0	0	0	0	0
370	0	0	0	0	0	0
380	0	0	0	0	0	0
390	0	0	0	0	0	0
400	0	0	0	0	0	0
Total	100.00	100.00	100.00	100.00	100.00	0.00

Table 12-4 Proportions of Axle Groups

SAST	SADT	TAST	TADT	TRDT	QADT
0.3930	0.1910	0.0090	0.2590	0.1480	0.000

Table 12-5 Main Carriageway 40yr Design Traffic Loadings – Flexible

Location	Failure Mode	Traffic Loading (SAR) based on nominated inputs
Main Carriageway	Asphalt fatigue	2.71E+08
	Rutting and loss of surface shape	3.83E+08
	Cemented material fatigue	3.01E+09

10 Other Roads

10.1 General

Pavements for the Other Roads must be designed to comply with the following criteria:

(a) Annual Growth Rate (compounded) must be as detailed in Table 12-6.

(b) Axle group load distribution must be as detailed in Table 12-4, proportions of axle groups must be as detailed in Table 12-3.

(c) Traffic Volumes (year 2019) must be as detailed in Table 12-6.

(d) The minimum 40 year design traffic loadings for flexible pavements on Other Roads based on the above criteria detailed in this Appendix 12 expressed in terms of repetition of standard axles for each failure mode must be as detailed in Table 12-7.

Table 12-6 Other Road Traffic Volumes

Road Category	Road	AADT (2021) vehicles per day both directions	% heavy vehicle	HVAG per heavy vehicle	Annual Growth Rate %
Category A Roads	Jamison Road Smith Street Maxwell Street Bringelly Road Aspen Street Castle Road Glenmore Parkway Wentworth Road Homestead Road	30,000	8	2.49	3
Category B Roads	Frogmore Road Tukara Road Garswood Road Tania Avenue Cross Road	12,500	4	2.49	3

Table 12-7 Other Road Design Traffic Loadings – Flexible

Road	Traffic Loading SAR		
Failure Mode	Asphalt fatigue	Rutting and loss of surface shape	Cemented material fatigue
Cat A Traffic based on nominated inputs	6.41E+07	9.05E+07	7.11E+08
Cat B Traffic based on nominated inputs	1.34E+07	1.89E+07	1.48E+08

10.2 Roundabouts

Roundabout pavements must be designed to comply with the following criteria:

(a) Annual Growth Rate (compounded): 3%;

(b) Percent heavy vehicle:

(i) Frogmore Road roundabout 8%

(ii) Maxwell Street/Aspen Street/Tania Avenue: 8%

(c) Axle group load distribution must be as detailed in Table 12-4 and proportions of axle groups must be as detailed in Table 12-3;

(d) Traffic Volumes must be as detailed in Table 12-6;

(e) Minimum Design HVAG (40 years) for roundabouts must be as detailed in Table 12-6; and

(f) Project design reliability: 95%

11 Configuration, Maintenance Diaries and Extent

(a) This section contains details on pavement configurations, pavement maintenance diaries and pavement extents and consists of Pavement Configuration schedules in section 11.1, Pavement Maintenance Diaries in section 11.2 and Extent of Pavements in section 11.3 for the following Pavement Tags.

Table 12-8 Pavement Tags

Pavement Tag	Pavement Description
MC	Main Carriageway - Thick Asphalt over Heavily Bound Subbase
M4R	M4 Ramps - Thick Asphalt over Heavily Bound Subbase
RB1	Roundabout Pavement for Category A Roads - Full Depth Asphalt
RB2	Roundabout Pavement for Category B Roads - Full Depth Asphalt
HP	Full Depth Asphalt Heavy Patching of Existing Jamison Road
LR1	Category A Other Roads - Granular with thin asphalt surfacing
LR2	Category B Other Roads - Granular with thin asphalt surfacing
LR3	Golf Club Access - Granular with thin asphalt surfacing
BD	Bridge Deck Pavement
AS	Approach Slab Pavement
FP	Concrete Foot Path Pavement
TI	Traffic Island Infill
WSR	M4 Emergency Bay Wearing Surface Resheet
MB	Maintenance Bays

(b) The maintenance diaries and drawings identified in Table 12-11 are provided as electronic files on a separate disc titled:

Design and Construction of
The Northern Road Upgrade - Stage 3 North
Contract No.15.3662.2254
Exhibit F - Electronic Files

11.1 Pavement Configurations

(a) Table 12-9-1 to Table 19-9-14 contains a form detailing the pavement configurations required for each Pavement Tag identified in Table 12-8.

Table 12-9-1 Pavement Configuration for Main Carriageway - Thick Asphalt over Heavily Bound Subbase (MC)

Pavement Tag		**MC**
Pavement Description:		Main Carriageway Thick Asphalt over Heavily Bound Subbase
Configuration:	**Thickness (mm):**	**Layer Description:**
1	45	AC14 A15E Wearing Course
2	50	AC14 AR450 Intermediate Course
3	130	AC20 AR450 Base Course
4	4	7mm low cutter seal (C170)
5	250	Heavily Bound Subbase (includes 10 mm construction tolerance)
6	4	7mm low cutter seal (C170)
7	300	Selected Material Zone as per RMS Specification D&C R44, CBR ≥ 15%
8	300	Lower UZF subgrade material as per RMS Specification D&C R44, CBR ≥ 5%

Table 12-9-2 Pavement Configuration for M4 Ramps - Thick Asphalt over Heavily Bound Subbase (M4R)

Pavement Tag		**M4R**
Pavement Description:		M4 Ramps (two lanes and less) Thick Asphalt over Heavily Bound Subbase
Configuration:	**Thickness (mm):**	**Layer Description:**
1	45	AC14 A15E Wearing Course
2	50	AC14 AR450 Intermediate Course
3	140	AC20 AR450 Base Course
4	4	7mm low cutter seal (C170)

Pavement Tag		M4R
5	250	Heavily Bound Subbase (includes 10 mm construction tolerance)
6	4	7mm low cutter seal (C170)
7	300	Selected Material Zone as per RMS Specification D&C R44, CBR ≥ 15%
8	300	Lower UZF subgrade material as per RMS Specification D&C R44, CBR ≥ 5%

Table 12-9-3 Pavement Configuration for Roundabout Pavement for Category A Roads - Full Depth Asphalt (RB1)

Pavement Tag		RB1
Pavement Description:		Roundabout Pavement for Category A Roads Full Depth Asphalt
Configuration:	**Thickness (mm):**	**Layer Description:**
1	45	AC14 A15E Wearing Course
2	45	AC14 AR450 Intermediate Course
3	260	AC20 AR450 Base Course (includes 10mm construction tolerance)
4	4	7mm low cutter seal (C170)
5	300	Selected Material Zone as per RMS Specification D&C R44, CBR ≥ 15%
6	300	Lower UZF subgrade material as per RMS Specification D&C R44, CBR ≥ 5%

Table 12-9-4 Pavement Configuration for Roundabout Pavement for Category B Roads - Full Depth Asphalt (RB2)

Pavement Tag		RB2
Pavement Description:		Roundabout Pavement for Category B Roads Full Depth Asphalt
Configuration:	**Thickness (mm):**	**Layer Description:**
1	45	AC14 A15E Wearing Course

Pavement Tag		RB2
2	45	AC14 AR450 Intermediate Course
3	190	AC20 AR450 Base Course (includes 10mm construction tolerance)
4	4	7mm low cutter seal (C170)
5	300	Selected Material Zone as per RMS Specification D&C R44, CBR ≥ 15%
6	300	Lower UZF subgrade material as per RMS Specification D&C R44, CBR ≥ 5%

Table 12-9-5 Pavement Configuration for Full Depth Asphalt Heavy Patching of Existing Jamison Road (HP)

Pavement Tag		HP
Pavement Description:		Category A Roads (Jamison Road) Full Depth Asphalt Heavy Patching of Existing Jamison Road
Configuration:	**Thickness (mm):**	**Layer Description:**
1	45	AC14 A15E Wearing Course
2	70	AC14 AR450 Intermediate Course
3	200	AC20 AR450 Base Course (includes 10mm construction tolerance)
4	-	Existing pavement insitu subgrade

Table 12-9-6 Pavement Configuration for Category A Other Roads - Granular with thin asphalt surfacing

Pavement Tag		LR1
Pavement Description:		Category A Other Roads (Jamison Road, Smith Street, Maxwell Street, Bringelly Road, Aspen Street, Castle Road, Glenmore Parkway, Wentworth Road and Homestead Road)
Configuration:	**Thickness (mm):**	**Layer Description:**
1	45	AC14 AR450 Wearing Course

Pavement Tag		LR1
2	4	7mm low cutter seal (C170)
3	225	DGB20 (Category A) (includes 10mm construction tolerance)
4	100	DGS20 (Category A)
5	300	Selected Material Zone as per RMS Specification D&C R44, CBR ≥ 15%
6	300	Lower UZF subgrade material as per RMS Specification D&C R44, CBR ≥ 5%

Table 12-9-7 Pavement Configuration for Category B Other Roads - Granular with thin asphalt surfacing

Pavement Tag		LR2
Pavement Description:		Category B Other Roads (Frogmore Road, Tukara Road, Garswood Road, Tania Avenue and Cross Road) Granular with thin asphalt surfacing
Configuration:	**Thickness (mm):**	**Layer Description:**
1	45	AC14 AR450 Binder
2	4	7mm low cutter seal (C170)
3	140	DGB20 (Category B) (includes 10mm construction tolerance)
4	130	DGBS20 (Category B)
5	300	Selected Material Zone as per RMS Specification D&C R44, CBR ≥ 15%
6	300	Lower UZF subgrade material as per RMS Specification D&C R44, CBR ≥ 5%

Table 12-9-8 Pavement Configuration for Golf Club Access - Granular with thin asphalt surfacing

Pavement Tag		**LR3**
Pavement Description:		Golf Club Access Granular with thin asphalt surfacing
Configuration:	**Thickness (mm):**	**Layer Description:**
1	10	14/7mm double double seal (C170)
2	140	DGB20 (Category D) (includes 10mm construction tolerance)
3	200	DGS20 (Category D)
4	300	Selected Material Zone as per RMS Specification D&C R44, CBR ≥ 15%

Table 12-9-9 Pavement Configuration for Bridge Deck Pavement

Pavement Tag		**BD**
Pavement Description:		Bridge Deck Pavement
Configuration:	**Thickness (mm):**	**Layer Description:**
1	45	AC14 A15E Wearing Course
2	25	AC7 AR450 Correction Course
3	7	10mm SAMI seal (Bridge deck waterproof membrane)
4	-	Quick Dry Prime (K2/P or equivalent)
5	-	Concrete Bridge Deck

Table 12-9-10 Pavement Configuration for Approach Slab Pavement

Pavement Tag		**AS**
Pavement Description:		Approach Slab Pavement
Configuration:	**Thickness (mm):**	**Layer Description:**
1	45	AC14 A15E Wearing Course
2	-	Quick Dry Prime (K2/P or equivalent)

Table 12-9-11 Pavement Configuration for Traffic Island Infill

Pavement Tag		TI
Pavement Description:		Traffic Island Infill
Configuration:	**Thickness (mm):**	**Layer Description:**
1	100	20MPa concrete (brushed finish)
2	300	R173 Select Fill Type U (to fill low areas)

Table 12-9-12 Pavement Configuration for Traffic Island Infill

Pavement Tag		FP
Pavement Description:		Concrete Foot Path
Configuration:	**Thickness (mm):**	**Layer Description:**
1	150	32MPa R173 concrete (brushed finish with an integral oxide pigmentation, grey in colour equal to colour concrete systems 'onyx')
2	150	DGS20 (Category D)

Table 12-9-13 Pavement Configuration for M4 Emergency Bay Wearing Surface Resheet

Pavement Tag		WSR
Pavement Description:		M4 Emergency Bay Wearing Surface Resheet
Configuration:	**Thickness (mm):**	**Layer Description:**
1	45	AC14 A15E Wearing Course
2	-	Milled surface of existing pavement

Table 12-9-14 Maintenance Bays

Pavement Tag		MB
Pavement Description:		Maintenance Bays
Configuration:	**Thickness (mm):**	**Layer Description:**
1	4	4mm ALD Primer Seal with 10mm Aggregate and C170 Binder

Pavement Tag		MB
2	150	DGB20 (Category D) (includes 10mm construction tolerance)
3	200	Upper zone of foundation other than selected material (CBR ≥ 10%)

11.2 Pavement Maintenance Diaries

(a) Table 12-10 contains a form for the maintenance diaries required for each pavement tag;

(b) Except for routine maintenance, any maintenance activities identified in the maintenance diaries will be treated as a defect in accordance with clause 16 of the Deed.

Table 12-10 Pavement Maintenance Diaries

Year	Proposed maintenance, rehabilitation or reconstruction treatment
1	
2	
3	
etc.	

11.3 Extent of Pavements

(a) Table 12-11 contains the documents detailing the pavement maintenance diaries and locations and extents of pavement configurations.

Table 12-11 Extent of Pavements

Drawings Number	Drawing Title	Date	Revision	Electronic File Reference
Pavement Maintenance Diaries				
-	Appendix B Pavement Maintenance Diaries	-	-	LL-TNR3N_2-D_Pavement - Appendix B Maintenance Diary.pdf
Pavement Design				
TNR3N - TD - PV - DRG - 0001	COVER SHEET - SHEET 1	10/06/2016	A	PAVEMENT-CONCEPT-DESIGN-DRGs v2.pdf
TNR3N - TD - PV - DRG - 0002	DRAWING INDEX - SHEET 1	10/06/2016	A	
TNR3N - TD - TR - DRG - 0010	PAVEMENT PROFILES - SHEET 1	10/06/2016	A	
TNR3N - TD - TR - DRG - 0011	PAVEMENT PROFILES - SHEET 2	10/06/2016	A	
TNR3N - TD - TR - DRG - 0021	GRANULAR PAVEMENT WITH BITUMINOUS SURFACING EDGE DETAILS - SHEET 1	10/06/2016	A	
TNR3N - TD - TR - DRG - 0022	FULL DEPTH ASPHALT EDGE DETAILS - SHEET 2	10/06/2016	A	
TNR3N - TD - TR - DRG - 0023	ASPHALT OVER BOUND SUB-BASE PAVEMENT EDGE DETAILS - SHEET 3	10/06/2016	A	
TNR3N - TD - PV - DRG - 0301	PAVEMENT PLANS - SHEET 1	10/06/2016	A	
TNR3N - TD - PV - DRG - 0302	PAVEMENT PLANS - SHEET 2	10/06/2016	A	

Drawings Number	Drawing Title	Date	Revision	Electronic File Reference
TNR3N - TD - PV - DRG - 0303	PAVEMENT PLANS - SHEET 3	10/06/2016	A	
TNR3N - TD - PV - DRG - 0304	PAVEMENT PLANS - SHEET 4	10/06/2016	A	
TNR3N - TD - PV - DRG - 0305	PAVEMENT PLANS - SHEET 5	10/06/2016	A	
TNR3N - TD - PV - DRG - 0306	PAVEMENT PLANS - SHEET 6	10/06/2016	A	
TNR3N - TD - PV - DRG - 0307	PAVEMENT PLANS - SHEET 7	10/06/2016	A	
TNR3N - TD - PV - DRG - 0308	PAVEMENT PLANS - SHEET 8	10/06/2016	A	
TNR3N - TD - PV - DRG - 0309	PAVEMENT PLANS - SHEET 9	10/06/2016	A	
TNR3N - TD - PV - DRG - 0310	PAVEMENT PLANS - SHEET 10	10/06/2016	A	
TNR3N - TD - PV - DRG - 0311	PAVEMENT PLANS - SHEET 11	10/06/2016	A	
TNR3N - TD - PV - DRG - 0312	PAVEMENT PLANS - SHEET 12	10/06/2016	A	
TNR3N - TD - PV - DRG - 0313	PAVEMENT PLANS - SHEET 13	10/06/2016	A	
TNR3N - TD - PV - DRG - 0314	PAVEMENT PLANS - SHEET 14	10/06/2016	A	
TNR3N - TD - PV - DRG - 0315	PAVEMENT PLANS - SHEET 15	10/06/2016	A	
TNR3N - TD - PV - DRG - 0316	PAVEMENT PLANS - SHEET 16	10/06/2016	A	
TNR3N - TD - PV - DRG - 0317	PAVEMENT PLANS - SHEET 17	10/06/2016	A	
TNR3N - TD - PV - DRG - 0318	PAVEMENT PLANS - SHEET 18	10/06/2016	A	
TNR3N - TD - PV - DRG - 0319	PAVEMENT PLANS - SHEET 19	10/06/2016	A	

Transport
Roads & Maritime
Services

Exhibit A –
Scope of Works and Technical Criteria
Appendix 13 – Structural Performance and Design Requirements
for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

November 2016

Document Author: Roads & Maritime Services

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About this document

Project data

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Prepared by:	Roads & Maritime Services
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Table of Contents

1 Reference Documents

(a) Structures, as defined in section 5.15 of the SWTC, must be designed in accordance with the requirements of the Reference Documents in Appendix 8 that include "RMS Bridge Technical Direction Manual" and "RMS Technical Directions". "RMS Bridge Technical Direction Manual" and "RMS Technical Directions" contain design and design detailing requirements that are additional to the requirements of Australian Standard AS 5100 Set Bridge Design Set and other relevant Australian Standards and Standards Australia handbooks.

2 Application of AS 5100 Set 2007 - Bridge Design Set

2.1 AS 5100.1 – Bridge design Part 1: Scope and general principles

(a) AS 5100.1, clause 6.2: Design life

Structures must be designed and detailed to comply with the design lives detailed in section 5.5.1 of the SWTC.

(b) AS5100.1 clause 7.1: Piers and Abutments

(i) Scour depths at bridge piers, wall abutments, arch structures and retaining walls including reinforced soil walls must be calculated ignoring the presence of any scour protection provided.

(ii) Reinforced soil walls must be founded below the 100 year scour depth.

(iii) Some scouring of abutment spill-through embankments due to floods up to the 100 year ARI flood event is permissible, provided the effective batter slope measured on a line from the scoured toe of the embankment to the front soffit of the abutment sill beam shall not be steeper than 1:1. Scour protection may be used on spill-through embankments to ensure this outcome is achieved.

(iv) For flood events greater than the 100 year ARI event and up to the 2000 year ARI flood, the design must ensure that under the permanent loads and water flow effects the bridge will not collapse. For these floods it shall be assumed that the embankment at the bridge abutments will be scoured away to an equal height in front and behind the abutments.

(c) AS 5100.1, clause 9.7: Vertical clearance over roadways

The minimum clearance for road bridges is 5.4 metres. The minimum clearance for pedestrian and shared path bridges is 2.5 metres.

(d) AS 5100.1, clause 10: Road traffic barriers

(i) clause 10.1: Scope

Traffic barriers for bridges and traffic barriers located along the edges of vertical or near vertical earth retaining structures, including reinforced soil walls, must be designed in accordance with the requirements for traffic barriers on bridges in AS 5100.1, AS 5100.2 and subsection (ii) to (v) below. Internal traffic barriers on bridges must be designed to the same performance level or higher as for the external traffic barriers.

(ii) clause 10.2: General

Cyclists must be considered and addressed in determining the height of the bridge traffic barriers. Where the height of bridge traffic barriers on one side of a bridge is raised to contain cyclists, the bridge traffic barriers on the other side of the bridge must be raised to the same height and designed to the same details except where a higher performance level is required to comply with subsection (iii) below.

All bridge traffic barriers must be integrally connected to the bridge deck, except over link slabs where the traffic barriers must be debonded from the link slabs for a distance not less than 500 mm either side of the link slab centreline with a 3 mm thick cork layer. The bottom of the inside face of the traffic barrier must be provided with a 20 mm x 20 mm rebate and sealed with an appropriate sealant in accordance with RMS D&C B312.

(iii) clause 10.5: Performance levels

Traffic barriers on each bridge must be designed to:

A. a medium performance level: or

B. the performance level required by the risk assessment procedure in AS5100.1 Appendix B;

whichever is the highest.

Further to subsections A. and B. above all traffic barriers on a bridge must be designed to the highest performance level.

(iv) clause 10.6.1: Parapet type barriers

A. Traffic barriers must consist of precast concrete parapets mounted with two rail tubular metal barriers that comply with the Medium Performance Level traffic barrier - Type MAO requirements in RMS Standard Bridge Drawings B503 and B504. The Type MAO barriers must be terminated in accordance with the details in RMS Standard Bridge Drawings B505 and B506.

B. Concrete parapets must not be constructed using the slip-forming method.

C. Exposed joints between adjoining precast concrete parapets of traffic barriers must be sealed around the outside perimeter of the joints to a depth of 10mm with an appropriate sealant conforming to RMS D&C B312.

(v) clause 10.6.3: Bridge approach barriers

A. A transition barrier must be provided on the approach to all bridges. Bridge barriers must be extended and transitioned smoothly in stiffness, strength and performance levels prior to connecting to the roadside barriers.

B. The performance levels of the approach barriers must be assessed and designed to the same procedures as the bridge barriers. Traffic barriers at the approaches shall contain and redirect errant vehicles leaving the travel lane at 15 degree departure angle, bypassing the end of the barriers on the bridge structure and encroaching beyond the clear zone. Consideration must be given to distances to:

1. right of way boundary;
2. rigid objects;
3. steep descent,
4. pedestrian and other crossings beneath the bridge; and
5. parallel walkways and service roads.

(e) AS 5100.1, clause 11.2: Collision from road traffic

The need for protection of bridge elements including superstructure, abutments and piers for collision loads from road traffic must be determined in accordance with Bridge Technical Direction BTD 2008/07 and the following:

(i) where "x": is the minimum distance between nearest face of the bridge support and the edge of the nearest travel lane;

(ii) where "x" is greater than 11 metres the bridge support does not need to be designed for collision from road traffic if adequate sight distance has been provided;

(iii) where "x" is less than 5.5 metres and traffic barriers complying with subsection (v) below have not been provided, the bridge supports must be designed for the full collision load specified in clause 10.2 in AS 5100.2;

(iv) where "x" is between 5.5 metres and 11 metres and traffic barriers complying with subsection (v) below have not been provided, the bridge supports must be designed for a collision load varying linearly from the full load specified in clause 10.2 in AS 5100.2 when "x" is 5.5 metres to zero load when "x" is 11 metres;

(v) Traffic barriers provided to protect bridge supports must be at least Medium Performance Level.

(vi) Bridge superstructures where collision from road traffic has the potential to cause significant damage, collapse or loss of service:

A. bridge superstructures and superstructure elements must designed, as a minimum, to absorb the collision loads for protection beams specified in AS 5100.2 without significant damage, collapse or loss of service; and

B. superstructure elements potentially subject to impact must be designed with sufficient redundancy to prevent collapse or loss of service if damaged by road traffic collision.

(f) AS 5100.1, clause 12: Pedestrian and bicycle-path barriers

Where an internal traffic barrier is located on a bridge which separates the road carriageway from a cycleway or a combined pedestrian cycleway, a smooth continuous running rail must be provided to avoid snagging of pedals or other parts of the bicycle or rider on the barrier. The running rail must be located 1.3 metres above the top of the cycleway or the combined pedestrian cycleway. The running rail, including its connection and joints, must be detailed such that it does not come loose in the event of a vehicle impact to prevent spearing into the vehicle or pedestrian/cyclists. Beyond the ends of the bridge where the running rail terminates it must be suitably flared downwards to prevent spearing into vehicles or pedestrians/cyclists.

(g) AS 5100.1, clause 14: Drainage

(i) The drainage system must be designed so that a minimum amount of water flows across deck joints. Deck drainage systems may be omitted where the width of gutter flow is contained within the road shoulder for the design storm event.

(ii) Drainage pits must be provided just outside the ends of both the bridge approach slabs to minimise the run off entering and exiting the bridge deck.

(iii) Scuppers in a piped drainage system must not be spaced more than 12m apart. Free draining scuppers through decks must not be used unless approved by the relevant Authorities. Free draining scuppers must be designed to prevent use by fauna, including bats and birds and must be maintenance free for a 100 year design life.

(iv) Where grated inlet drains are provided, they must not be located over the closed voids of bridge girders unless the girders are concrete box girders and the voids are large enough for the connecting pipework within the girder to be easily and safely accessible for future inspections and maintenance. Drainage pipework must not be located within the voids of steel box or steel trough girders. Inlet drains must be located clear of any integral connection between girders and the deck slab.

(v) Components of the grated drains that are not readily removable must be designed to be maintenance free and made from Grade 316 stainless steel.

(vi) All longitudinal pipework for drainage must be a minimum of 225 mm diameter and resistant to fire and corrosion and to all commonly occurring chemical spillage. Where pipework is located in a concrete box girder the parts of the pipework that are located outside the box must be designed such that ignited flammable liquids cannot discharge into the pipework located inside the box girder.

(vii) Hanging rods and associated anchorage fixtures that support the drainage system must be made from Grade 316 stainless steel.

(viii) All drainage structures must be readily accessible for cleaning and maintenance purposes.

(h) AS 5100.1, clause 16: Utilities

(i) The requirements of all relevant Authorities to accommodate and provide for existing and planned future Services within and on the bridges must be satisfied. Ducts or conduits provided in bridges for planned future services must be installed with stainless steel draw wires of sufficient length and strength to permit future installation of Services.

(ii) In addition to any ducts that may be required for lighting and by Service Authorities, traffic barriers on all bridges must contain, as a minimum, an additional 100 mm inside diameter UPVC, SWV pipe duct and suitable fittings, to AS 1415, for future services in accordance with Bridge Technical Direction BTD 2008/08. In twin bridges, the Services ducts must be provided in the outside (nearside) traffic barrier of each of the bridges.

2.2 AS 5100.2 – Bridge design Part 2: Design loads

(a) AS 5100.2, clause 5.3: Superimposed dead loads

Deck wearing surfaces, additional concrete to compensate for prestressed girder hogs or geometric requirements and earth fill on top of bridges or other similar structures must be taken as superimposed dead loads with an ultimate limit state (**ULS**) load factor of 2.0.

(b) AS 5100.2, clause 6: Road traffic loads

(i) clause 6: Road traffic loads

All bridges, culverts, underpasses and retaining walls supporting traffic must be designed for SM1600 loadings.

(ii) clause 6.3: Heavy load platform

A. All bridges, culverts, underpasses and retaining walls supporting traffic must be designed for HLP400 heavy load platforms.

B. The lateral position of the HLP400 must be shown on the Cover sheet and on the General Arrangement sheet of the bridgework set of drawings in the Design Documentation.

C. The lateral position of the centre of the HLP400 must be determined as follows:

1. one lane bridge: Within ± 1.0 m either side of the centreline of the carriageway; or

2. two lane bridge: Within ±1.0 m either side of the centreline of carriageway; or

3. three (or more) lane bridge: Within any two marked travel lanes the vehicle travelling on centreline of the two marked lanes, or on the centreline of carriageway, which ever produces the most critical effect. The bridge must also be designed for one half of the SM1600 loading on any adjacent unoccupied travel lane in conjunction with the HLP400 loading. The accompanying lane factor for both the HLP400 loading and the one half of the SM1600 loading must be taken as 1.0. The design must allow for errors in positioning the

heavy load platform loads not less than 1m laterally in either direction from the specified position.

(c) AS 5100.2 clause 9: Minimum Restraint Capacity

A positive restraint system between the superstructure and the substructure shall be provided at piers and abutments. The restraint system shall be designed to resist an ULS force of 500kN or 5% of the superstructure dead load at that support, whichever is greater acting in any inclination between horizontal and vertical applied at any potential impact points on the superstructure concurrent to the minimum permanent vertical load acting on the support with a ULS load factor of 0.75. The impact force shall be taken to act at the level of the soffit of the superstructure. Supports providing this restraint shall also be designed to resist this design force. Where the total vertical reaction due to permanent effects at a support is less than 500 kN, the positive vertical restraint shall be provided for the difference.

(d) AS 5100.2, clause 11.2.5: Continuity

Metal traffic barrier railings must be made continuous by providing bolted sleeve joints in accordance with RMS Standard Bridge Drawings B504. The bolts must be designed to have cupped ("mushroom") heads with the cupped heads located at the top of the rails. The threaded bottom of the bolt must not project beyond the nut by more than a bolt diameter.

(e) AS 5100.2, clause 14: Earthquake forces

(i) clause 14.3.2: Bridge classification

All bridges on or over the Main Carriageway are essential for post-earthquake recovery and are classified as Type III bridges.

(ii) clause 14.3.4: Site factor

In determining the bridge earthquake design category (BEDC) of the structure the site factor must be obtained from Table 2.4(a) in AS 1170.4 -1993 to suit soil profile below pile cap or footing.

(iii) clause 14.7: Structural detailing requirements for earthquake effects

Bridges with a BEDC of BEDC-2, BEDC-3 or BEDC-4 must be designed with ductility reinforcement within the potential hinge zones in accordance with the requirements of clause 10.7.3.5 in AS 5100.5 irrespective of the value of the structural response factor used to analyse the bridges.

(f) AS 5100.2, clause 15: Forces resulting from water flow

(i) clause 15.1: General

A. Scour shall be calculated by one of the following methods:

1. in accordance with the Hydraulic Engineering Circular No 18 – Evaluating Scour at Bridges, Fifth Edition, April 2012(Publication No FHWA HIF-12-003) assuming any soil is granular (i.e. non-cohesive);

2. where suitable technical references justify the estimate of effective pier width (for simple single column pier forms of narrow and

transition pier proportion and for common pier forms of narrow and transition pier proportions), scour may be calculated using the simplified Sheppard-Melville method described in NCHRP Web Only Document 175: Evaluation of Bridge Scour Research: Pier Scour Processes and Predictions; or

3. by physical hydraulic modelling acceptable to the RMS Representative.

B. Where the adjacent spans are longer than 20m and the catchment upstream of the bridge is not heavily timbered, the effective or projected width of the pier need not be increased to account for debris.

(ii) clause 15.2.2: Serviceability limit state

The serviceability design flood must be the 1 in 100 year ARI flood event.

(g) AS 5100.2, clause 16: Wind loads

Wind loads on noise barriers must be in accordance with clause 16 in AS 5100.2 and RMS D&C R271. The total load on the structure must include the wind load on attachments including noise barriers, lighting, traffic signals and traffic sign structures.

(h) AS 5100.2, clause 17.3 & 17.4: Differential temperature

In any load combination that includes differential temperature effects, the load factor for shears, reactions and moments due to differential temperature effects in concrete bridges in Table 13-1 must be adopted.

Table 13-1 Load Factors

Concrete Bridge Type	SLS load factor	ULS load factor
Reinforced concrete	0	0
Continuous prestressed concrete superstructure	0.7	0.5
Segmental prestressed concrete with no non-stressed reinforcement across joints	1.0 in load combinations excluding traffic loading 0.7 in load combinations including traffic loading	0.7

For segmental prestressed concrete without non-stressed reinforcement across joints, the residual stresses must also be accounted for at the serviceability limit state.

(i) AS 5100.2, clause 21: Construction forces and effects

For the design of incrementally launched prestressed concrete bridges the following parameters must apply during the construction stage:

(i) dead load - as per AS 5100.2;

(iii) live load – a minimum of 0.5kPa on all deck surfaces with an ULS factor of 1.5;

(iv) differential temperature - 70% of AS 5100.2 for SLS and 50% of AS 5100.2 for ULS;

(v) wind load - 70% of AS 5100.2 for both SLS and ULS, with no launching to be carried out during strong winds;

(vi) differential settlement and construction tolerance allowances between bearing levels- as specified in design documentation and RMS D&C B152 (must be monitored and controlled) during construction; and

(vii) load factors, limit states – as per AS 5100.2

(j) AS 5100.2, clause 22.2: Ultimate limit state load combinations

(i) In all ultimate limit state load combinations, except for load combination (f), bridges must be designed for ultimate loads concurrent with water flow forces for floods up to the 100 year ARI flood event and the corresponding scour depths.

(ii) For ultimate limit state load combination (f), account must be taken of the effects of scour up to and including the 1 in 2000 year ARI design flood event.

(iii) For ultimate limit state load combination (b) and (e), the flow and debris forces due to the100 year ARI flood event must be considered if they produce adverse effects.

(iv) For ultimate limit state load combination (c), ship impact loads must be included in this load combination.

2.3 AS 5100.3 –Bridge design Part 3: Foundations and soil supporting structures

(a) AS 5100.3, clause 6.2: Design investigations

(i) Sufficient and adequate geotechnical investigations must be undertaken for the design of bridge foundations. A minimum of one borehole must be drilled within 2 metres of the centre of each pier and abutment. Where the length of the pier or abutment foundation is greater than 12 metres measured along the transverse (or skew) centreline of the substructure, a borehole must be drilled for every 12 metres measured along the transverse (or skew) centreline of the substructure, within 2 metres of the centreline of each pier and abutment. The boreholes must be more than 5 metres and less than 12 metres apart measured along the transverse (or skew) centreline of the substructure, must not be located on the same side of the centreline of the pier or abutment and must be located within the footprint of the foundation. Twin bridges must be treated as two separate bridges to determine the extent of geotechnical investigation required. This minimum level of geotechnical investigation only applies to bridge sites with relatively uniform subsoil strata and easily defined foundation conditions. If the subsoil is not relatively uniform, additional geotechnical investigations must be carried out as required to accurately define the foundation conditions.

(ii) The depth of the boreholes must extend to a minimum distance of 3.0 m below the founding level for pad footings and culvert base slabs and 3.0 m or five times the pile diameter below the founding level, which ever is greater, for pile foundations. Sufficient core must be recovered from the boreholes at and below the pile founding level to demonstrate the design parameters for the pile have been achieved.

(b) AS 5100.3, clause 9.4: Durability of steel

Steel piles and steel anchors must not be used in acid sulphate soils or potential acid sulphate soils where the measured or potential pH of the soil is equal to or less than 4 and/or the sulphate levels are greater or equal to 400 mg/l. In soils where the measured or potential pH of the soil is greater than 4 and the sulphate levels are less than 400mg/l, the minimum corrosion allowances specified in Bridge Technical Direction BTD 2007/13 must be adopted.

2.4 AS 5100.4 – Bridge design Part 4: Bearings and deck joints

(a) AS 5100.4, clause 5: Functions of bearings and deck joints

(i) The number of deck joints shall be minimised. For bridges less than 120m long deck joints shall be located only at the bridge abutments. For bridges longer than 120m the maximum number of deck joints shall be equal to the bridge length divided by 60 rounded down to the nearest integer.

(ii) The deck joints at the abutments must only be connected to the bridge approach slab by small movement joints detailed to the requirements of Roads and Maritime Standard Bridge Drawings B620 and B621 or medium movement strip seal joints.

(b) AS 5100.4, clause 7.4: Provision for replacement

The superstructure and substructure of bridges must be designed to allow for the jacking up of the bridge superstructure for future replacement of bridge bearings under traffic in accordance with the requirements specified in Bridge Technical Direction BTD 2007/12. Jacks must be located on top of abutment and pier headstocks and not on temporary support structures. The locking rings must be in contact with the soffit of the superstructure. The design of headstocks must also make allowance for the provision of temporary packers during jacking. The location of the jacking points, the associated maximum jacking loads and the required size of the steel plate must be shown in the Design Documentation and marked For Information Only.

(c) AS5100.4, clause 7.7: Access

(i) Provision of inspection and maintenance access must comply with BTD 2008/02 and with the following additional requirement for vertical and spill through abutments:

A. A bench with a minimum width of 1.0 m shall be provided in front of the abutment, that provides a minimum vertical clearance of 1.0 m under the soffit of girder and slab type bridges where there is a clear gap between girders of at least 1.0 m or a minimum vertical clearance of 1.5 m for superstructures with a wide soffit.

B. Maintenance bays must be provided at suitable locations in close proximity to the benches (as required by 2.4(c)(i)A. above) for the purposes of safe access for maintenance activities on the M4 Motorway Interchange bridge. The maintenance bays must be of dimensions suitable for vehicles and personnel to safely access the M4 Motorway Interchange bridge to undertake maintenance activities.

(d) AS 5100.4, clause 12: Elastomeric bearings

(i) clause 12.5.1: General

Plain strip or pad bearings must not be used to support prestressed concrete (PSC) planks in spaced plank superstructures.

(ii) clause 12.6.7: Fixing of bearings

Inequality 12.6.7(2) must be replaced with the following inequality:

Nmin.PE ≥ 2.2foAb

where parameters Nmin.PE, fo, and Ab are as defined in AS 5100.3.

(iii) clause 12.7.4: Inclined elastomeric bearings

Strip, plain pad and laminated elastomeric bearings must not be installed on an incline unless:

A. the shear deflection of the bearings caused by the application of the self weight of the superstructure is less than 6 mm. Where the bearings are inclined about both axes, the shear deflection must be taken as the vector sum of the longitudinal and transverse deflection; and

B. laminated elastomeric bearings are mechanically restrained on both the top and bottom faces.

(e) AS 5100.4, clause 14.2: Materials

Polished stainless steel surface mating with PTFE must be in accordance with ASTM A240/A240M-03b and not AS 1449.

(f) AS 5100.4, Section 17.2: Joint types

(i) Small movement sealant type joints must be detailed in accordance with RMS Standard Bridge Drawings B620 and B621.

(ii) For small to medium movements, strip seal joints comprising prefabricated rubber extrusion type joints between heavy reinforcing angles and with a maximum opening width less than 85 mm under ULS conditions (refer to clause 17.3.5 in AS 5100.4), must be used.

(iii) Finger plate type joints, saw tooth joints or modular bridge expansion joints must be used for larger movements.

(iv) Where pedal cyclists are not precluded from travel on a bridge, the design of bridge joints must allow for the safe passage of cyclists. Suitably designed coverplates may be provided over the shoulders only for the safe passage of cyclists so that the maximum opening does not exceed 200mm during service.

(v) Bonded steel/rubber type joints must not be used.

(vi) Steel cover plates must be provided over traffic barrier openings at deck expansion joint locations where the maximum opening in the expansion joint gap is equal to or greater than 50 mm under ULS conditions. The openings in the traffic barriers must be measured in the longitudinal direction of the bridge. For joint movements up to 85 mm under ULS conditions, steel cover plates must cover both the inside face and the top of the barriers. Where the joint movements are greater than 85 mm under ULS conditions, steel cover plates must also cover the outside face of the traffic barriers for its full depth. Steel cover plates must not be less than 10 mm thick. The faces of the traffic barriers must be recessed such that, after installation of the steel cover plates, the exposed faces of the steel cover plates and the traffic barriers are on the same respective planes.

(vii) Bridge deck joint products must be chosen from the List of Roads and Maritime Approved Bridge Components to suit performance requirements.

(g) AS 5100.4, clause 17.3: Requirements.

(h) AS 5100.4, clause 17.3.1: General.

(i) Bridge deck joints must be designed in accordance with the requirements in Bridge Technical Direction BTD 2008/10.

(ii) Joints must be selected, detailed and constructed such that the noise generated by traffic crossing the joint is kept to a minimum.

(iii) Joints must not inhibit the proper placement of concrete and must have adequate provision for maintenance and inspection access. Stainless steel drainage troughs must be provided under open finger plate type joints without seals in accordance with the requirements of Bridge Technical Direction BTD 2008/10 to prevent water or other liquids from staining any pier or abutment, causing any damage to bearings or restraints or causing corrosion or deterioration to concrete or metal surfaces.

(iv) The surface of bridge deck joints and bridge approach joints must not deviate by more than 3mm when measured from a 3m straight edge, including surface seal and cover plate areas.

(v) Edges of deck under the joints must be stiffened with an edge beam to ensure sound concrete around the anchors, reduce congestion of reinforcement and limit deflections to 3mm during service.

(vi) Surface structural joints must not present a hazard to any road users, including pedal cyclists, motorcyclists, pedestrians, wheelchair users and disabled persons.

(i) AS 5100.4, clause 17.3.2: Design loads

(i) Modular bridge expansion joints and their associated anchorages must be designed for the load cases contained in RMS D&C B316.

(ii) For deck joints other than modular bridge expansion joints, the joints and their associated anchorages must be designed for the load cases contained in clause 17.3.2 of AS 5100.4.

(j) AS 5100.4, clause 17.6: Specific provisions for modular deck joints

(i) Modular deck joints must be designed, fabricated and installed in accordance with RMS D&C B316.

(ii) Where modular bridge expansion joints are used, adequate space, a minimum 800mm wide and a minimum 1500mm high, must be provided in the voided zone under the expansion joints to permit future inspection, maintenance and replacement of the individual components of the modular bridge expansion joints.

2.5 AS 5100.5 - Bridge design Part 5: Concrete

(j) AS/RMS 5100.5, clause1.1: Scope and application:

(i) clause 1.1.1 Scope

The design of concrete bridge elements must be in accordance with the interim concrete bridge design code "*AS/RMS 5100.5 – Interim (Interim RMS Edition)*" (**AS/RMS 5100.5**) and not AS 5100.5.

(ii) clause 1.1.2 Application

Bridg elements must not be designed or constructed using Ductility Class L steel reinforcement (as defined in AS/NZS 4761). In other structures ductility Class L steel reinforcement must not be used where the structure is required to undergo plastic deformation.

(k) AS/RMS 5100.5, clause 2.8: Cracking

Where the smallest principal dimension (that is the length, width or height of the majority of the element) of a concrete element exceeds 1000mm, the temperature differential of the core surface of the element must not exceed 20°C during the curing period. A temperature differential up to 25°C during the curing period is permitted provided CIRIA C660 modelling is undertaken to demonstrate that predicted long term crack widths will be less than 0.2 mm. Thermocouples must be located within the concrete element to monitor the maximum temperature and temperature difference between the core and the surface of the concrete.

(l) AS/Roads and Maritime 5100.5, clause 4.10.3: Cover for corrosion protection

(i) References to concrete cover to steel reinforcement in “Roads and Maritime Standard Bridge Drawings”, “Roads and Maritime Bridge Technical Direction Manual” and “Roads and Maritime Technical Directions” are to “nominal” cover as defined in clause 4.10.3.1 of AS/Roads and Maritime 5100.5 unless stated otherwise. Concrete covers in Design Documentation drawings of reinforced concrete structures must be nominal covers in accordance with clause 4.10.3 of AS/Roads and Maritime 5100.5.

(ii) Waterproof membranes or wearing surfaces placed on top of concrete bridge decks and/or mass concrete placed against reinforced concrete elements must not be considered as barriers to environmental exposure when determining the required concrete cover to the steel reinforcement in bridge decks.

(m) AS/ Roads and Maritime 5100.5, Table 4.10.3(A):

The following amendments shall be made to the nominal cover requirement in Table 4.10.3 (A) where standard formwork and compaction are used:

(i) For exposure classification A must be increased to 45mm for Grade 32MPa concrete and 35mm for Grade 40MPa concrete.

(ii) For exposure classification B1 must be increased to 55mm for Grade 32MPa concrete and 45mm for Grade 40MPa concrete.

(n) AS/RMS 5100.5, Table 4.10.3(B):

The following amendments shall be made to the nominal cover requirement in Table 4.10.3 (B) for precast elements with rigid formwork and intense compaction:

A. For exposure classification A must be increased to 35mm for Grade 32MPa concrete and 30mm for Grade 40MPa concrete.

B. For exposure classification B1 must be increased to 45mm for Grade 32MPa concrete and 35mm for Grade 40MPa concrete.

(o) AS/RMS 5100.5, clause 4.10.3: Cover for corrosion protection

(i) References to concrete cover to steel reinforcement in "RMS Standard Bridge Drawings", "RTA Bridge Technical Direction Manual" and "RTA Technical Directions" are to "nominal" cover as defined in clause 4.10.3.1 of AS/RMS 5100.5 unless stated otherwise. Concrete covers in design documentation drawings of reinforced concrete structures must be nominal covers in accordance with clause 4.10.3 of AS/RMS 5100.5.

(ii) Waterproof membranes or wearing surfaces placed on top of concrete bridge decks and/or mass concrete placed against reinforced concrete elements must not be considered as barriers to environmental exposure when determining the required concrete cover to the steel reinforcement in bridge decks.

(p) AS/RMS 5100.5, clause 8: Design of beams for strength and serviceability

(q) AS/RMS 5100.5, clause 8.2.12: Detailing of shear reinforcement.

Shear reinforcement must not be lap spliced. Longitudinal bar must be placed in the corners of fitment bends and hooks for anchorage.

(r) AS/RMS 5100.5, clause 8.3.4: Requirements for torsional reinforcement

In checking the requirement for torsional reinforcement in a concrete beam, the calculated torsion moment T* in clauses 8.3.4(a)(i) and 8.3.4(a)(ii) of AS/RMS 5100.5, must be calculated assuming the uncracked section properties in the analysis.

(s) AS/RMS 5100.5, clause 8.5.3: Beam deflection by simplified calculations.

Icr shall be calculated as "second moment of area of a cracked section with the reinforcement transformed to an equivalent area of concrete". Ie.max. is limited to I or 0.6I as per equations 8.5.3.1(2) and 8.5.3.1(2).

(t) AS/RMS 5100.5, clause 8.6.1: Crack control for tension and flexure in reinforced beams

Crack control for tension and flexure in reinforced concrete beams must be in accordance with clause 8.6.1 of AS/RMS 5100.5.

(u) AS/RMS 5100.5, clause 8.6.2(a): Crack control for flexure in prestressed beams

Crack control design for prestressed beams must be in accordance with clause 8.6.2(a)(ii) of AS/RMS 5100.5, except that the increment in steel stress must be limited to 160 MPa as the load increases from the decompression state to the maximum combined serviceability limit state load.

(v) AS/RMS 5100.5, clause 9.1.2: Distribution reinforcement for slabs

(i) Where the main steel reinforcement in the deck slab is transverse to the direction of traffic, the longitudinal distribution steel reinforcement in the deck slab must conform to the following requirements:

A. for bridge skews less than 25 degrees, the minimum quantity of longitudinal reinforcement to be provided must not be less than 1300 mm2 per metre width in the top face of the slab and 880 mm2 per metre width in the bottom face of the slab.

B. for bridge skews equal to or greater than 25 degrees, the minimum quantity of longitudinal reinforcement to be provided must not be less than 1300 mm2 per metre width in both the top and bottom faces of the slab.

(ii) Where a bridge skew is greater than 25 degrees, a rigorous and accurate analysis must be undertaken to account for both the skew effects on the transverse and longitudinal bending of deck and link slabs and the differential shrinkage effects between the deck slab and the bridge girders particularly in the vicinity of the acute corners of the bridge deck. Special attention must be given to control cracking of the bridge decks to within specification limits.

(w) AS/RMS 5100.5, clause 9.1.3: Edge Stiffening

The transverse edges of deck slabs must be stiffened with discrete edge beams or crossgirders having a minimum depth of not less than half the clear span between longitudinal girders, designed for the full effects of wheel loads and to minimise differential deflections.

(x) AS/RMS 5100.5, clause 10.7.3: Restraint of longitudinal reinforcement

The design and detailing of lateral restraints must comply with the access requirements specified in the RTA's Chief Bridge Engineer Circular, CBE 00/05.

(y) AS/RMS 5100.5, clause 10.7.3.4(c): Detailing of lateral ties and helices

A helix must be anchored at its ends and splice locations by 1.5 extra turns of the helix at zero pitch and either a hook around a main longitudinal reinforcing bar or welding.

2.6 AS 5100.6 – Bridge design Part 6: Steel and composite construction

(a) AS 5100.6, clause 7: Composite box girders

Steel box or trough girders must be designed with sealed manholes to provide safe access into the inside of the girders for future inspections and maintenance in accordance with BTD 2008/02. The manholes must be fitted with vandal-proof locks.

(b) AS 5100.6, clause 8.2.6: Temporary cross bracing

Any temporary cross bracing left in as part of the permanent works must meet the same durability requirements and have the same surface coating system as the element it is connected to.

3 Provisions for specific structure types

3.1 Precast concrete girder and plank bridges and steel girder bridges

(a) Bridge superstructures consisting of multiple (2 or more) precast concrete girders with a concrete deck slab, where the depth of the precast girder is greater than 740mm must have end cross girders. The minimum depth of the end cross girder, measured from the top of the concrete deck slab must be 800mm, or 0.6 times the precast girder depth, whichever is the lesser. Cross girders must not extend beyond the face of the outside web of the edge bridge girders.

(b) The details shown on RMS Standard Bridge Drawings Nos. B200 to B214 inclusive must be used for the design of bridges with precast prestressed concrete planks placed side by side.

(c) The maximum clear spacing between planks, cross section and prestressing for spaced plank bridge decks must conform to the details shown on RMS Bridge Standard Drawings B300 to B330 inclusive . Plain elastomeric strip or pad bearings must not be used to support PSC planks in spaced plank superstructures.

(d) Where precast concrete or steel bridge girders are designed for continuity over piers or integral with the substructure:

- (i) the bridge must not have a skew greater than 10° or an angular deviation between the centreline of opposing girders on either side of a pier must not be greater than 5°;
- (ii) untensioned strands, wire or high tensile bars must not be considered in the calculation of section capacity;
- (iii) they must be designed for full continuity and partial continuity;
- (iv) where continuity includes an integral connection between the ends of girders and the top of the pier, the bottom of the girders must not be supported off the top of the pier. All temporary supports must be removed; and
- (v) the number of bridge girders must be the same on either side of the piers and align over the piers.

(e) The effects of staged construction, creep, shrinkage, differential shrinkage and differerential temperature and a minimum 10 mm differential settlement between adjacent piers must be rigorously assessed in the design.

(f) Schematic details of any temporary supports of the precast girders and the loads on them shall be provided in the bridge drawings.

(g) Positive moment connection between precast girders over the piers due to residual hog, differential shrinkage, differential temperature and effects of any prestressing through the integral diaphragm must be designed for assuming gross section properties and reducing any pre-compression from pouring the deck slab after constructing the integral diaphragm by an appropriate creep factor.

(h) Shear at the ends of the girders with corresponding positive and negative moments including checking anchorage of the longitudinal reinforcement at the face of the bearing must be rigorously assessed.

(i) The minimum requirements for steel reinforcement in deck and link slabs for both girder and plank bridges must be as detailed in RMS Standard Bridge Drawings B600, B601 and B602 respectively unless specified otherwise in the SWTC.

(j) The minimum concrete compressive strength at 28 days for cast-in-place concrete deck slabs must be 40MPa. The concrete mix must be designed to achieve a maximum target strength not exceeding 48MPa notwithstanding the maximum target strength specified in RMS D&C B80.

(k) Precast concrete girders must be manufactured using a concrete mix having a maximum nominal aggregate size not less than 14mm. Precast concrete or steel bridge girders must be supported on bridge bearings.

(l) Half-joints must not be used in bridge girders either during the construction stage or in the completed bridge.

(m) Major steel members must be designed to enable all steel surface protective coatings to be maintained as follows.

   (i) Adequate space, a minimum 800mm wide and a minimum 1500mm high, must be provided around all painted girder surfaces to permit future inspection, maintenance and replacement of the surface coating.

   (ii) The girders must be designed to support temporary scaffolding needed to carry out the maintenance and replacement of the surface coating and so noted on the Cover Sheet. Discrete ferrules or lugs must be provided to the underside of the top flanges of the steel girders to facilitate maintenance and replacement of the surface coating.

(n) Simply supported Super-T girder bridges must be designed to comply with the maximum span lengths specified in Bridge Technical Direction BTD 2011/06.

3.2 Incrementally launched concrete bridges

(a) During launching the maximum tensile stress in the superstructure assuming uncracked section properties, for SLS load combination, taking account of all load effects including self-weight, construction live load, differential deflection due to settlement, construction tolerances and differential temperature effects, the maximum tensile stress in the superstructure, assuming uncracked section properties, must not exceed $0.5\sqrt{f'_c}$ where f'_c is the minimum compressive 28 day strength of the concrete.

(b) The loading and load factors during construction must be as per section 2.2(h) of this Appendix 13.

(c) Launching pads must be placed at least 75 mm from the outside face of the web.

(d) Concrete cover between the soffit of the webs and the post-tensioning ducts must be no less than 150 mm.

(e) The eccentricity of the reaction of the sliding pads from the intersection of the centrelines of the web and the bottom flange must be considered.

3.3 Balanced cantilever bridges

(a) Construction stage loadings for balanced cantilever bridges must be assessed using "*AASHTO LRFD Bridge Design Specifications*" or "*SETRA Design Guide: Prestressed Concrete Bridges Built by the Cantilever Method*". External tendons must be designed to be fully replaceable.

3.4 Cable stayed bridges

(a) In addition to the requirements of AS 5100, cable stayed structures must satisfy the requirements of "*PTI Guide Specification: Recommendations for Stay Cable Design, Testing and Installation*".

3.5 Integral bridges

(a) Integral bridges must be designed in accordance with Bridge Policy Circular BPC2007/05, except that the length of semi integral bridges must be limited to 50m and the membrane and sand layer under the slab, required by section 4 of Bridge Policy Circular BPC2007/05, must be replaced by 150mm thick lean-mix concrete to RMS D&C R82.

3.6 Soil and slope structures

In addition to the requirements of section 5.15 of the SWTC and other requirements of this Appendix 13, the design of soil and slope structures (SSS), including soil nail walls and slopes, reinforced soil walls, gravity retaining walls, cantilever retaining walls, anchored walls, reinforced soil slopes, unreinforced soil slopes and embankments on poor ground (ground which consists of firm or weaker soil layers as defined in Table A4 of Australian Standard AS 1726 Geotechnical Site Investigations (**Poor Ground**)) must comply with the following requirements:

(a) Reinforced soil walls must be designed in accordance with RMS D&C R57.

(b) For SSS other than reinforced soil walls, the following limit state load combinations must be considered:

(i) Load Combination A

permanent effects and nominal vertical traffic live load; and

(ii) Load Combination B

permanent effects and the most critical transient load (ie only 1 transient load at any time);

where transient loads include, but are not limited to, earthquake load with annual probability of exceedance of 1 in 500, traffic impact load, traffic braking load, wind load and rapid drawdown load.

(c) Embankments on Poor Ground (including piled embankments) must be designed in accordance with BS8006. In addition to the loads specified in BS8006, earthquake loading with an annual probability of exceedance of 1 in 500 must be included in the design and addressed in the Design Documentation. For earthquake load cases, the partial load factor for external live load may be reduced to 0.

(d) For designs of foundations for piled embankments in accordance with BS8006, the enhancing effect of the sliding resistance of the foundation soils may be utilised in the design analysis for lateral sliding.

(e) Unreinforced soil slopes and rock slopes must be designed with minimum factors of safety (F.O.S.) of 1.5 and 1.25 (unless otherwise agreed with RMS) for Load Combination A and Load Combination B in section 3.7 (b) of this Appendix 13 respectively.

(f) The design ground water level must be determined in accordance with section 1.3.8(g)(vii) of this Appendix 13.

(g) Soil and slope structures, except those referred to in sections 3.6(a) to 3.6(d) of this Appendix 13, must be designed and constructed in accordance with AS5100 except that:

(i) the geotechnical strength reduction factors for all load combinations for strength and stability design must comply with Table 13-2 of this Appendix 13 instead of Table 13.3.1(A) of AS 5100.3.

(ii) the strength reduction factors for ground anchors must not exceed the reciprocals of the minimum safety factors specified in Table 2 of BS8081, and S* may be taken as 1.0Se.

(iii) the acceleration coefficient 'a' referred to in AS 5100.2 must be replaced by the Hazard Factor 'Z' as defined in AS 1170.4.

(iv) wall frictional angles and adhesion must comply with section 5.11 of the "Guide to Retaining Wall Design, 1993, published by the Hong Kong Government.

(v) base shear resistance must comply with section 5.12 of the "Guide to Retaining Wall Design, 1993", published by the Hong Kong Government.

(vi) calculations of earth pressure must comply with section 6 of the "Guide to Retaining Wall Design, 1993", published by the Hong Kong Government.

(vii) other than for reinforced soil walls, the design ground water level must be one which has a return period of 1 in 10 years. The determination of the design ground water level must consider storm response as well as seasonal response. The design ground water level must be either of the following cases, whichever is more critical:

A. a 1 in 10 year return period storm rise added to a typical wet season ground water level; or

B. a typical storm rise added to a 1 in 10 year return period seasonal rise.

When checking stability during rapid drawdown, the water table within soil and slope structures must correspond to a 1 in 100 year event.

Alternatively, the design ground water table may be taken as one at least 2m above the maximum observed ground water table or a justifiable prediction if the ground water table will be substantially altered after the construction.

(viii) AS 5100.3 Clause 13.3.1 on provision of over-excavation is to apply only to cantilever retaining walls, not to L-shape cantilever or other gravity retaining structures.

(ix) Unless otherwise specified, provision for future utility excavation at the toe of the structures is not required. Appropriate notes in the drawings to ensure stability of these structures must be included when such excavation by others is needed or is likely to occur.

Table 13-2 - Range of Values of Geotechnical Strength Reduction Factor (ϕ_g) for Soil and Slope Structures

Load Combination Case	Range of values of ϕg			
	Bearing and passive capacity	Restoring moment contributed by gravity force and non-passive pressure	Shear strength in sliding and slip surface analyses.	Pullout strength of soil reinforcement (excluding ground anchors)
A	0.35-0.50	0.50	0.65	0.50
B	0.50-0.65	0.65	0.80	0.65

(x) slip surface analyses must be carried out to identify the most critical slip surface for each design load combination specified in clause 22.3 of AS 5100.2 and:

A. the design geotechnical shear strength along the complete slip surface must be determined using the ultimate geotechnical shear strength multiplied by the relevant geotechnical strength reduction factor in Table 13-2 of this Appendix 13;

B. the design geotechnical pullout strength of soil reinforcements and ground anchors must be determined using the ultimate strength and the corresponding geotechnical strength reduction factor;

C. the design structural strength of geosynthetic reinforcements must be determined in accordance with section 5.3.3, Annexure A and Annexure D of BS8006 (1995);

D. the design strength of soil reinforcements or ground anchors must be the lesser of the design geotechnical pullout strength and the design structural strength; and

E. the combined design geotechnical shear strength along the slip surface and design strength of soil reinforcements/ground anchors must be capable of maintaining all the critical slip surfaces in a stable condition.

Simultaneous occurrence of more than 1 transient effect is not required to be considered in the slip surface analyses.

(h) Stability of soil slope structures during construction must be considered. A minimum factor of safety (FOS) of 1.2 may be deemed to be satisfactory for intermediate construction stages, however, the minimum acceptance criteria must include consideration of the nature, extent and duration of the immediate stages, the consequence of failure, details and extent of risk management with contingency plan, degree of emergency and other factors. A set of appropriate acceptance criteria for each intermediate construction stage, taking into account all relevant factors, must be established and stated in the Design Documentation.

(i) A minimum nominal vertical live load of 20 kPa for stability and 10 kPa for settlement must be allowed for in the design of soil and slope structures. Where soil and slope structures neither retain road embankments nor support structures and where there is no possibility of these being constructed in the future, the minimum nominal vertical live load allowed for in the stability design may be reduced to 10 kPa. Construction surcharge is to be considered separately where necessary.

(j) The design of soil and slope structures must address all drainage issues associated with the structures, including provisions for cleaning and maintenance of the drainage infrastructure. Drainage must be provided behind any facing panels provided on soil and slope structures.

(k) Soil and slope structures must be provided with suitable free draining backfill and / or drainage systems to ensure there is no build up of water pressure behind the structure. Full width geotextile must be provided behind facing panels provided on soil and slope structures where the base of the oil and slope structures is below the level of the design flood event.

(l) Cement stabilised sand must not be used in reinforced soil walls.

(m) Abutment piles must have minimum 500mm clearance from RSW panels to facilitate compaction.

(n) All earth retaining structures carrying water mains or similar utilities within their influence zones are to consider the effect of accidental rupture of such utilities.

(o) Where soil and slope structures abut hillsides or are located in areas where water may enter the structure from behind and where water pressure is neglected in the design:

  (i) a full height drainage layer must be provided at the back of the structure;

  (ii) where the height of the structure is greater than 4 metres the drainage layer must comprise a suitable granular filter material complying with Cl 5.4 of RMS D&C R57 wrapped with a synthetic filter and separation fabric complying with RMS D&C R63;

  (iii) where the height of the structure is 4 metres or less the drainage layer must comprise either:

    A. a suitable granular filter material complying with Cl 5.4 of RMS D&C R57 wrapped with a synthetic filter and separation fabric complying with RMS D&C R63; or

B. a prefabricated cellular material wrapped with a synthetic filter and separation fabric complying with RMS D&C R63;

(iv) granular fill material must be Grade F20 Type A aggregate filter material defined in RMS R32; and

(v) surface water must be collected and discharged by a separate surface water drainage system, which must discharge to the stormwater drainage system.

(p) Structures supported by soil and slope structures must be designed to accommodate all movements resulting from settlement and creep of the soil and slope structures. The maximum movements of all soil and soil supporting structures supporting traffic must be the smaller of 0.5% of the retained height of the structure or those deformation criteria stipulated for road pavement designs and/or road embankments applicable under the serviceability limit state criteria specified elsewhere in the SWTC.

(q) Assessment of foundation conditions, design criteria, design calculations, geotechnical models, geotechnical investigation report and geotechnical interpretation report must be presented in the design documentation.

(r) The design of soil and slope structures must consider and address, but not be limited to, the following geotechnical failure mechanisms, both internal and external to the structures:

(i) Ultimate Limit States:

A. bearing failure;

B. sliding failure;

C. rotational failure; and

D. slip failure.

(ii) Serviceability Limit States:

A. settlement and lateral movement;

B. tilting and rotation;

C. differential settlement.

(s) The slope of batters in front of spill through bridge abutments must not be steeper than 1.0V:1.5H.

(t) Type F concrete traffic barrier must not be used as a retaining structure.

(u) Where existing structures are affected, their stability and deformation must be assessed and documented, and where required strengthening measures are to be designed to conform to the SWTC requirements.

(v) All design assumptions are to be included in the drawings for appropriate verification during construction by suitably qualified personnel.

(w) Unprotected gabion walls are not to be used within 4 m of the carriageway. The design must consider the need to restrict public access and prevent vandalism.

3.7 Precast arch structures

(a) The design of precast arch structures must assess and address foundation stability, settlements, including differential settlements, and foundation treatment requirements.

(b) The design must also assess and address loads that will be induced during the construction of the precast arch structures, including varying staged backfill levels, and the effects of construction traffic.

(c) In addition account must be made of variation in the design density of fill material both minimum and maximum during construction and in the permanent state.

3.8 Sign structures

(a) Sign structures must comply with the requirements of test 3-60 of the US National Cooperative Highway Research Program – Report Number 350 (NCHRP350). If sign structures are not designed to collapse, protection must be provided in accordance with part 6 of "*RTA Supplements*".

(b) Sign structures must comply with RMS D&C R143.

(c) Sign structures must be designed in accordance with Bridge Technical Direction BTD 2009/01.

3.9 Noise barrier design

(a) Noise barriers and support systems must comply with RMS D&C R271. Concrete work must be in accordance with the requirements of RMS D&C B80. Steel components must comply with the requirements of RMS D&C B241 and be hot dip galvanised in accordance with the requirements of RMS D&C B220.

4 Investigations and Studies

4.1 Hydrology and Hydraulics

(a) Hydrologic and hydraulic studies must be conducted for each bridge site that includes:

(i) assessing the impact of afflux on adjacent land upstream and downstream of the bridge for a range of floods up to the 2000 year ARI flood;

(ii) Estimate the flood levels, water flow velocities, effects of scour at Abutments and depth of scour at Piers for a range of floods up to the 2000 year ARI event.

(iii) The range of floods investigated shall include the 100 year and 2000 year ARI floods, and the over-topping flood if this is lower than the 2000 year ARI flood. Also the flood level shall be determined for the 50 year ARI flood.

4.2 Geotechnical studies for structures

(a) A geotechnical and foundation study must be undertaken for each new structure in the Project Works and the Temporary Works and for each existing structure that is affected by the Project Works and the Temporary Works.

(b) This study must:

(i) be sufficient to identify and provide all the information required to design, construct and maintain each new structure and to preserve and protect existing structures;

(ii) encompass the structural adequacy, long term deformation and durability of the foundation, including the effects of the placement of fill in embankments near or adjacent to structures; and

(iii) predict and control to within acceptable limits the insitu ground movement, structural movement and groundwater movement.

(iv) include sufficient chemical testing to identify any ground or groundwater that may be potentially harmful to concrete in the vicinity of the Project Works. The type and quality of the concrete used in the Project Works must be designed to achieve the required Design Life;

(v) include sufficient chemical testing of groundwater samples in the vicinity of the Project Works that have the potential to block drainage systems by precipitation of insoluble salts. Appropriate flushing points for maintenance must be provided and the drainage systems for the Project Works below ground must be designed to achieve the required Design Life;

(vi) include sufficient surface drainage on the soil and soil-supporting structures to capture and divert to stormwater discharge to avoid soil erosion. The drainage system must be designed to be self-cleaning with minimum maintenance; and

(vii) where the soil and soil supporting structures are suceptible to damage by tree root actions, the design must eliminate the growth of such trees within the active zone of the structures.

(c) For each structure site a separate geotechnical investigation report must be provided as part of the Design Documentation in accordance with Chief Bridge Engineer Circular, CBE 2000/09. The geotechnical investigation report must be prepared by a recognised geotechnical and foundation expert and must contain recommendations of design parameters for the design of the bridge foundations. Instead of providing a separate geotechnical investigation report for each bridge site, the geotechnical investigation report for each bridge site may be included as part of the bridge design report. The cover sheet of the bridgework set of drawings in the Design Documentation must cross reference the geotechnical investigation report.

(d) If, during the course of performing the Contractor’s Work, the actual conditions vary from those predicted in the Design Documentation, the variance is a non-conformity which must be treated in accordance with section 3 of the SWTC.

5 Provisions for Specific Bridge Elements

5.1 Bored cast-in-place piles

(a) Testing of bored cast-in-place concrete piles for integrity and geotechnical strength must comply with the requirements of Bridge Technical Direction BTD 2011/08.

5.2 Concrete infilled steel tubular piles

(a) Concrete infilled steel tubular piles must be designed to comply with the following requirements:

(i) Longitudinal steel reinforcement must be evenly distributed around the perimeter of the concrete infill and must be provided for the full length of the concrete infill. The cross sectional area of the longitudinal reinforcement must not be less than one percent of the gross cross sectional area of the concrete infill.

(ii) Not Used

(iii) Full composite action between the concrete infills and the steel tubes must be assumed to commence at a distance not less than three times the pile diameter below the bottom of the top section of the steel tube and within a distance of not less than three times the pile diameter from the bottom of the concrete infill.

(iv) Weld beads must be provided circumferentially within the inside face of the steel tubular piles for the full depth of the concrete infill zone. The weld beads must be not less than 3 mm thick and must be spaced not greater than 300 mm apart. The weld beads must not be taken into account when determining the design length of the concrete infill.

(v) Driving shoes at the toe of steel tubular piles must not be less than 50 mm thick and not less than 1000 mm long. The driving shoes must be fabricated from the same grade of steel as the tubular piles and must have the same outside diameter as the tubular piles.

5.3 Reinforced concrete piles with column extensions or piers without pile caps

(a) Reinforced concrete piles that support single circular column extensions must have diameters at least 200 mm greater than the diameters of the column extensions to account for construction tolerances when installing the piles. The outside faces of column extensions (circular or otherwise) must be located within the outside faces/perimeters of the supporting piles.

(b) Except for single circular column extensions, where pier walls or columns are supported directly on piles without pile caps, the minimum edge distance of the piles to the edge of the pier walls or columns must not be less than 200 mm.

(c) The construction joints between the tops of the supporting piles and the bottom of the column extensions or the tops of the supporting piles and the bottom of pier walls or columns must be located:

(i) at least 1000 mm below the existing or finished ground levels, whichever is the lowest, for columns on land;

(ii) at least 200 mm below the normal water levels for non-tidal watercourses; and

(iii) at least 500 mm below the MLWSL for tidal watercourses.

5.4 Pile caps

(a) Pile caps that are constructed on land must be designed and constructed with the top of the pile caps located a minimum of 0.5 m below the existing ground level or finished ground surface level whichever is the lowest.

5.5 Design of bridge abutments affected by embankments

(a) Where the depth of soft soil over weathered bedrock exceeds 3 metres, raking pile configurations must not be used in abutments.

(b) Displacement restraint and rotational restraint at abutment pile heads must be minimised to reduce the internal pile forces (bending moments, shear forces) induced by lateral soil movement. Downdrag (negative skin friction) effects due to settlement on piles must be allowed for in the design of such piles, together with methods to reduce such effects.

(c) The maximum lateral soil movement after the construction of bridge abutment piles must be no greater than that designed in advance of construction.

(d) If embankments constructed adjacent to existing bridges cause soil settlement or lateral soil movement at existing bridge foundations including at abutments or piers, the design must assess the impacts of the settlement or lateral soil movement on the existing bridge and the Contractor must address and mitigate these impacts.

5.6 Spill through batter

(a) The slope of batters in front of spill through bridge abutments must not be steeper than 1.0V:1.5H.

5.7 Lateral restraint blocks

(a) Where restraint blocks are provided on top of bridge piers and abutments to transfer lateral loads, such as earthquake loads, from the bridge superstructure to the bridge substructure, a high density, low friction plastic sliding pad must be provided. Concrete to concrete, or concrete to steel contact between the lateral restraint block and the sides of bridge girders must not occur. To ensure that a uniform gap between the lateral restraint blocks and the sides of the bridge girders is achieved, the lateral restraint blocks must be constructed after the adjoining bridge girders have been erected.

5.8 Stainless steel dowel bars

(a) Stainless steel dowel bars must be provided where bridge approach slabs are connected to bridge abutments and in other situations where the dowel bars are acting structurally, including horizontal restraints between the bridge substructure and superstructure, and in contraction joints of culvert base slabs and retaining walls. Stainless steel dowel bars must be Grade 304 conforming to ASTM A276.

5.9 Bearings

(a) The installation of elastomeric bearings supporting concrete bridge girders must comply with the requirements of Bridge Policy Circular BPC 2007/02. Recesses to the underside of the girders to fix the top of the elastomeric bearings must not be used except for plank bridges.

(b) Elastomeric bearings with sliding contact surfaces must be designed to comply with the following requirements:

(i) the bottom of the bearing must be mechanically anchored and must not rely on friction for anchorage.

(ii) the sliding contact surface must be located between the top of the bearing and the underside of the girder.

(iii) the attachment plate on the top of the bearing must be designed with keeper plates to prevent movement of the top of the bearing relative to the attachment plate.

(iv) the sliding contact surface must be designed to comply with the requirements of clause 14 in AS 5100.4 and to any additional requirements specified in RMS D&C B282.

(v) elastomeric bearings must be designed for serviceability limit state conditions. All other components including mechanical anchors and attachment plates must be designed for ultimate limit state conditions.

(vi) a dust seal must be provided to prevent contamination of the contact sliding surface.

5.10 Composite deck slab systems

(a) Concrete deck slabs incorporating precast concrete panels as permanent formwork with an insitu concrete overlay must comply with the following requirements:

(i) Where the reinforcement in the precast panels is to function as the transverse reinforcement in the deck slab, the reinforcement must anchor past the front face of the stiff support of the panel in accordance with clause 8.1.8.3 of AS/RMS 5100.5.

(ii) Where the precast concrete panels have not been designed to act structurally in the longitudinal direction, a bottom mat of longitudinal reinforcement must be provided, at a minimum clear distance of 25mm above the top of the precast panels with a minimum reinforcement area of 500mm^2 per m width.

(iii) Where the precast concrete panels have been designed to act structurally in the longitudinal direction, a cast insitu stitch between the ends of the precast panels having a width of at least the length of the splice length of the reinforcement must be provided.

5.11 Bridge approach slabs

(a) Bridges must be provided with adequately designed and suitably proportioned approach slabs. Approach slabs must not be integral with the bridge decks and/or approach pavements (i.e. must not be seamless pavements). Bridge approach slabs must be a minimum 6.0 metres long and detailed to comply with RMS Standard Bridge Drawings B049E, B049F, B049G and B049H as applicable. Traffic barriers that are adjacent to bridge approach slabs must be designed as an integral part of the abutment wingwalls and not as part of the approach slabs. In fill areas provision must be made to enable jacking of the bridge approach slabs after any settlement occurs. The methodology for re-levelling of bridge approach slabs after settlement occurs must be included in the Design Documentation and Maintenance Plan.

(b) Drainage pits must be located adjacent to both the approach slabs but not within the bridge approach slabs.

(c) For each bridge, the details of the design of the bridge approach slabs must be provided on the bridgework drawings.

5.12 Safety Screens

(a) Safety screens must be provided on bridges over the Main Carriageways, including the M4 Motorway. Safety screens must be in accordance with Bridge Technical Direction BTD 2012/01 and section 31 of the “RTA Structural Drafting and Detailing Manual”

(b) All vertical joints or overlaps in the safety screen mesh panels must be located at safety screen posts.

5.13 Anti-graffiti coatings

(a) Except for structures and walls that are not visible to users driving on the road network, using pedestrian walkways or community facilities, the surfaces of structures, noise walls, walls and barriers must be treated with non-sacrificial anti graffiti coatings which:

(i) must match the adjacent surfaces and the colours and the application of which does not alter the appearance of the structure;

(ii) must be to a minimum height of 3 metres above surrounding reinstated ground levels or any accessible footholds; and

(iii) where part of an element of a structure or wall requires treatment based on the height criteria in subsection 5.13(a)(ii) above, must be applied to the whole of the element of the structure or wall.

(b) To protect surfaces prior to applying the permanent anti graffiti coating, a sacrificial coating may be applied, provided that it in no way interferes with the adhesion of the permanent coating.

5.14 Design findings of main structural elements

(a) For each bridge design, a table summarising the design findings of the main structural elements of a bridge must be included in the Design Documentation. The design findings for each of the main structural elements must identify the critical design effects (including shear, bending moments) and their locations together with the associated governing load case. The design findings must also include a comparison of the critical design effects with the structural capacity for each of the main structural elements as well as any comments that may be relevant.

6 Application of the "RTA Structural Drafting and Detailing Manual"

(a) Structural drawings must comply with the "*RTA Structural Drafting and Detailing Manual*". Reference numbers prefixed with SDDM in this section 6 refer to section numbers in the "*RTA Structural Drafting and Detailing Manual*". For example: SDDM 4.2 refers to section 4.2 in the "*RTA Structural Drafting and Detailing Manual*".

(i) SDDM 1.0

All structural drawings for the Project Works must conform to the drafting practices described in the Structural Drafting and Detailing Manual.

(ii) SDDM 3.6

Each set of structural drawings must have a "Registration Number of Plans".

Except for gravity or reinforced soil walls, each set of drawings for retaining walls with a structural height of 3.0 m or more at any location must have a Bridge Construction Registration Number and not a Road Construction Registration Number. Retaining walls with a structural height less than 3.0 m need not have a Bridge Construction Registration Number.

The Registration Numbers of Plans will be provided by RMS Representative.

(iii) SDDM 12.0

Notes including general notes, concrete notes, steel reinforcement notes, structural steelwork notes and prestressing notes must be provided on each of the individual drawings to which they pertain. A single standard notes sheet must not be used to provide these notes.

(iv) SDDM 20.0

In accordance with clause 1.2 of AS 5100.2, the cover sheet of the set of drawings for each bridge must state all the loads for which the bridge has been designed. In addition to the design loads, the cover sheet must state the BEDC and the acceleration coefficient, the site factor and the bridge classification. In accordance with Chief Bridge Engineer Circular CBE 2000/09, the cover sheet must cross reference the geotechnical investigation reports and other relevant reports on which the bridge design is based.

(v) SDDM 23.0

Bar shapes labelling for reinforcement must be provided in the drawings.

(vi) SDDM 32.0

Bridge size culverts and underpasses having a Bridge No must be detailed in accordance with section 32 of the SDDM.

7 Durability

7.1 General

(a) Durability standards and guidelines detailed in sections 2.14 and 5.9 of the SWTC, reference documents in section 1 of this Appendix, and the additional requirements in section 7.2 of this Appendix must be applied for the various materials and components used in all permanent structures.

(b) For each bridge, a separate durability assessment report must be provided as part of the bridge design report in the Design Documentation. The cover sheet of the bridgework set of drawings must cross reference the durability assessment report.

7.2 Additional requirements

(a) Materials, components and processes for all structural parts of the Project Works must provide the required durability.

(b) Durability design for concrete structures with a design life greater than or equal to 40 years must be in accordance with reference documents in section 1 of this Appendix and the following requirements:

(i) dense, durable high strength concrete must be used. The minimum strength concrete to be used must be 40 MPa, except for blinding or mass concrete. In areas of severe exposure (equal to or exceeding AS 5100.5 exposure classification B2), blended cements must be used;

(ii) concrete mix design must include provisions for the prevention of the deleterious effects of erosion, delayed ettringite attack, acid attack and sulphate attack as applicable; and

(iii) except where stainless steel reinforcement is used, allowance must be made for possible future cathodic protection in accordance with the requirements of Bridge Technical Direction BTD 2008/13 for all reinforced concrete elements that have a concrete exposure classification B2 or more severe. Allowance must also be made for possible future cathodic protection of piled foundations where the diameter of the excavated pile holes varies with depth. Electrical continuity must be provided for all non-stressed and stressed reinforcement, fitments and anchor plates. Anchors for metal items with a large exposed surface area must be electrically isolated from the remaining reinforcement. The electrical continuity must be demonstrated for each reinforced concrete element for which allowance for cathodic protection has been provided. The electrical continuity must be tested in accordance with Australian Standard AS 2832.5 Cathodic Protection of Metals, Part 5: Steel in Concrete Structures.

(c) Measures must be taken to minimise the possible deleterious effects of heat of hydration in thick concrete sections, which may include the use of blended cements, cooling concrete during curing, insulated forms and the use of larger aggregates.

(d) The durability of reinforcement which is incorporated in or contributes to the action of soil reinforcement techniques must comply with the requirements of RMS D&C R57.

(e) Exposed steelwork must be either:

(i) of suitable grade to resist corrosion; or

(ii) protected by a high grade protective coating having a minimum maintenance free life in accordance with Appendix 29 (Asset Items and Sub-Items – Specified Design Lives). At the end of the maintenance free life, the coating must remain soundly adhered to the steel substrate and must be suitable for overcoating without removal. Lead based coatings, chlorinated rubber based coatings and alkaloid based coatings must not be used.

(f) Structures must be designed to enable items such as bearings (except elastomeric strip bearings conforming to RMS D&C B280), expansion joint seals, railings and drains to be easily maintained and readily replaced. Structures must be designed to enable all steel coatings to be maintained.

(g) Where an item is not readily accessible for maintenance or replacement, it must be designed so that it will function for the life of the structure without maintenance.

(h) Protection must be provided against stray electrical currents.

(i) Prestressing tendons must be placed in polyethylene ducts. Metal sheathing or ducts must not be used.

(j) All pot bearings and bearing attachment plates , must be manufactured from grade 316 stainless steel.

(k) Reinforced soil walls must not be used where it is subjected to water flow forces and susceptible to scour.

8 Single Bridges

(a) A single bridge must be designed as either:

(i) single substructures supporting separate superstructures for each carriageway provided that the piles supporting the substructures are founded on a sound rock stratum. The superstructures must seperated by a minimum horizontal gap 50 mm that is located within a raised median or between bridge barriers; or

(ii) single bridges carrying both carriageways which must comply with the following requirements:

A. the bridge deck slab must be constructed from an RMS approved concrete mix design having a shrinkage strain not greater than 500 microstrain at 56 days;

B. the deck slab must be wet cured and fully insulated for at least 14 days;

C. the deck slab must be constructed, either:

1. without any traffic loadings on the bridge, in which case a longitudinal construction joint is permitted. A maximum pour width of 30m is permitted between any construction joints along the deck width and minimum time lapse of 3 to 7 days between adjacent deck slab pours on the same span; or

2. in two stages to allow traffic loadings during construction and in accordance with the requirements in Section 8.1 of this Appendix.

D. for girder and slab type bridges, the deck slab must not have any transverse construction joints except at the link slabs; and

E. the substructure must be supported by piles founded on a sound rock stratum.

(b) Notwithstanding section 2.4(a) of this Appendix 13, a deck expansion joint may be provided between the abutments.

(c) Deck expansion joints must comply with section 2.4 (f) and section 2.4 (g) of this Appendix 13. At pier locations, where it is not physically possible to provide drainage troughs directly under the deck expansion joint, drainage troughs may be located between the top of piers and the underside of the girders, provided stainless steel splash plates are attached to the ends of the bridge girders for the full width of the bridge and for the full depth of the girders. The stainless steel splash plates must not be less than 3mm thick.

8.1 Two Stage Deck Construction

(a) A single bridge deck constructed in two stages to allow traffic loadings during construction must:

(i) have a closure strip between stage 1 and stage 2 of the deck construction;

(ii) include a detailed investigation to develop a procedure for the construction of the closure strip pour between stage 1 and stage 2 of the bridge elements. The procedure is subject to RMS' approval prior to construction and must account for the planned construction methodology and traffic restrictions for construction staging of the bridge deck to meet the following, as a minimum, concrete strength and peformance requirements:

A. The closure strip must provide integral structural connection between stage 1 and stage 2, so that most of the stage 1 deck can be constructed independent of the stage 2 bridge deck.

B. The closure strip shall be poured with concrete having a minimum 28 day concrete strength of 50MPa.

C. Prior to pouring the closure strip, traffic on the stage 1 bridge deck shall be relocated so that the edge of the closest traffic lane is at least 7 m clear from the edge of the closure strip. The traffic speed limit shall be reduced to a maximum of 40km/h.

D. the spacing of the N16 longitudinal reinforcement must be reduced to 100mm in the closure strip(s) over a minimum width of 1000mm adjacent to the previous deck pour.

E. Prior to pouring the closure strip, the lapping projecting reinforcement from the stage 1 bridge deck and the partly constructed stage 2 deck shall be securely connected with a minimum of triple wire ties over the lapped section of the bars.

F. The stage 1 traffic lane may be reinstated to a minimum 3.5m offset from the edge of the closure strip after a minimum of 24 hours from the completion of pouring and finishing the concrete. This is subject to the strength of the concrete after 24 hours (as measured by a pair of concrete cylinders cast and cured with the closure pour) being a minimum of 15MPa.

G. The stage 1 traffic lane may be reinstated to a minimum 1.0m offset from the edge of the closure strip after a minimum of 36 hours from the completion of pouring and finishing the concrete. This is subject to the strength of the concrete after 36 hours (as measured by a pair of concrete cylinders cast and cured with the closure pour) being a minimum of 20MPa.

H. Subject to meeting the minimum concrete strength requirements after 36 hours, the traffic speed limit reduction to 40km/h can be removed for Stage 1 traffic.

I. All traffic control signals shall be minimum of 10m away from edge of a bridge approach slab during construction of and curing of the closure strip to avoid braking forces on the bridge during construction and curing. This requirement must be maintained for at least 14 days aftet the completion of pouring the closure strip.

Transport
Roads & Maritime
Services

Exhibit A –
Scope of Works and Technical Criteria
Appendix 14 – Not Used
for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

November 2016

Document Author: Roads & Maritime Services

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About this document

Project data

Project name:	Western Sydney Infrastructure Plan, The Northern Road Upgrade - Stage 3 North Project
Contract type:	Design and Construction
Contract number:	15.3662.2254
Location:	Penrith, New South Wales
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Document name:	WSIP The Northern Road Upgrade - Stage 3 North Project Exhibit A – SWTC Appendix 14
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Prepared by:	Roads & Maritime Services
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Table of Contents

1 Not Used

Transport
Roads & Maritime
Services

Exhibit A –
Scope of Works and Technical Criteria
Appendix 15 – Urban Design Performance and Design Requirements
for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

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Table of Contents

1 General

(a) The Urban Design must be prepared and implemented in accordance with the requirements of this Appendix 15 and in accordance with the Environmental Documents.

(b) The Project Works must:

(i) satisfy the Environmental Documents;

(ii) be sensitive and responsive to the landform and character of the landscape context of the Project Works and the surrounding area;

(iii) minimise impacts on existing properties, infrastructure, open space and vegetation;

(iv) exemplify innovative and integrated engineering, urban and landscape design;

(v) include excellent design quality for all structures and built elements in terms of form and scale, neatness of design and quality of finishes;

(vi) provide road corridors that are well vegetated, with planting that matches the character of the local context and adjoining vegetation communities as closely as possible, and retains good views to the surrounding area;

(vii) ensure that signage and wayfinding elements are coordinated with all other aspects of the design to avoid clutter and impact to views;

(viii) achieve a self-explaining, intuitive and safe road environment, irrespective of signage; and

(ix) provide a visually attractive artefact in the landscape.

(c) The following are elements of the Project Works that are substantial in the landscape, affecting the scale and character of the area and its connectivity, and require an appropriate and responsive urban design approach, in accordance with 'Beyond the Pavement Urban Design Policy Procedures and Design Principles' (RMS, 2014), to meet the project objectives:

(i) landscape planting and strategy that minimises the scale and extent of hard pavement in the road corridor and allows for the replacement of mature trees that are required to be removed to facilitate the Project Works;

(ii) major interchanges, particularly their footprints and structural design resolution;

(iii) verge areas, including interface with adjacent existing and planned land uses and incorporation of a shared path;

(iv) earthworks, including cuttings, fill embankments and retaining walls;

(v) bus facility location and design integration;

(vi) design and integration of noise attenuation measures; and

(vii) location and design integration of signage and wayfinding.

(d) The Contractor must provide as part of the Urban Design; 3D artistic representations, articulated with text, of key views that relate to the following areas or items, and must be submitted as part of the Design Documentation. All artistic representations must be accompanied by an 'existing' image of the same view to allow for comparison between the proposal and the current condition:

(i) A view from driver's level on the M4 looking towards the new overpass structure;

(ii) A view from the shared path from immediately north of the Glenmore Parkway intersection looking north;

(iii) A view of the road corridor in the residential area north of Maxwell Street.

(e) The Contractor must include qualified and experienced urban designers (including architects and landscape architects) in the design team for the Project Works. The urban designers must:

(i) be registered on RMS's (Urban Design Services) Category U2 list of Registered Contractors;

(ii) be integrated in the design organisation and with all the various design disciplines;

(iii) be involved in the ongoing development, detailing and finalisation of the urban and landscape design and all its elements;

(iv) attend the site during the construction activities to monitor the implementation of the design, and;

(v) review and advise on all design issues and modifications affecting the design quality of the Project Works during the construction period, in consultation with the RMS Representative.

(f) The Contractor must ensure that the major urban elements, particularly the M4 Motorway interchange with The Northern Road and associated built elements, bridges, overpasses, retaining walls and noise walls are:

(i) developed to high urban design standards in the whole and the parts; and

(ii) designed to be consistent the desired landscape character identified in the Environmental Documents.

(g) The Project Works must be 'best urban design practice', as this requirement is detailed and required by, but not limited to, the following Reference Documents:

(i) 'Beyond the Pavement - RTA urban design policy, procedures and design principles' – RMS, 2014;

(ii) 'South Western Sydney Urban Design Strategy – Draft' – Cox Architecture, 2016

(iii) 'Bridge Aesthetics - Design guidelines to improve the Appearance of Bridges in NSW' – RMS, 2012;

(iv) 'Noise Wall Design Guidelines' – RMS, 2016;

(v) 'Shotcrete Design Guidelines - RTA guidelines to avoid, minimise and improve the appearance of shotcrete' – RMS 2016;

(vi) 'Landscape Guideline' – RTA. 2008;

(vii) 'Water Sensitive Urban Design Guideline, Consultation Draft' – RMS, 2016

(viii) 'Designing To Minimise Vandalism (Final Draft)' – RTA. November 2008; and

(ix) 'Biodiversity Guidelines – Protecting and managing biodiversity on RTA projects' – RMS, 2011

(h) The Contractor's detailed urban design outcome must comply with:

(i) current road safety requirements;

(ii) current road design requirements;

(iii) WH&S requirements for both construction and maintenance;

(iv) the Environmental Documents; and

(v) Penrith City Council's maintenance and design requirements.

2 Bridges and Overpasses

2.1 Requirements for all Bridges and Overpasses

(a) The design of all bridges and overpasses must be in accordance with 'Bridge Aesthetics - Design guidelines to improve the Appearance of Bridges in NSW' (RMS, 2012)

(b) Bridges must present smooth, clean lines, and have a minimum structural depth consistent with their spans and method of construction. The design of the bridges, including parapets, balustrades, safety screens and noise barriers, must address the slenderness ratio of the structures.

(c) The bridges and overpasses for the Project Works are to be designed as a consistent family of bridges according to type (e.g. shared path bridge or overpass), with similar forms, detailing, materials or finishes, and:

(i) with consideration to adjoining sections of the road network where relevant; and

(ii) where appropriate, be individually distinctive to act as visual markers and reflect their location, role and span.

(d) Where applicable, the use of smoothly tapered haunched girders is preferred over single depth beams. Design girders and associated shadow lines to reduce the perceived thickness of structure. Except for haunched or arched bridges, the depth of the bridge superstructure must be constant for all spans on a bridge.

(e) Proportions of the bridge must represent the spanning and supporting requirements, and must respond to the context of the individual bridge localities.

(f) If required, noise barriers located on bridges must:

(i) be integrated with the design of the bridge as a whole; and

(ii) be constructed from a transparent and shatter proof material (acrylic in preference to glass) provided with markings/symbols to reduce the likelihood of bird strike.

(iii) be designed to minimise glare at adjacent residences; and

(iv) be designed to ensure privacy of adjacent residents being overlooked;

(g) Where safety screens are required on bridges and overpasses:

(i) they must be integrated with the design of the bridge or overpass as a whole;

(ii) post spacing must be designed to have a pleasing and ordered visual relationship with other bridge details, including where applicable: safety barrier posts, lighting columns and parapet joints;

(iii) post spacing must be equivalent to the whole of or fraction of parapet joints, where applicable, with posts either aligned with parapet joints or spaced so that the parapet joint is located midway between the posts;

(iv) the screens on the overpasses must be terminated by tapering ends towards the parapet. Screens must extend the full length of the overpass with a generous tapered overlap of the overpass approach or departure; and

(v) fixing points must be in line with the double rail vehicle barrier, where applicable, to minimise visual clutter. Safety screens, including posts, must not obscure the outer faces of the parapets and must be integral with the shape and form of the parapets, including the traffic barrier railing system and any skirt systems to hide services or drainage pipes.

(vi) Any artwork on bridges being replaced must be replaced with new artwork to an equivalent design standard on new safety screens.

(h) Bridge or overpass parapets must:

(i) be elegant and attractive with neat, evenly spaced joints, smooth even lines and consistent high quality surfaces and colour;

(ii) extend parallel to the road surface for the full length of the bridge, with a generous overlap of the bridge abutments;

(iii) have outside faces with smooth single plane surfaces, must not contain visible joints or kinks and must be slanted slightly outwards to catch the sunlight, such that the bottom of the parapet is furthest from the centreline of the bridge;

(iv) have a top surface that angles towards the road to channel rainwater onto the bridge to minimise staining of the outside face of the parapet;

(v) for curved bridges, be designed on a smooth curve irrespective of the alignment of the girders;

(vi) where the parapets are to be constructed using precast concrete units, have the adjoining parapet units installed plumb to ensure that all lines along the parapets are smooth, continuous and parallel to the road surface for the full length of the bridge;

(vii) have a bottom surface which overhangs below the underside of the bridge deck slabs (including girder flanges) by a minimum of 200mm or to cover service pipes by greater than 50mm;

(viii) be sculpted to be self-cleaning; and

(ix) integrate with traffic barriers where applicable.

(i) Signage must not be located on bridges or overpasses, except for bridge name plates, overpass bridge road names, clearance markers and navigation markers.

(j) Connections between road and overpass traffic barriers must be neat and simple.

(k) Where overpass barriers are of different heights to adjoining traffic barriers on the approach or departure, transitions must be 10:1 or flatter between the adjacent heights.

(l) Where applicable, traffic barriers on bridges and overpasses must consist of a metal two rail and post system mounted on top of a concrete parapet.

(m) Where required, the bridge or overpass deck draining systems must be discrete and concealed from view. Drainage pipes, services and future provisions for services must not be visible except from directly underneath the bridges. The thickness of the bridge deck structure or parapets must not be increased above the minimum that is structurally required to accommodate drainage systems, services and provisions for services.

(n) In the direction transverse to the bridge centre lines, the bridge decks must extend beyond the limits of the substructures, including abutments, so as to avoid staining to the substructures and so as to produce shadow lines. The designs must incorporate drip lines to the soffits and flanges of the bridges to reduce staining.

(o) Exposed shotcrete must not be used around the curtilage of bridges or overpasses.

(p) Bridge abutments must be designed such that they are easily maintainable and do not promote vagrancy or graffiti.

(q) Pile caps must be concealed below finished ground surface.

(r) The requirements of Section 2.2 of this Appendix are additional to, and to the extent of any discrepancy or inconsistency with this Section 2.1, take precedence over this section.

2.2 M4 Interchange Bridge

As a minimum, the M4 interchange bridges must meet the following requirements:

(a) Where spill through abutments are utilised, abutment treatments must extend 1m beyond the parapet line. Abutment treatments must extend into the horizontal portion of the abutments by 1.5m.

(b) Where retaining wall abutment structures are utilised, unless required to support ramps they must return back to the bridge alignment to form buttresses. Retaining wall abutment structures must be finished in concrete panels and must be designed so that the horizontal joints are accentuated to provide strong horizontal banding and the vertical joints are minimised and less accentuated. Abutments must visually relate to other retaining structures.

(c) Walls parallel to the centrelines of bridges must be recessed from the front face of the parapet face by a minimum of 250mm by cantilevering the parapet.

(d) Piers must be of the column or wall type without headstocks which protrude in the bridge elevation.

(e) Batter slopes under the bridge, must be finished in a paved or hard surface. Abutment hard surfacing treatments must be designed to be aesthetically pleasing, vandal resistant and to complement the context and aesthetics of the upgrade. Abutment hard surfacing areas must be edged to reduce future crumbling and to form a neat interface Steps must be incorporated in the same material as the batter slope face to facilitate maintenance access to inspect the bearings.

(f) Areas of residual bridge deck shall be designed with consideration of the visual appearance from both the pedestrian and motorist perspective as well as future maintenance requirements.

3 Earthworks, Landform and Slope Stabilisation

(a) The earthworks and stabilisation treatments must be integrated with the local landform.

(b) The vertical and horizontal alignment of the Project Works must be flowing and responsive to the landform and landscape. Independently grading the carriageways is an acceptable method to achieve this outcome.

(c) The tops and bottoms of batters must be rounded and feathered into the adjacent landform. The ends of cuttings must be rounded off and feathered into the adjacent landform to avoid an artificial character. The ends of batters in cuttings must be rounded and the batter slope progressively flattened over an appropriate distance, but not less than 30 metres, to blend the batter into the surrounding landform.

(d) Embankments must be graded out at the toe to reduce the visual impact of any obvious junctions between the fill material and the natural landform, and to assist in avoiding an artificial character to embankments.

(e) Cut and fill batter interfaces, roundings, feathering and transitions must be computer modelled. The results from this work must be included in the Design Documentation in the relevant road design plans and cross-sections.

(f) The potential for successful and ongoing vegetation establishment must be treated as integral to the design of cuttings and embankments in order to significantly reduce the 'engineered' nature of cuttings and embankments and the proportion of slopes exposed to viewers from any one angle.

(g) All fill embankments must be vegetated – either by planting, turfing or revegetation, as appropriate to the plant species and location of the embankment.

(h) The Contractor must avoid the use of shotcrete wherever possible in accordance with the principles set down in the RMS document titled 'Shotcrete Design Guidelines – Design guidelines to avoid, minimise and improve the appearance of shotcrete' (RMS, 2016) including but not limited to:

(i) laying back cuttings;

(ii) allowing sufficient space at the base of cutting for protective fence or safe debris fall; or

(iii) by utilising alternative stabilisation methods.

(i) Where underlying rock is stable with shotcrete likely to be less than 10% of the surface area, an exposed rock finish to cut batters is preferred to minimise impacts on existing landscape character, vegetation and adjoining properties. Subject to other requirements of the SWTC, such batters must be constructed as steeply as the material will allow.

(j) Where shotcrete coverage will or is likely to exceed 10% of the batter surface area, the batter must be laid back to slopes that are appropriate for planting or the application of a compost blanket. Where this cannot occur due to property or environmental constraints, or incompatible adjoining landscape character, the following requirements apply:

(i) wherever possible the shotcrete covered cutting must not be visible to the road user, adjacent properties or public land; and

(ii) the shotcrete must be faced with a material and finish that is appropriate to the character of the surrounding landscape. Acceptable materials include concrete panels with a simple non-pictorial surface texture or pattern, stone, brick or architectural concrete block masonry, and rock-filled architectural (non-structural) gabion 'facing' using local stone or stone that is similar to the local geology.

(k) Where the use of shotcrete is unavoidable and is visible from the road, or surrounding land:

(i) shotcrete must not be used around the base of light columns or other roadside fittings or furniture;

(ii) the extent of the shotcrete must be minimised;

(iii) the edges of the shotcrete must be masked off to avoid overspray;

(iv) the colour of the shotcrete must be adjusted to match the colour of the surrounding rock batter, where the batter is visible, or be a dark recessive colour;

(v) for areas of shotcrete wider and/or longer than 1 metre, a surface finish must be applied so that the stabilised cutting appears in texture and colour to match the texture and colour of the surrounding rock; and

(vi) test panels must be provided in accordance with RMS D&C R68 to demonstrate compliance of the shotcrete with requirements of the SWTC.

(l) Exposed rock batters must have neat, stable and uniform slopes. Exposed rock beneath structures must have continuous slopes and not be stepped.

(m) Other than for cuttings in rock:

(i) all batters or embankments must be designed with grades appropriate for planting, seeding or the application of compost blanket; and

(ii) batter slopes and benches in cuttings must be treated with a weed free topsoil and vegetation to visually soften them.

(n) Subject to REF Determination and environmental statutory requirements, the design and permanent placement of excess material or spoil from the Contractor's Work is to be in accordance with the following.

(i) Placement of spoil is integrated with the Project Works' earthworks and road formation as per clause 3(a) above,

(ii) As a priority, placement of spoil must be used

A. to provide flatter embankment batter slopes for the Project Works; or

B. to provide increased topsoil depths for revegetation treatment; or

C. to provide screening to mitigate visual impact or noise impact where required by the Standard Mitigation Measures and Safeguards

(o) Where spoil is not able used in any of the priority situations mentioned above, a strategy indicating proposed sites for the placement of excess spoil must be submitted to the RMS representative prior to placement. The submission must describe the area, maximum height, maximum slope and surface finish of each proposed site.

4 Requirements for Drainage

(a) A system of water sensitive drainage devices must be used, where practical and/or required, to drain and cleanse runoff. Such devices must include swales, ponds and/or basins to control the intensity of, and remove pollutants from, stormwater runoff from locations where it leaves the pavement or bridge surface to the locations where it is discharged into receiving environments.

(b) Landform for swales, water treatment ponds, detention basins and other permanent drainage landforms must be informal and 'natural' in appearance and not be geometric and rectangular in shape.

(c) Concrete or shotcrete must not be used in drainage channels that are visible to road users, adjoining residents or members of the public on public land where practical alternative means of scour protection are available. The use of natural materials as drainage channel stabilisation materials, including stone in wire mattresses, must be maximised in these situations.

(d) Where concrete or shotcrete channels are unavoidable and visible from the road, residences or public spaces, the location and line of the channel must minimise visual impacts and planting must be designed to screen the channel. The lining material must be darkly coloured to achieve an unobtrusive colour that is consistent with the local natural rock colours.

5 Vegetation

5.1 General

(a) Revegetation and planting must be in accordance with:

(i) "RTA Landscape Guideline: Landscape design and maintenance guidelines to improve the quality, safety and cost effectiveness of road corridor planting and seeding" (RTA, April 2008);

(ii) RMS D&C Specifications R178 (Vegetation), R179 (Landscape Planting), R176 (Seed Collection); and

(iii) Relevant Penrith City Council guidelines and strategies.

(b) Revegetation and planting is an integral part of the Contractor's Work, and:

(i) the Contractor must ensure that the Project Works and surrounds are complete at project opening, with an emphasis on the use of mature or semi-mature trees and advanced size mass planting at sufficient densities to achieve this;

(ii) regular monitoring of the revegetation and planting implementation during construction and post-construction is required to ensure that the landscape design is successfully achieved; and

(iii) the landscape works must be adequately costed regarding supply, implementation and maintenance to ensure that the full landscape and planting design concept can be delivered.

(c) As a minimum, the landscaping and planting must be designed and constructed to:

(i) provide an attractive approach to and departure from the developed areas along the Project Works;

(ii) provide a well vegetated road corridor to ensure long term viability and match the character of the local landscape and adjoining vegetation communities as much as possible;

(iii) maximise the retention and protection of existing roadside vegetation in order to minimise the degree of visual change;

(iv) match and reinforce the existing spatial sequence and character of the landscape, both built and unbuilt, along the Project Works;

(v) reinforce enclosure when passing through areas with denser adjacent tree coverage and provide long distance views for road users when such views are available;

(vi) retain existing district views for residents;

(vii) provide screening of the road from viewer locations identified in the Environmental Documents;

(viii) fulfil the environmental, safety and functional requirements, including consideration of ongoing maintenance costs, identified in the SWTC;

(ix) revegetate cuttings and embankments where possible to reinforce the landscape setting of the corridor;

(x) rehabilitate and revegetate residual disused land acquired for the Project Works;

(xi) mitigate the visual impact of fauna fencing and overhead power lines where required; and

(xii) take into consideration road signage planning to avoid conflict with road signs and their approach views.

(d) Reused Site topsoil must meet the requirements of clause 5.5 (c). Imported topsoil used in the landscape works must be weed free if practicable, and sourced from a reputable supplier, which must provide documentary evidence of the source and physical/chemical properties of the material provided.

(e) Utilities and services locations must be coordinated with landscape design to ensure that they do not preclude nor conflict with the planting of trees (and their ultimate root systems) within the road corridors.

(f) Distinctive and locally characteristic semi-mature tree plantings must be used to emphasise intersections identified in the Environmental Documents and to integrate the Project Works into the local landscape context, including any street tree plans in place for the local government area.

(g) The plant species and mixes of the landscape design must conform to the landscape character zones through which the Project Works pass.

(h) New planting must be integrated with existing vegetation to reinforce local and remnant vegetation patterns and to maintain or enhance existing landscape character.

(i) Treatments adjacent to and within half the average crown height of forested areas retained following clearing should be limited to revegetation processes only, preferably through the application of compost blanket.

(j) Non-frangible vegetation must conform to clear zone requirements or be protected by a safety barrier.

(k) New trees or large shrubs that are planted within the clear zone must have trunk diameters when fully mature of no more than 100 millimetres.

(l) Safe sight distances and signage must not be obscured by planting and revegetation regrowth.

(m) Setbacks must be provided for structures, roadside furniture and pathways to enable clear access for maintenance and visual inspections when the vegetation matures.

(n) All grassed areas in public spaces must be turfed with rolls and not seeded.

5.2 Plant Species Provenance

(a) The following definitions apply to native plant species to be used in the Project Works:

(i) endemic plant species are those that are native and can be found ONLY in a particular location and don’t occur elsewhere (mainly refers to subspecies).

(ii) local or indigenous plant species are those that are native and can be found in a particular location as well as other locations.

(b) For planting and revegetation in ecologically sensitive areas and bush revegetation areas:

(i) plants or propagules that are endemic to the Site are to be used in preference to indigenous plants or propagules of local provenance;

(ii) where there are insufficient quantities of endemic plants or propagules for the required revegetation works, priority for their use is to be given to areas that have the highest ecological value;

(iii) indigenous plants or propagules may be used where there are ecosystems or vegetation at the Site that will not be detrimentally impacted by non-endemic species, or where endemic materials are unavailable;

(iv) indigenous materials may be collected from the Site or procured elsewhere subject to agreement by the RMS Representative. Matching ecosystems and environmental conditions must be identified radially from the Site to source indigenous materials. Environmentally and geographically closest options must be used; and

(v) non-indigenous materials including non-invasive exotic species may be used concurrently subject to ecological review and by agreement by the RMS Representative.

(c) For native plantings elsewhere in the Project Works, priority is to be given to indigenous species, where appropriate and available, in both the species selection and plant procurement.

5.3 Planting

(a) Except where verges and medians are sealed, planting must be used to revegetate verges and medians of the Project Works.

(b) Planting must be used in all areas where trees, shrubs and ground covers are required, including:

(i) for early visual effect, particularly at intersections, interchanges, ramps and other locations nominated for specific landscape outcomes such as enclosed driving experiences, avenue reinstatement, screening and riparian zones;

(ii) for neat attractive finishes at the Date of Completion;

(iii) for visual mitigation of noise barrier elements such as walls or mounds;

(iv) for air quality filtering to avoid potential hazards to road users such as dust clouds and chemical spray drift;

(v) for visual screening to and from properties; and

(vi) for early landscape establishment in locations that may require special landscape provisions such as fauna movement corridors, riparian corridors, ecological niches, mitigation of the effects of construction clearing on wildlife, and in significant cultural or community landscape areas.

(c) The planting design must provide a strong emphasis on creating a well vegetated corridor. The planting mix must contain tubestock for indigenous groundcover species, and larger stock for feature / marker planting and non-indigenous or horticulturally cultivated species. Tubestock may be used where not in conflict with other requirements in Tables 15-1 and 15-2.

(d) All street trees must be 75 litres in size (semi-mature) or larger. All other trees must be at least 200mm pot size or larger. As well as their general use throughout the project to complement surrounding planting patterns and provide spatial definition, trees must be used in the locations listed in Table 15-1. The densities and sizes identified in Table 15-1 have been specified to meet the minimum requirements of clauses 5.3(b) and 5.3(c).

Table 15-1 Tree Locations and Tree Planting Density

Tree Locations	Tree Planting Density and Size
Planting at interchanges and feature/marker planting at selected locations as identified in the Environmental Documents	No less than 1 tree per 30m². Trees must be 75 litres or larger.
Visual screens or buffers at noise walls, retaining structures and private properties	No less than 3 metre spacing.
Street tree planting – where required to continue existing avenues at intersections being realigned as part of the Project Works	Consistent with existing street character and consistent with any of the local Council area requirements, but with: • no more than 10 metre spacing.

(e) Shrubs, ground covers and native grasses must also be used to complement surrounding planting patterns and provide spatial definition, including in the situations and at the densities listed in Table 15-2. The densities and sizes identified in Table 15-2 have been specified to meet the minimum requirements of clauses 5.3(b) and 5.3(c).

Table 15-2 Shrubs, Ground Covers and Native Grass Planting Density

Landscape	Shrub / ground cover planting density & pot size
Planting in medians, verges directly adjacent to road carriageways, and between footpaths/shared paths and property boundaries	Native grasses or ground covers: 6 plants per m² (150mm containers minimum) Shrubs: 4 per m² in 5L containers
Specific planting at interchanges	Native grasses or ground covers: 6 plants per m² (150mm containers minimum) Shrubs: 4 per m² in 5L containers
Screening to noise walls and retaining structures	Native grasses or ground covers: 6 plants per m² (150mm containers minimum) Shrubs: 3 per m² in 5L containers
Screening to existing properties	Native grasses or ground covers: 6 plants per m² (150mm containers minimum) Shrubs: 3 per m² in 5L containers
Screening to new project elements	Native grasses or ground covers: 6 plants per m² (150mm containers minimum) Shrubs: 3 per m² in 5L containers

(f) All planting areas must be mulched with hardwood chips derived from site clearing works or from certified renewable sources.

(g) *Acacia* spp must not be used in the planting mix.

(h) Sedges must be used in the planting mix for drainage and riparian areas.

(i) All planting, including the requirements in Table 15-1 and Table 15-2 are subject to Penrith City Council acceptance and Safety in Design considerations.

5.4 Revegetation

(a) For revegetation of disturbed land in forested areas, the application of compost blanket may present a more viable solution to planting and is preferred over planting or seeding to maximise the potential for successful and ongoing vegetation establishment. Other forms of revegetation may only be used with the approval of the RMS Representative.

(b) Compost blanket may be used on embankments that are particularly steep, rocky or require a quick, permanent establishment of vegetation cover. The use of compost blanket is to be determined as site conditions are exposed and areas with specific constraints identified in consultation with the RMS Representative.

(c) Compost blanket is the application by pneumatic spray of seed, fertiliser, high quality compost, organic tackifiers, biological stimulants, wetting agents and soil ameliorants.

Where compost blanket is used, the sprayed compost blanket layer must have a minimum thickness at any location of 5mm within 48 hours of application. Installation of compost blanket is to be in accordance with supplier's requirements and is to be supported by a guarantee of 80% strike rate.

(d) The use of compost blanket is to be in accordance with the 'RMS Guideline for Batter Stabilisation – Fact Sheet 13: Compost Blanket'.

(e) The following requirements apply for compost blanket and (where approved by the RMS Representative) hydroseeding or hydromulching:

(i) the seed mix must be an endemic/non-invasive grass and cover crop seed mix sown at a minimum rate of 8 kg/Ha; and

(ii) the seed mix must contain an appropriate ratio of native ground covers, grasses, shrubs and trees depending on the landscape context and adjacent levels. Endemic and/or indigenous seed is preferred.

5.5 Soil and Growing Media

(a) The Contractor must undertake soil paedology survey and analysis within each soil landscape and vegetation community type. Each soil landscape and vegetation community type must be tested in three locations, each with three sampling depths of A1, A2 and B1 horizon. Soil testing must be undertaken by a National Association of Testing Authorities (NATA) registered laboratory and include pH, salinity, cation exchange capacity, plant available phosphorous, total organic matter, total nitrogen and carbon / nitrogen.

(b) Soil testing and any recommendations for soil management must be made by an appropriately qualified professional soil scientist with expertise in revegetation and urban landscape reconstruction. A copy of these recommendations must be provided the Project Verifier and the RMS Representative. This data must be used in the selection and design of planting and revegetation.

(c) All growing media including topsoil re-used within planting and revegetation areas must be prepared in the following manner:

(i) a representative program of soil sampling of all soils to be used in planting and revegetation areas to address any soil deficiencies, including soil pH analysis, must be undertaken during the preparation and development of the Design Documentation and the results of the tests, together with advice from the soil scientist, must be used to determine the requirements for soil improvement and stabilisation to enable the establishment and maintenance of successful long term seed and plant growth and vegetation cover;

(ii) all soils must be conditioned or improved to comply with the recommendations of the soil scientist;

(iii) prior to the placement of topsoil, the Contractor must continuously eradicate weeds in treatment and adjoining areas by spraying, and monitor the weed cover four (4) weeks after each spray. When monitoring indicates that weed cover is less than five percent (5%) cover, a final eradication spray must be undertaken; and

(iv) subsoils must be ripped and surfaces roughened prior to spreading of growing media.

5.6 Biodiversity Protection and Recovery

(a) The requirements for biodiversity must be consistent with the Environmental Documents.

(b) Local bushland characteristics must be adopted in the design of planted areas, including the use of:

(i) species mixtures that reflect local natural species mixes and diversity;

(ii) occasional multi-species group plantings to reflect natural closely spaced companion plants; and

(iii) diversified rather than standardised, spacing between plants.

(c) Biodiversity protection and recovery must be maximised in the landscape design adjoining environmentally sensitive areas, including measures to:

(i) protect and create habitat (using ground conditions and vegetation);

(ii) recover threatened species;

(iii) minimise habitat fragmentation and create habitat linkages;

(iv) minimise habitat pollution, including pollution due to pesticides, fertilisers and road run-off; and

(v) eliminate invasion by non-endemic species.

(d) The landscape design must use appropriate plant species to maximise wildlife habitat connectivity.

5.7 Landscape Management

(a) A Landscape Management Plan (LMP), detailing all landscape maintenance actions for the project's landscape works, must be prepared as part of the Design Documentation.

(b) The LMP must be consistent with the requirements identified in the Environmental Documents and must comply with the requirements described in:

(i) 'RTA Landscape Guideline: Landscape design and maintenance guidelines to improve the quality, safety and cost effectiveness of road corridor planting and seeding' (RTA, April 2008)

(ii) RMS D&C Specifications R178 (Vegetation), R179 (Landscape Planting), R176 (Seed Collection); and

(iii) Relevant Penrith City Council guidelines and strategies.

(c) The landscape works must:

(i) be cost effective;

(ii) minimise ongoing maintenance requirements; and

(iii) utilise endemic and native species, dense planting, bold simple planting designs and rapid planting establishment to assist in achieving the requirements of the above.

6 Requirements for Road Furniture

(a) All services, roadside furniture, signposting, plant and equipment within the road corridor (including variable message signs, variable speed limit signs, access ladders and antennae), must be incorporated into and integrated with the overall urban and landscape design.

(b) Where not required for noise attenuation purposes, safety barrier types must be selected to maximise visual connections from the carriageways to the surrounding landscape context. Visually permeable systems such as double rail 'bridge' barriers, W-beam barriers or wire rope barriers are be used in preference to solid barrier types. The upstands/posts of wire rope type barriers must be white.

(c) Fauna fencing, where required, must be placed behind plantings to obscure it from the Main Carriageways and Other Roads. Views of fencing on the skyline must be minimised. All fencing mesh must be dark coloured or black in appearance where it is visible from the Main Carriageways and Other Roads.

(d) Signposting must be located to prevent the visual obstruction of good views of the landscape, avoid clutter and minimise views of signs above the skyline.

(e) The design and placement of lighting must minimise visual intrusion and must include the use of slender, simple and refined lighting columns that eliminate unnecessary light spillage.

7 Requirements for Road Structures

7.1 General

(a) Road structures, including culverts, underpasses and walls, must be unobtrusive. Visible road structures must be simple, refined and without any unnecessary embellishments.

(b) The design of retaining structures must be undertaken in consideration of all other elements such as bridges, noise walls and landscape works and provide a cohesive and unified design outcome.

(c) The appearance of concrete retaining structures associated:

(i) with bridges must have a strong horizontal emphasis; and

(ii) with retaining walls must have a strong vertical emphasis.

(d) Where rock filled gabions are proposed for use as retaining walls or wall facings in areas visible from the road or surrounding properties:

(i) the design must demonstrate consideration of the three-dimensional form of the batter face; and

(ii) they must be constructed using techniques that control appearance of the visible face, including the use of formwork, architectural welded cages and hand-packing individual stones.

(e) Retaining walls over 1 metre in height must be tilted outwards at the base at no less than a five degree (5^{o}) angle from the vertical, except for walls with facing panels.

(f) The design of individual retaining walls or classes of walls must respond to their immediate context and their specific role in the Project Works.

(g) Retaining walls adjacent to residential properties should be designed using materials which are complementary in scale, finish and colour to the context of the adjoining area.

(h) Retaining wall returns and terminals including driveways to adjoining properties are to be designed with consistent detailing over the length of the wall.

(i) The tops of the retaining walls must in general not be stepped and must form a continuous flowing line. Where stepping the retaining walls is unavoidable, for example due to steep topography, stepping should be neat and architecturally appropriate and preferable at property boundaries.

(j) The contractor should consult with affected landowners regarding design materials and finishes, where the retaining wall forms part of the boundary, or is immediately adjacent to the property boundary.

(k) Boundary fences on top of retaining walls should be responsive to the individual context of each property and not be repeated as one standardised style of fence for all properties.

(l) Structures must be neutral in colour and have non-reflective finishes.

(m) On all exposed concrete surfaces on structures, including Type F barriers:

  (i) the finishes and colour must be uniform;

  (ii) form tie holes must be aligned in a uniform pattern; and

  (iii) patching of any Defects must match the appearance of the remainder of the surface.

(n) Structures must be designed and placed to minimise visual intrusion and be screened by existing or proposed vegetation to minimise their visibility to road users and residents.

(o) Adjacent and separate planting beds must be used to reduce the visual impact of structures.

(p) Wall plan layouts must be simple and be straight, or have large radius curved alignments sympathetic to the alignment and interfaces with adjoining infrastructure, including roads, pathways and bridges, and environmental features, including creeks and stands of trees, landscape design and the immediate route context. Kinks and bends must not be used in walls in either horizontal or vertical alignments.

(q) Walls must be designed with copings that neatly finish the wall with smooth flowing lines. Drainage must be diverted and aligned away from wall faces. Copings, drainage channels, barriers, balustrades, noise walls, noise mounds and headlight screens must be integrated.

(r) Structures must be provided with safe access for maintenance purposes.

(s) Fixings for retaining structures must be concealed, or expressed as part of the structure's design if concealment cannot be achieved.

(t) Precast panels must have hidden fixings and joints must be aligned and uniformly spaced.

(u) Test panels must be provided for cast in-situ concrete retaining walls. The first in-situ concrete pour for each wall finish type must be the test panel. Sufficient time and access must be allowed for the verification of the finished quality of the test panel before full production commences on the tested wall finish type.

(v) Retaining walls must be recessed from the front face of any parapet face by a minimum of 250 millimetres by cantilevering the parapet.

(w) Structures must be designed to minimise graffiti. Whole of life costs must be considered in the design of structures and the design must minimise the need for ongoing repair works due to vandalism or graffiti.

(x) The design of all structures, noise walls, walls, barriers and other features must consider and address the aesthetic impact of anti-graffiti coatings on the element, the structure and the family of structures.

(y) Protection systems, fencing, safety barriers, noise barriers and headlight screens must be integrated with structures to reduce visual clutter. All joints must align to reinforce the vertical emphasis.

7.2 Requirements for Noise Walls and Headlight Screens

(a) The approach to noise wall location and design must be in accordance with the RMS document titled 'Noise wall design guidelines – Design guidelines to improve the appearance of noise walls in NSW' (RMS, 2016).

(b) The visual impact of noise barriers must be considered primarily from viewpoints that are external to the road corridor.

(c) Noise barriers must be designed using forms, materials, colours and textures that are sensitive to the local area, that complement the existing landscape or built character, and (where possible and desirable) recede into the landscape. Planting of vegetation must be used to integrate noise barriers into their setting.

(d) Selection of the type of noise barrier (including noise mounds) and headlight screens, must be based on the following order of precedence, except where otherwise required by the Environmental Documents:

 (i) landscaped mound or 'false' cutting with slopes appropriate for planting;

 (ii) noise mound and low wall/screen combination to reduce perceived height of noise barriers and integrate them with adjoining landforms; and

 (iii) noise walls or headlight screens.

(e) Unless otherwise required by the Environmental Documents:

 (i) noise walls must be simple, plain structures in form and utilise a minimum of durable materials;

 (ii) noise walls (including noise mounds) and headlight screens must respond appropriately to the landscape in which they are located;

 (iii) noise walls and headlight screens must be easily maintainable, durable and aesthetically pleasing and maintain an acceptable standard of appearance over time;

 (iv) noise walls and headlight screens must enhance the Project Works and surrounding neighbourhood environment; and

 (v) all noise walls and headlight screens must be designed and detailed, including their texture, materials, finishes and colour, to be consistent, contextual and have interesting forms.

(f) The Contractor must consult with the local community on the finishes to noise walls and headlight screens.

(g) The appearance of both sides of the noise walls and headlight screens must be equivalent in design quality and must satisfy the expectations of both the residents adjoining the Project Works and the road users.

(h) Noise walls located to the north of any residential properties must make provisions for adequate solar access and:

 (i) the use of transparent panels to at least part of the noise wall at each residential property must be considered;

(ii) privacy to residences must be considered in the design of the transparent panels; and

(iii) if transparent panels are used, they must be designed in to present a cohesive appearance in the context of the entire noise wall.

(i) Noise walls and headlight screens must comply, as a minimum, with the following requirements:

(i) the appearance of both sides of noise walls if not transparent must be a concrete panel type. Exposed Z clips must not be used in the noise walls;

(ii) timber, glass or other fragile or easily damaged materials must not be used for noise walls or headlight screens;

(iii) fixing systems must be integrated in the walls or screens and footings must be concealed;

(iv) where sufficient width is available, a planted zone, with a minimum width of 2 metres, must be provided between noise walls and the road and between noise receptors and noise walls;

(v) where sufficient width is available, a planted zone, with a minimum width of 2 metres, must be provided on both sides of headlight screens;

(vi) the tops of noise walls and headlight screens in general must not be stepped and must form a continuous flowing line. Where stepping of noise walls is unavoidable, for example, due to steep topography, stepping should be neat and architecturally appropriate;

(vii) the horizontal alignment of the noise walls and headlight screens must be parallel to the outside edge of the carriageways and roads;

(viii) where noise walls are constructed of lapped panels, the lapping must be in the direction of traffic on the immediately adjacent carriageway lane. Noise wall or headlight screen support posts must not be visible from the adjacent travel lanes;

(ix) noise walls must not start or terminate abruptly with vertical faces. Noise walls must emerge from the ground and gain height with smooth flowing lines and must have a vertical emphasis;

(x) noise walls and headlight screens must respond to the locality in which they are situated. Noise walls in feature areas must be sculptural, dynamic and interesting;

(xi) noise walls and headlight screens must be integrated with each other and with other structures, including retaining walls, bridges and landscape works;

(xii) noise walls and headlight screens on top of retaining walls must consolidate into one wall;

(xiii) where noise walls or headlight screens are located close to property boundaries and near neighbourhoods, they must be recessive and simple; and

(xiv) noise wall and headlight screen designs must address and accommodate drainage under the noise walls and include provisions to reduce noise penetration.

(j) Noise walls or headlight screens that would block views to high quality scenery from the living areas of the residences must be avoided.

(k) Transparent noise walls must be considered for residences where views to high quality scenery would otherwise be blocked by opaque noise walls.

(l) The design of noise walls and headlight screens must include an anti-graffiti strategy, for both sides of the structures.

8 Requirements for Footpaths, and Shared Use Paths

8.1 General

(a) The Project Works must preserve and maintain convenient, safe, visually attractive and suitably lit connectivity across the Works, including pedestrian footpaths and shared use paths that are critical for continual access and connectivity of local communities.

(b) Footpaths and shared use paths must be constructed from a brushed finished concrete with an integral oxide pigmentation, grey in colour equal to Colour Concrete Systems 'Onyx' to reduce glare.

(c) Footpaths and shared use paths must:

(i) Incorporate retention of existing mature trees and significant vegetation; provision of further shade tree planting to the paths and, subject to Penrith City Council requirements and safety in design considerations, include a planted buffer between the carriageways and the paths;

(ii) be designed to provide the greatest sight distance possible at any given location; and

(iii) be designed to minimise potential hazards where cyclists and pedestrians are at risk of hitting or being hit by vehicles, highlighting intersections of shared paths with footpaths by the use of contrasting pavement threshold treatments and continuing the shared path treatment across driveway pavements.

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Exhibit A -

Scope of Works and Technical Criteria

Appendix 16 – Delineation and Signposting Performance and Design Requirements

Design and Construction for

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

November 2016

Document Author: Roads & Maritime Services

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About this document

Project data

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1 Delineation General Requirements

(a) All delineation must comply with RMS “Delineation Manual” (Amended December 2010), Australian Standard AS 1742 Manual of Uniform Traffic Control Devices, and RMS Australian Standard Supplement to AS 1742.

1.1 Road Markings

(a) Profile linemarking must not be installed on low noise pavements.

(b) Linemarking must be provided on pavement surfaces as follows:

(i) Other Roads requiring adjustment, waterborne paint linemarking; and

(ii) Main Carriageway - thermoplastic linemarking.

1.2 Guideposts

(a) Guideposts must be provided in accordance with AS 1742.2 on the nearside and offsides of any section of unlit Other Roads that is affected by the Contractor’s Work.

(b) Guidepost reflectors must be red on the nearside and yellow on the offside of the carriageways. The reflector pattern must be integrated so that there is consistent guidance provided through cuttings and across embankments, especially in the vicinity of safety barriers and on bridges.

(c) Longitudinal spacing of guideposts must comply with the requirements of fog prone areas.

(d) Where there is no safety barrier adjacent to the shoulders of Main Carriageway pavements, the guideposts must be located 0.5m off the edge of pavement or SO gutter, whichever is applicable.

2 Signposting General Requirements

(a) All signposting and associated signage infrastructure must:

(i) be located to comply with the clear zone requirements detailed in the *"Austroads Guide to Road Design" "RTA Austroads Guide Supplements"*, Australian Standard AS 1742 Manual of Uniform Traffic Control Devices, and RMS Australian Standard Supplement to AS 1742; or

(ii) be protected by an approved RMS safety barrier system installed to the manufacturers specification.

(b) The Contractor must provide all signposting on road plans in locations approved by RMS (approval of which must be obtained during the design process).

2.1 Signposting Installation and Structures

2.1.1 Directional Signposting

(a) Directional signposting must be provided to suit the Project Works and must be developed in consultation with RMS and in accordance with AS 1742.15 Manual of Uniform Traffic Control Devices – Direction Signs, Information Signs and Route Numbering, and RMS Guide Sign Manual 2014. The signs must be designed using TraSiCAD (NSW Version 2.6 or later) software.

(b) The Contractor must confirm all sign face details with RMS as part of the signposting design process, including the "New Road Name" and the road number(s) on the signs. Road numbering must comply with the alphanumeric route marking system (MAB system) identified in RMS Technical Direction TDT 2013/02 "Management of changes to the Alphanumeric (MAB) Route Marking system in New South Wales". Signs must be designed and manufactured with MAB system road numbers. RMS will provide the required sign face design templates.

(c) The Contractor must determine the sign locations of all directional signposting in consultation with RMS' Guidance and Delineation Manager.

2.1.2 Guide / Regulatory / Warning Signposting

(a) Guide, regulatory and warning signs must be provided in accordance with AS 1742 Manual of Uniform Traffic Control Devices and the RMS Sign Register 2014 and provide clear delineation of intersections, curves, manoeuvres and one way networks.

(b) Exit ramp speed and advisory speed signs must be installed in accordance with AS 1742 Manual of Uniform Traffic Control Devices, RMS Australian Standard Supplement to AS 1742 and the RMS Sign Register September 2014.

2.1.3 Speed Limits

(a) All speed limit signs including variable signs must be provided in accordance with RMS Speed Zoning Guidelines 2011 and supplementary documents. Under current delegations RMS Speed Management is required to authorise speed limits on the road network.

(b) R4-1 type speed limit signs and pavement numerals must be provided at all changes in speed limit on road carriageways and on all entry ramps. The speed limit sign sizing will be in accordance with RMS Speed Zoning Guidelines 2011 and subject to a decision by RMS about the posted speed limit during detailed design. R4-1 reminder signs must be provided after major intersections, interchanges and at regular intervals in accordance with Speed Zoning Guidelines. The reminder signs must be placed only on the left side of carriageways.

(c) Variable Speed Limit Signs (VSLS) must be used and installed in accordance with Appendix 20 (Traffic Control Signals) and Appendix 18 (Intelligent Transport Systems) of the SWTC.

(d) R4-1 speed limit signs and pavement numerals must be provided on all exit ramps, designating the speed limit of the adjoining road, in accordance with RMS Speed Zoning Guidelines 2011.

(e) Final approval of speed limit signage must be sought from the Speed Management Unit (Senior Network and Safety Officer, Speed Management) within RMS prior to the 100% detailed signage plan.

2.1.4 Creeks and Rivers

(a) All creeks and rivers must have the relevant name displayed and be signposted. The signposting of creeks and rivers must be submitted for RMS approval with the Direction Signposting Scheme.

2.1.5 Emergency U-Turn Facilities and Stopping Bays

(a) Where provided, emergency U-Turn facilities must be signposted in accordance with AS 1742 Manual of Uniform Traffic Control Devices, RMS WHS Safe operation, Australian Standard Supplement to AS 1742 and the RMS Sign Register September 2014.

(b) Where provided, stopping bays must be signposted in accordance with either R5-59(L/R) “Emergency Stopping Bay” or G9-200(L/R) “Emergency Stopping Bay Only” from the RMS Sign Register September 2014. All signposting must be in accordance with AS 1742 Manual of Uniform Traffic Control Devices, RMS Australian Standard Supplement to AS 1742 and the RMS Sign Register September 2014.

2.1.6 Not Used

2.1.7 Carriageway Transitions

(a) Any temporary or staged crossovers must be signposted and delineated in accordance with AS 1742 Manual of Uniform Traffic Control Devices, RMS Australian Standard Supplement to AS 1742, RMS Traffic Control at Worksites and the RMS Sign Register September 2014.

2.1.8 Shared Use Paths Signposting

(a) Signposting and delineation of shared use paths for cyclists and pedestrians must be provided in accordance with RMS “NSW bicycle guidelines – RTA Version 1.2 July 2005”.

2.1.9 Not Used

2.1.10 Overbridges

(a) All overbridges must have the relevant name displayed and be signposted. The signposting of overbridges must be submitted for RMS approval with the Direction Signposting Scheme.

2.2 Sign designs

(a) The Contractor is required to prepare sign designs and submit to RMS for approval.

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Exhibit A –
Scope of Works and Technical Criteria
Appendix 17 – Not Used
for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

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1 Not Used

Exhibit A –
Scope of Works and Technical Criteria
Appendix 18 – Intelligent Transport Systems
for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

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1 Intelligent Transport Systems

1.1 ITS Overview

(a) This Appendix 18 of the SWTC describes the Intelligent Transort System (ITS) requirements for the design and construction of the Project.

(b) The Project requires that The Northern Road interfaces with M4 Smart Motorway project.

(c) The Project must be operated from the RMS M4 Smart Motorway Control Room.

(d) The ITS requirement for the Project is to supply, reinstate and upgrade all permanent ITS Field Equipment Sites identified in the SWTC in accordance with current RMS policy and ITS Specifications.

(e) To support both current and future ITS Field Device deployments, the Contractor must construct a new ITS Cableway as part of the Project. The ITS Cableway must enable the construction of an ITS Corridor Communications Network (CCN) via cableway communications conduits which will provide integrated access to all nominated ITS Devices in the Project area, and support the ITS Corridor Power Distribution (CPD) system via cableway power conduits. The ITS Cableway must interconnect with the current M4 Smart Motorway ITS Cableway, and support connection to the future M4 Smart Motorway ITS Cableway.

(f) The ITS CCN will connect to a broadband IP communications access service provided by RMS, which will provide connectivity between the ITS Corridor Communications Network and the TMC. All connections from ITS Field Equipment Sites via the ITS CCN will utilise IP over fibre optic cable. The ITS CCN will extend to and interconnect with the WAN Fibre Cabinet located on the M4 Motorway eastbound exit ramp to The Northern Road adjacent to the existing VMS 4903.

(g) The M4 Interchange section of the Project must also be constructed with appropriate access to the ITS CCN, and must be able to support installation of planned ITS Devices in future.

(h) All Project ITS Field Devices and ITS communications must integrate with the RMS M4 Smart Motorway Control Systems.

(i) The abbreviations used in this Appendix 18, and their meanings, are defined in section 9 of this Appendix 18.

(j) All defined terms in this Appendix 18 have the meanings given to them in the following RMS specifications:

(i) R155 (Design and Construction of Underground Cableways);

(ii) TS200 (Register of ITS Field Equipment);

(iii) TS105 (ITS Electronic Message Sign Site);

(iv) TS104 (ITS Vehicle Detection Site);

(v) TS106 (ITS Video Surveillance Camera); or

(vi) TS020 (ITS Communications System).

1.1.1 General

(a) All elements of ITS design for the Project must be prepared and implemented in accordance with this SWTC Appendix 18, current RMS Policy and current RMS ITS specifications.

(b) The ITS design must be submitted and reviewed in accordance with the requirements set out in Appendix 24 (Contractor's Documentation Schedule) to the SWTC.

(c) The Contractor must adhere to the Hold Points and Witness Points identified in each of the Technical Specifications referred to in this Appendix 18 and Appendix 7 (RMS Technical Specifications). The Contractor must document, within their Design Plan required by Section 5 of Appendix 21 to the SWTC, how to manage Hold Points and Witness Points within the existing design review regime stipulated within Appendix 24 to the SWTC.

1.1.2 Requirements Overview

(a) The following are the ITS requirements that must be provided for the Project by the Contractor:

(i) Two (2) new Variable Message Sign (VMS) sites must be provided at the locations shown in Figure 18.3 in Annexure 1 of this Appendix 18. The VMS' must be integrated with, and controlled by, the RMS VMS Host Control system.

(ii) Seven (7) new Traffic Control Sites (TCS) must be provided in accordance with section 3 of this Appendix 18 and as shown in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18.

(iii) Seven (7) new Video Surveillance Cameras (VSC) sites must be provided in accordance with section 4 and as shown in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18.

(iv) Two (2) new Traffic Information Sites (TIS) must be provided in accordance with section 5 of this Appendix 18 and as shown in Figure 18.2 in Annexure 1 to this Appendix 18.

(v) Inclusion of M4 Smart Motorway ITS works in accordance with section 6 of this Appendix 18 and as shown in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18.

(vi) To support the future installation of four (4) new Integrated Speed Limit & Lane Use Signs (ISLUS), provide ITS Cableway, loops and ITS CCN fibre connections at locations indicated in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18.

(vii) Supply and installation of all SCATS Traffic Detection Loops shall be incorporated in the road pavement to ensure optimal performance of ITS devices.

(viii) At the new M4 Motorway interchange, including the on and off ramps to the M4 Motorway, make provision for the future installation of Ramp Control signals, controllers, signs (Ramp Control Sign – Type 1 (RC1) and Type 2 (RC2)) and lanterns. Provide conduits, pits and feeder cables coiled into the associated pit junction box to each location shown in Figure 18.3 in Annexure 1 to this Appendix 18. Consider these future devices the ITS CCN design. Whilst the Ramp Control signals, controllers, signs and lanterns will not be installed by the Project, the SCATS Traffic Detection Loops required must be pre-installed by the Contractor in the pavement at locations to be nominated by RMS.

(ix) An ITS Cableway must be provided, including physical access to existing, planned and proposed ITS Field Sites, as shown in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18, and is to be supplied and installed in accordance with R155, TS020, and this Appendix 18.

(x) An ITS Corridor Communications Network (CCN) must be provided in accordance with this Appendix 18, and is to be supplied in accordance with TS020. This CCN must be design to connect to RMS Communications Network via dual "head-end" Access Services to enable high availability communications to the RMS control systems. The communications conduits of the ITS Cableway will be utilised by the CCN for extension and distribution of communications to support current and future ITS devices. The ITS CCN design is required to make provision (physical and logical) for connection to future ITS Field Sites within the Site as identified in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18, and this Appendix 18.

(xi) An ITS Corridor Power Distribution system is required to be supplied as part of the Project Works. All ITS Devices (at ITS Field Equipment Sites) and the ITS Corridor Communications Network must be provided with 240 VAC power.

2 Variable Message Signs

2.1 General

(a) Variable Message Signs (VMS) must be installed to provide information messages to motorists driving along The Northern Road, and also to provide targeted information for motorists approaching the M4 Motorway.

(b) The permanent new VMSs must be designed and constructed in accordance with RMS Specification TS105, TS020, TS200, RMS Policy PN028i and RMS Supplement to Austroads Guide to Traffic Management Part 10.

(c) All VMS supplied must be pre-approved by RMS to ensure control system compatibility and compliance with RMS Specifications.

2.2 Variable Message Sign Requirements

(a) The permanent VMSs must be provided by the Contractor in accordance with Table 18-1 and shown in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18. The specific location of the permanent VMS must be agreed with by both RMS and TMC prior to installation.

Table 18-1: Permanent Variable Message Signs

No.	Road	Location
VMS1	The Northern Road	Northbound approaching the M4 westbound entry ramp.
VMS2	The Northern Road	Southbound approaching the M4 eastbound entry ramp.

(b) The permanent VMSs and existing VMS 4903 located on the M4 Motorway must be incorporated into the RMS M4 Smart Motorway Management System (MMS). The Contractor must ensure that new VMS (and existing VMS that are impacted by the Project) are incorporated into MMS.

(c) All VMSs must be supplied as specified in TS105. VMS equipment shall be sourced as specified in TS200.

3 Traffic Control Sites

3.1 Traffic Control Site – Design

3.1.1 General

(a) As TCSs are a specific type of ITS Field Equipment Site, they are considered as part of the ITS Requirements specified in this Appendix 18.

(b) Details of TCS Design and Construction are described separately in Appendix 20 to the SWTC.

3.2 Traffic Control Site - Locations

(a) The permanent Traffic Control Sites, as listed in Table 18-2 and shown in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18, must be provided by the Contractor.

Table 18-2: Traffic Control Site Locations

No.	Intersections for new Traffic Control Sites	Configuration / Coverage
TCS1	Jamison Road / TNR intersection TCS	2 turn symetripole loops per lane as shown in the approved traffic signal design (in accordance with SWTC Appendix 20)
TCS2	Smith Street / TNR intersection TCS	2 turn symetripole loops per lane as shown in the approved traffic signal design (in accordance with SWTC Appendix 20)
TCS3	Maxwell Street / Bringelly Road / TNR intersection TCS	2 turn symetripole loops per lane as shown in the approved traffic signal design (in accordance with SWTC Appendix 20)
TCS4	Frogmore Road / Tukara Road / TNR intersection TCS	2 turn symetripole loops per lane as shown in the approved traffic signal design (in accordance with SWTC Appendix 20)
TCS5	M4 / TNR interchange - North TCS	2 turn symetripole loops per lane as shown in the approved traffic signal design (in accordance with SWTC Appendix 20)
TCS6	M4 / TNR interchange - South TCS	2 turn symetripole loops per lane as shown in the approved traffic signal design (in accordance with SWTC Appendix 20)
TCS7	Glenmore Parkway / Wentworth Road / TNR intersection TCS	2 turn symetripole loops per lane as shown in the approved traffic signal design (in accordance with SWTC Appendix 20)

(b) In addition to the TCS locations identified in Table 18-2, all existing TCS locations are to be kept operational, and re-configured where necessary to account for intersection and traffic changes resulting from the Contractor's Work.

(c) All TCS sites for the Project must connect via the new ITS CCN to the SCATS Traffic Control System.

(d) An RMS approved and nominated SCATS communications modem must be provided for each TCS communications connection.

(e) All new Traffic Control Site equipment must to be sourced as per RMS specification TS200, and the TCS sites must be designed and installed in accordance with SWTC Appendix 20.

(f) The Contractor shall facilitate integration of all TCS into the SCATS Traffic Control and Management System, in conjunction with RMS.

3.3 Detection Loops for TCS

(a) The Contractor must incorporate the supply and installation of all inductive loops at a sufficient depth so as not to be impacted by pavement re-surfacing.

(b) The SCATS pavement Loop configuration shall comply with RMS Specification SI/TCS/8.

(c) Connect all loop tails to the TCS Cabinet via the TCS Ducts or the ITS Cableway’s power conduits where required.

(d) Install all loops within the pavement, in accordance with RMS TDT 2010/02 and current ITS technical guidance.

4 Video Surveillance Cameras

4.1 Video Surveillance Camera Sites

(a) The Video Surveillance Camera Sites must to be supplied, designed, and installed in accordance with RMS specification TS106 and with reference to TS020.

(b) The Video Surveillance Camera Sites identified in Table 18-3 must be installed to provide suitable surveillance of all traffic flows as required by RMS specification TS106.

(c) Where feasible, suitable surveillance of roadworks during construction should be supplied by the installed VSC sites.

Table 18-3: Video Surveillance Camera Site Locations

No.	Location	Views provided by Video Surveillance Cameras
VSC1	Jamison Road / TNR intersection	observe at least 200m on each approach
VSC2	Smith Street / TNR intersection	observe at least 200m on each approach
VSC3	Maxwell Street / Bringelly Road / TNR intersection	observe at least 200m on each approach
VSC4	Frogmore Road / Tukara Road / TNR intersection	observe at least 200m on each approach
VSC5	M4 / TNR interchange – North	observe at least 200m on each approach
VSC6	M4 / TNR interchange - South	observe at least 200m on each approach
VSC7	Glenmore Parkway / Wentworth Road / TNR intersection	observe at least 200m on each approach

(d) In addition to the new locations identified above, all existing permanent Video Surveillance Camera locations are to be retained and upgraded to meet RMS specification TS106 and to communicate via the ITS CCN.

(e) The Contractor shall facilitate integration of all Video Surveillance Camera Sites into the Video Camera Control and Management System, in conjunction with RMS.

5 Vehicle Detection Sites

5.1 New Traffic Information Sites

(a) Two (2) new Traffic Information Sites (TIS) must be provided, as shown on Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18.

(b) The TIS will provide per lane flow/classification/speed information for future planning purposes, and must be upgradable to provide real-time information to RMS host systems in accordance with RMS specifications TS104 and TS020.

(c) The Contractor must connect the TIS to the ITS CCN.

5.2 Detection Loops for TIS

(a) The Contractor shall incorporate the supply and installation of inductive loops in each lane at the two (2) TIS, north and south of the new M4 Motorway interchange, to ensure optimal performance of both ITS as per Table 18-4.

Table 18-4: Vehicle Detection Sites

No.	VDS - TIS Locations	Configuration / Coverage
VDS1	480m north of Glenmore Parkway / Wentworth Road / TNR intersection TCS	2 x 3 turn loops per traffic lane in both northbound and southbound directions
VDS2	480m north of Frogmore Road / Tukara Road / TNR intersection TCS	2 x 3 turn loops per traffic lane in both northbound and southbound directions

(b) The Vehicle Detection Site (VDS) device must be RMS Approved as indicated in RMS specification TS200, and the pavement Loop configuration must comply with RMS specification TS104 as "Type 1"

(c) Connect all loops tails to the VDS Control Cabinet via the Project ITS Cableway power conduits.

(d) Install all loops at a sufficient depth within the pavement, in accordance with RMS TDT 2010/02 and current ITS technical guidance so as not to be impacted by pavement re-surfacing works.

6 Provision for Future M4 Smart Motorway

6.1 Ramp Signalling Sites

(a) The Contractor must install power and communications conduits to the locations of the two future (Ramp Signalling) Traffic Control Sites (RSS1 and RSS5) shown in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18 at the end of the M4 Motorway on-ramps and as listed in Table 18-5.

(b) The Contractor must install an optical fibre communications cable to each future on-ramp TCS communications site access pit, and provide a two (2) metre loop of optical fibre cable to enable future connection to the ramp TCS controller cabinet.

(c) The Contractor must install power and communications conduits to the locations of the Ramp Control Signs (RC1 and RC2) as shown in Figure 18.3 in Annexure 1 to this Appendix 18 on the M4 Motorway on-ramps as listed in Table 18-5.

(d) The Contractor must install an optical fibre communications cable to each future on-ramp communications site access pit, and provide a two (2) metre loop of optical fibre cable to enable future connection to the Ramp Controller Signs.

(e) The Contractor must install TCS Loop Detectors at the locations identified in the RMS approved traffic signals design for the future ramp signalling TCS site, with the loop tails left coiled in the local Pit Junction Box (PJB).

(f) The Contractor must ensure that the ITS Corridor Communications Network design includes provision for future connection of the Ramp Signalling controller and RC1 signs.

(g) Supply two 10 core (5 pair) copper cables from the intersection TCS controller cabinet to each RC1 Ramp Control Sign to support local control of these signs.

(h) Supply two 10 core (5 pair) copper cables from the M4 ramp TCS controller cabinet to each RC2 Ramp Control Sign to support local control of these signs.

Table 18-5: Ramp Signalling Sites

No.	TCS and Ramp Control Signs	Configuration / Coverage
RSS1	M4 eastbound on-ramp and stop line	2 turn symetripole loops per lane as shown in the approved traffic signal design (in accordance with SWTC Appendix 20)
RSS2	Midpoint of M4 eastbound on-ramp	Ramp Control Sign – Type 2 Provide 2 x 10 core copper cable to the M4 ramp TCS controller cabinet
RSS3	Start of M4 eastbound on-ramp – Northbound TNR	Ramp Control Sign – Type 1 Provide IP fibre connection to the ITS CCN Provide 2 x 10 core copper cable to the intersection TCS controller cabinet
RSS4	Start of M4 eastbound on-ramp – Southbound TNR	Ramp Control Sign – Type 1 Provide IP fibre connection to the ITS CCN Provide 2 x 10 core copper cable to the intersection TCS controller cabinet
RSS5	M4 westbound on-ramp & stop line	2 turn symetripole loops per lane as shown in the approved traffic signal design (in accordance with SWTC Appendix 20)
RSS6	Midpoint of M4 westbound on-ramp	Ramp Control Sign – Type 2 Provide 2 x 10 core copper cable to the M4 ramp TCS controller cabinet
RSS7	Start of M4 westbound on-ramp – Northbound TNR	Ramp Control Sign – Type 1 Provide IP fibre connection to the ITS CCN Provide 2 x 10 core copper cable to the intersection TCS controller cabinet
RSS8	Start of M4 westbound on-ramp – Southbound TNR	Ramp Control Sign – Type 1 Provide IP fibre connection to the ITS CCN Provide 2 x 10 core copper cable to the intersection TCS controller cabinet

6.2 Integrated Speed Limit & Lane Use Signs (ISLUS)

(a) The contractor shall install power and communications conduits to the locations of the four (4) ISLUS signs as shown in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18 and as listed in Table 18-6.

(b) The Contractor shall install an optical fibre communications cable to each ISLUS Site Communications Site access pit, and provide a two (2) meter loop of optical fibre cable pit to enable future connection to the ISLUS controller Cabinet.

(c) The Contractor shall ensure that the ITS Corridor Communications Network design includes provision for future connection of the ISLUS sign controller.

Table 18-6: Integrated Speed and Lane Use Sign (ISLUS) Locations

No.	Intersections for new Traffic Control Sites
1, 2	TNR to M4 on-ramp eastbound, near M4 mainline
3, 4	TNR to M4 on-ramp westbound, near M4 mainline

7 Communication Network Requirements

7.1 ITS Cableway

7.1.1 General

(a) The overall ITS Cableway design including the provision of specific conduits and pits must be provided in accordance with RMS specifications R155, and TS020.

(b) The ITS Cableway design must provide for the distribution of communications (supporting the ITS CCN design) and the distribution of low-voltage mains power (supporting the ITS CPD design).

(c) The Contractor must provide the following as part of the Project:

(i) A Cableway to match the requirements of a Critical CCN, as defined in RMS specification R155, and shown in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18;

(ii) A Cableway to match the requirements of a Major CCN, as defined in RMS specification R155, and shown in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18;

(iii) A Cableway to replace the existing M4 Motorway Cableway between the two (2) existing ITS pits indicated in Figure 18.3 in Annexure 1 to this Appendix 18. Connectivity on operation of the M4 Motorway ITS Communications must be maintained throughout the Project for the duration of the Works;

(iv) The new M4 Interchange bridge over the M4 Motorway must include the ITS Cableway including the required Critical separation;

(v) ITS Offset branches at all current and planned ITS Field Sites;

(vi) Traffic Signal Ducts to the nearest ITS Cableway power pit at all nominated locations of Loop Detectors on both TNR and the M4 Motorway; and

(vii) The cableway route must provide access to both new and existing ITS Devices at street level and future ITS Field Sites as identified in this Appendix 18.

7.1.2 Construction

(a) The Contractor must design and install conduits and pits to support provision of a Corridor Communication Network (CCN) backbone, as defined by RMS specification R155 in accordance with Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18.

(b) The Contractor must design and install conduits and pits for Offset branches as defined by RMS specification R155.

(c) The Contractor must provide pits as specified in RMS specification R155 and TS020. Where not otherwise specified, ITS CCN access pits are required to be provided at the current and proposed locations of all ITS Field Equipment Sites, and at the termination points of the ITS Cableway or it’s Offset branches.

(d) The contractor must construct the ITS Cableways as listed above, to support ITS communication to all ITS devices along TNR with appropriate interconnections to the M4 Motorway Cableway/communications system.

7.2 ITS Corridor Communications Network

7.2.1 Overview

(a) The Contractor must design and install an ITS Critical Corridor Communications Network (CCN) as specified in RMS specification TS020 and this Appendix 18. The CCN shall be designed to provide IP communications services over discrete optical fibres to each nominated RMS ITS Field Device with high availability.

(b) The Contractor must provide the following with respect to the CCN as part of the Project:

(i) The CCN must utilize optical fibre transport to extend IP connectivity to all devices in the TNR corridor and the M4 Motorway interchange area;

(ii) The CCN must distribute IP communications from a dedicated WAN Fibre Cabinet located on the M4 Motorway eastbound exit ramp to The Northern Road adjacent to the existing VMS 4903 with connectivity to the M4 ITS Node 5;

(iii) The CCN must be connected to the dedicated RMS WAN Fibre Cabinet;

(iv) The CCN must be designed to support connections to all ITS Field Equipment Sites within the Site;

(v) The CCN must be designed to connect to TMC Communications Network via dual "head-end" Access Services to enable high availability communications to the RMS control systems. The communications conduits in the ITS Cableway must be utilized by the CCN for extension and distribution of communications to support current and future ITS devices. The ITS CCN design is required to make provision (physical and logical) for connection to future ITS Field Sites within the Site as identified in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18, and this Appendix 18;

(vi) The existing M4 Motorway ITS backbone, including communications and power connections, must be cut over to the new Project ITS Cableway between the existing M4 Motorway ITS pits as shown in Figure in Annexure 1 to this Appendix 18. This operational cutover must be coordinated via ITS Helpdesk with TMC Systems; and

(vii) The operation of the existing M4 Smart Motorway ITS backbone including communications and power connections to all existing M4 Motorway ITS devices must be maintained during construction.

7.2.2 Additional Requirements

(a) The Critical CCN design must include the provision of dual Access Gateways to ensure that loss of a single Core Access Service does not disrupt communications back to the RMS systems. The discrete optical fibres in the CCN will nominally terminate on the fibre termination panel within an ITS Communications cabinet. An example of a typical ITS Critical CCN is shown in Figure 18.1 in Annexure 1 to this Appendix 18.

(b) The ITS CCN design must nominate a suitable location for installation of physically separated ITS Access Gateway Cabinets, which must each act as head-ends for the ITS CCN. The ITS Access Gateways are also the point of service delivery and interconnection to the Core Access Network links to RMS M4 Smart Motorway control room.

(c) Each ITS Access Gateway Cabinet must be designed to provide a suitable environment for operation of the telecommunication provider's Network Termination Unit (NTU) equipment, and the RMS Core Access Router. The ITS Access Gateway Cabinet must be supplied as a double-skinned cabinet with passive cooling to ensure an internal operating environment of less than 50 Degree Celsius.

(d) The IP Addressing scheme used in the ITS CCN must be configurable to meet the requirements of RMS and TMC as specified in RMS specification TS020. All interconnection between telecommunications carrier services and RMS networks will be at ISO Layer 3, and connectivity will be established via secure RMS Virtual Private Wide Area Networks.

(e) The ITS CCN design must include the implementation of additional Layer 2 managed switches where required. Any additional Layer 2 managed switch included as part of the ITS CCN design must be located within an equipment cabinet, and must be suitable for its operating environment.

(f) All fibre cables used as part of the ITS CCN design must meet the specified requirements of RMS specification TS020, with a minimum of 48 fibres per cable per backbone path, and a minimum of 12 fibres per cable for the distribution cables to field sites.

(g) The RMS specification TS020 requirement for spare capacity on physical ports and cables in the ITS CCN design must be determined on the basis of the final CCN design, which must include provision for connectivity of all existing and future ITS devices, as specified in Figures 18.2 and 18.3 in Annexure 1 to this Appendix 18, and this Appendix 18 in the Project Site and the Project vicinity.

7.3 ITS Corridor Power Distribution

(a) The Contractor must design and install ITS Corridor Power Distribution as specified in RMS specification TS020, to extend low voltage mains power from appropriate points of connection to each nominated RMS ITS Field Equipment Site.

(b) The Contractor must design the Corridor Power Distribution system in a one-to-many or a many-to-many arrangement, but must include in their design the advantages of the power distribution scheme proposed (including consideration of future operations and maintenance of corridor power distribution).

8 Existing ITS Field Equipment

8.1 Management of Existing ITS Field Equipment

8.1.1 General

(a) Any existing ITS Devices (installed at an ITS Field Equipment Site) that are within the Project Site must be kept operational during and after the construction of the Project.

(b) The Contractor must ensure that any existing Traffic Management Unit (TMU) Equipment located in the vicinity of the M4 Motorway and impacted by the Project, are relocated to a new cabinet as part of this Project.

(c) Where an existing ITS Field Equipment Site is damaged during construction (for example, removal of Traffic Counting loops in the road surface), the ITS site must be restored to operational status as per the current guidelines, specifications and requirements for the ITS Device involved.

(d) Any proposal to replace or restore operation of damaged ITS Field Equipment must be directly approved by RMS, to ensure the restoration is in line with current RMS requirements and specifications.

(e) Where an existing ITS Field Equipment Site has physical access to a new ITS CCN, all design and construction provisions must be made by the Project to allow connection of ITS Field Equipment Sites to the ITS CCN (including migration to TCP/IP communications, and any additional equipment that may be required for this migration).

(f) The Contractor is not required to migrate existing ITS Field Equipment Sites to the ITS CCN, unless this is required to re-enable communications as a result of construction works, or unless specified on a per site basis by RMS.

(g) Any existing equipment that is decommissioned or no longer required as part of the delivery of the Contractor’s Work must be returned to RMS.

9 Glossary

(a) A glossary of abbreviations used in this Appendix 18 and other ITS related specifications are listed in Table 18-7.

Table 18-7: Abbreviations

Abbreviation	Description of Meaning
AM	Amplitude Modulation
ANSI	American National Standards Institute
APID	All Purpose Incident Detection Algorithm
AS	Standards Australian
AVID	Automatic Video Incident Detection
CCTV	Closed Circuit Television used for traffic surveillance
CMCS	Central Management and Control System
CMS	Changeable Message Sign
CNN	Corridor Communication Network
DAS	Driver Advisory Signs are single line message signs located in a tunnel ceiling space used to advise of specific emergency actions to drivers. (sometimes known as "Tunnel Management Signs" – TMS)
Device	All roadside equipment and plant equipment controlled by the MMS
DRS	Disaster Recovery Site
ISLUS	Integrated Speed Limit & Lane Use Signs (ISLUS) combines Variable Speed Limit Sign and Lane Use Sign to indicate the speed limit and whether motorists may use a carriageway lane. It incorporates LED sign facia, support, structure, ISLUS controller processor system and communications interface equipment.
ISO	International Organization for Standardization
ITS	Intelligent Transport System
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode as used in EMS and ISLUS on the Motorway, and DAS within tunnels
LUS	Lane Usage Sign
MCC	Motorway Control Centre
MIB	Management Information Base
MM	Moveable Median
MOT	Mean Outage Time

Abbreviation	Description of Meaning
MPB	A physical barrier mounted at tunnel entrances to prevent entry of traffic under emergency and maintenance operations.
MMS	Motorway Management System for M4 and public motorways
MTBF	Mean Time between Failures
MTTD	Mean Time To Detection
MTTR	Mean Time to Repair
MTTS	Motorway Travel Time System
NMS	Network Management System
NSW	New South Wales
NTCIP	National Transportation Communications for ITS Protocol
NTP	Network Time Protocol
NTU	Network Termination Unit
OMCS	Operations Management and Control System for Private Motorways
PLC	Programmable Logic Controller
PMCS	Plant Monitoring and Control System
PTZ	Pan Tilt Zoom
RAMS	Reliability, Availability, Maintainability and Safety
RCU	Remote Control Unit
RDBMS	Relational Database Management System
RF	Radio Frequency
RMS	Roads and Maritime Services (formerly RTA)
ROL	Road Occupancy Licence
RRB	Radio Rebroadcast
RTA	Roads and Traffic Authority (now known as RMS)
SAN	Storage Area Network
SCADA	Supervisory Control and Data Acquisition
SIL	Safety Integrity Level
SMOF	Single Mode Optical Fibre
SPOF	Single Point of Failure
SCATS	Sydney Coordinated Adaptive Traffic System
Telco	Telecommunications Company (abbreviation)
TfNSW	Transport for New South Wales
TIDS	Traffic Incident Detection System

Abbreviation	Description of Meaning
TIS	Traffic Information Sites
TMC	Transport for New South Wales - Transport Management Centre
TCS	Traffic Control Site (includes lanterns, loops, and TSC cabinet)
TMS	Traffic Monitoring Site
TSC	Traffic Signal Controller (located within TCS cabinet)
VCS	Video Control and Management System
VDS	Vehicle Detection Sites
VMS	Variable Message Sign is a type of Electronic Message Sign which incorporates LED sign facia, support, structure, local control system and communications interface equipment. These signs can provide the functionality of an RC3
RSS	Ramp Signalling Sites
RWS	A type of Electronic Message Sign which incorporates LED sign facia, support, structure, local control system and communications interface equipment. This sign provides the functionality of an RC1

Annexure 1 - Figures

Figure 18-1: Typical Critical ITS Corridor Communications Network (reference RMS specification TS020)

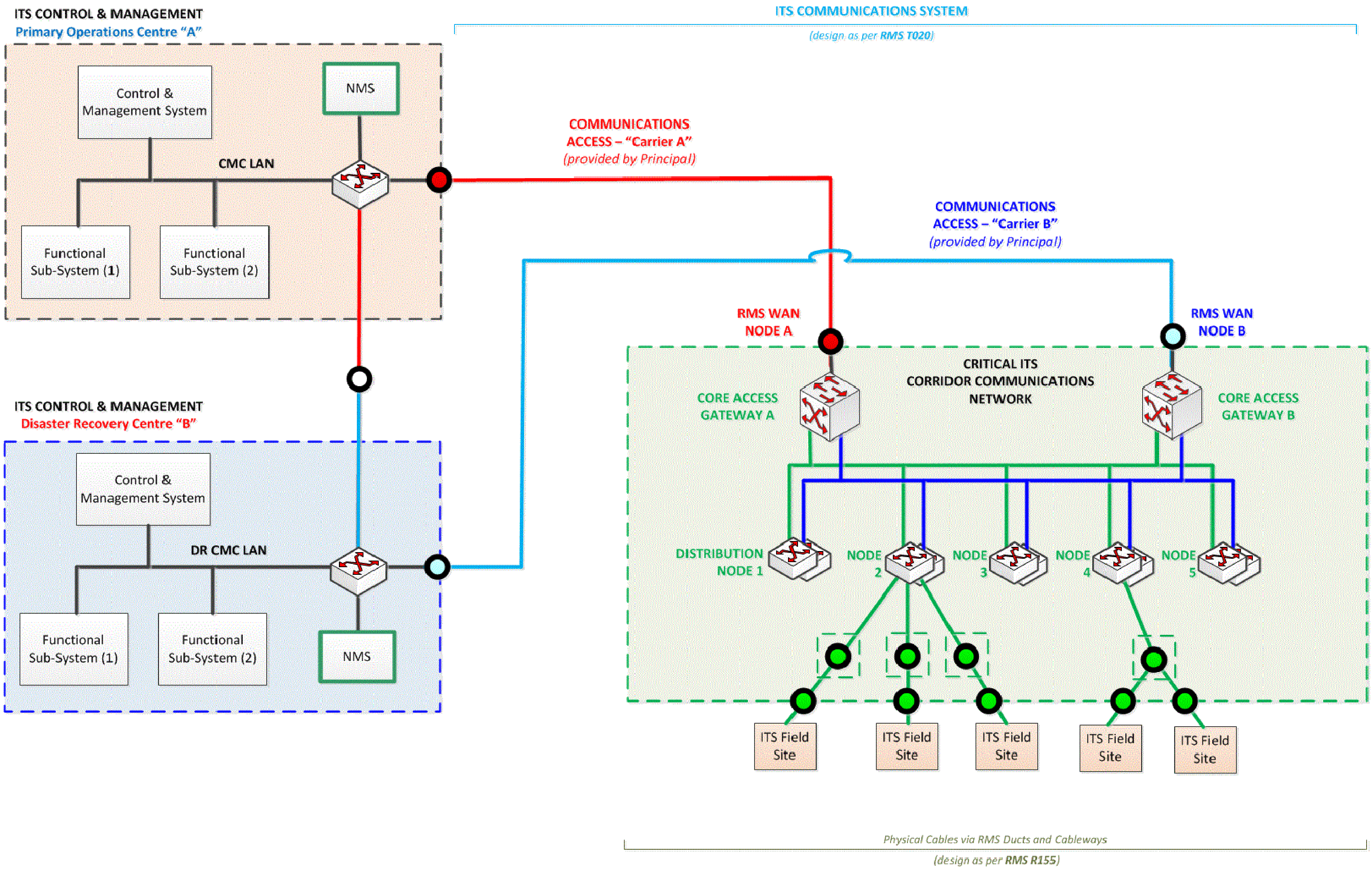

Figure 18-2: ITS Requirements Schematic No. 1

Figure 18-2: ITS Requirements Schematic No.1

The Northern Road Stage 3 North Project

SWTC Appendix 18 (Intelligent Transport Systems)

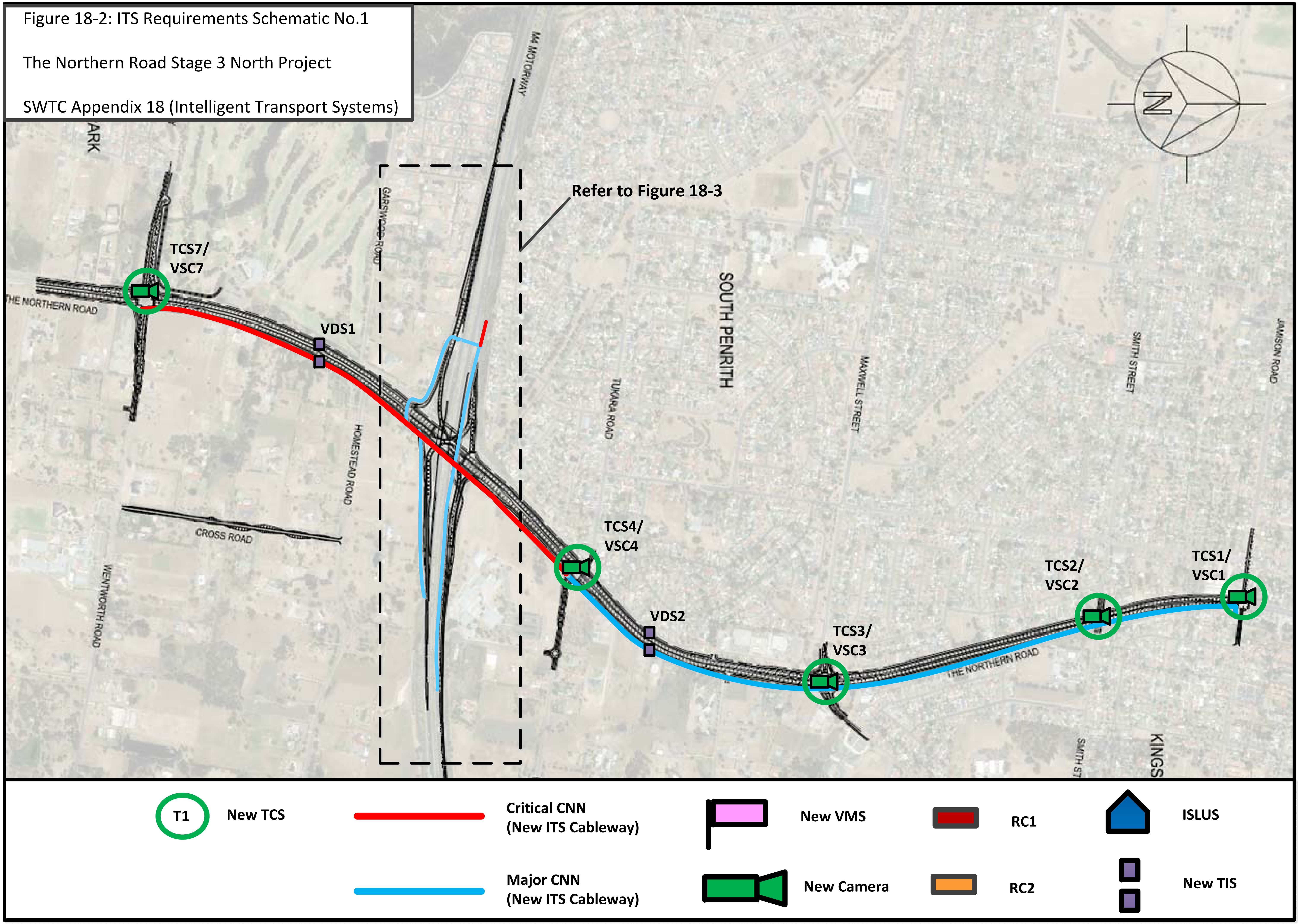

Figure 18-3: ITS Requirements Schematic No.2

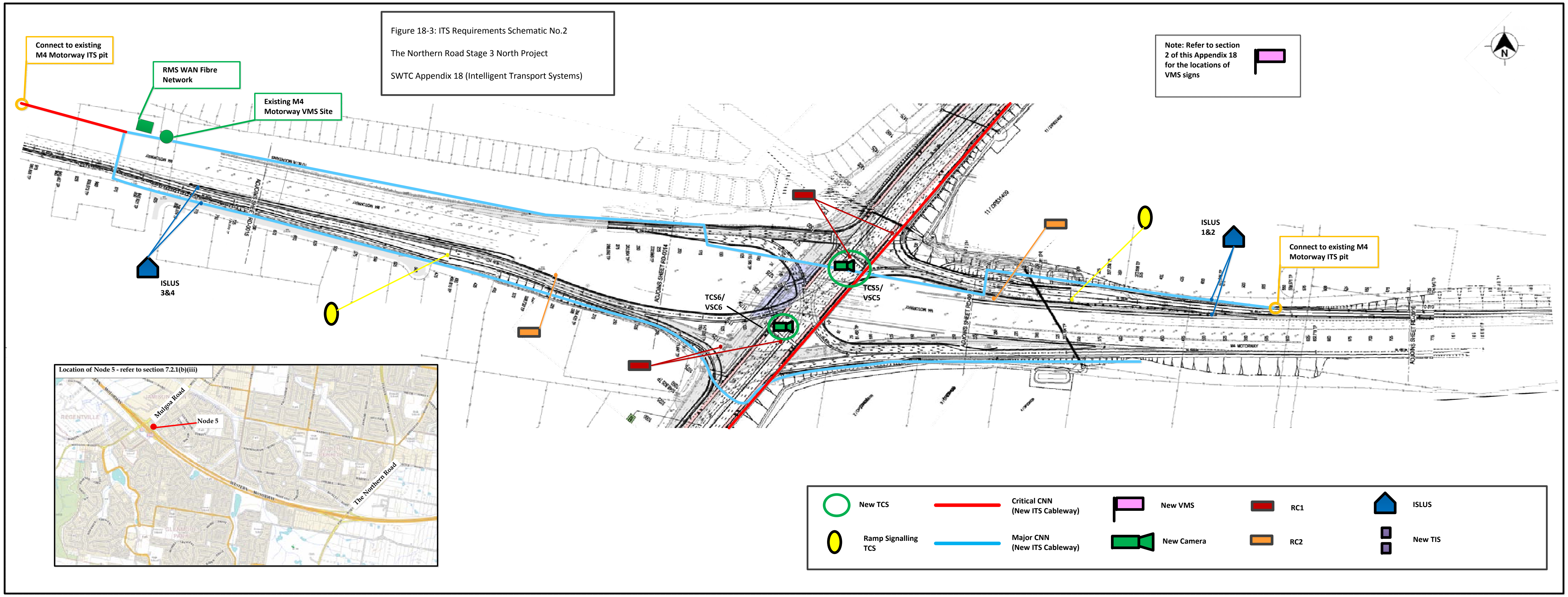

Figure 18-3: ITS Requirements Schematic No.2

The Northern Road Stage 3 North Project

SWTC Appendix 18 (Intelligent Transport Systems)

Exhibit A –

Scope of Works and Technical Criteria Appendix 19 – Provisional Sum Work for

Design and Construction of

Western Sydney Infrastructure Plan - The Northern Road Upgrade - Stage 3 North Project

Penrith, New South Wales

Contract number: 15.3662.2254

November 2016

Document Author: Roads & Maritime Services

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Table of Contents

1. General

(a) This Appendix 19 to the SWTC details the scope of works and all other requirements for Provisional Sum Works.

(b) The scope of works for the Provisional Sum Works includes at-residence operational noise treatment works, electrical Service Works and telecommunications Service Works.

(c) The Contractor must ensure that Provisional Sum Work is coordinated with the Project Works.

(d) The Contract Program must fully detail the duration and schedule dependencies and constraints associated with all Provisional Sum Work.

(e) The Contractor must provide the following information to RMS during the procurement of each subcontractor engaged by the Contractor to undertake Provisional Sum Work, unless otherwise agreed with RMS:

(i) Notification of Tenderers: Prior to inviting organisations to tender for Provisional Sum Work, the Contractor is to provide to RMS a notification of tenderers. The notification of tenderers is to identify the organisations that the Contractor intends to invite to tender for the Provisional Sum Work;

(ii) Tender Evaluation Report: Immediately following the identification of a preferred tenderer, the Contractor is to issue to RMS a tender evaluation report. The tender evaluation report is to include: a summary of the Contractor's evaluation of the price and non-price elements of each tenderer's submissions against the evaluation criteria; identify the preferred tenderer; describe the reasons for the selection of the preferred tenderer; and document the estimated final subcontract price; and

(iii) Notification of Contract Award: Immediately following the award of Provisional Sum Work to a subcontractor, the Contractor is to provide to RMS a notification of contract award. The notification of contract award is to include the company details of the subcontractor, the subcontract award price, and the estimated final subcontract price.

2. At-Residence Operational Noise Treatment Works

(b) The Provisional Sum Work for at-residence operational noise treatment works includes all work associated with the design and construction of at-residence operational noise treatment measures required to comply with the REF (Exhibit E to the Project Deed) and Appendix 4 (Additional Environmental Requirements) of the SWTC.

(c) The at-residence operational noise treatment works includes the works required at each of the property locations listed in Appendix 4 of the SWTC, or as otherwise agreed with RMS Representative.

(d) Any other at-residence operational noise treatment works, including works agreed between the Contractor and property owners additional to the necessary at-residence operational noise treatment works in 2(b), will not form part of Provisional Sum Work unless otherwise approved by RMS Representative.

(e) The Contractor's Work for at-residence operational noise treatment works must comply with Environmental Safeguards and Mitigation Measures of the REF (Exhibit E of the Project Deed).

3. Electrical Service Works

(f) The Provisional Sum Work for the electrical Service Works includes all works performed by an Accredited Service Provider Level 1 in the construction, testing and commissioning of the adjustments to existing electrical Services owned by Endeavour Energy, that can only be performed by an Accredited Service Provider Level 1, excluding:

(i) potholing, investigation and design work;

(ii) communication and coordination with Service owners and Authorities;

(iii) obtaining Approvals from Services' owners and Authorities;

(iv) payment of fees, levees and the like required by Services' owners and Authorities;

(v) traffic management;

(vi) environmental safeguards;

(vii) safety protection works;

(viii) Temporary Works; and

(ix) survey work, including survey work that is required to allow Services to be handed over to Services' owners and Authorities.

4. Telecommunications Service Works

(a) The Provisional Sum Work for the telecommunication Service Works includes all design and construction work undertaken by the Service Authorities, those being Telstra, Optus, NBN and TPG, or their appointed representatives, service providers or contractors.

(b) Without limitation, any Temporary Works associated with the telecommunication Service Works referred to in paragraph (a) does not form part of the Provisional Sum Work (except those undertaken by the Service Authority or their appointed representative, service provider or contractor).

(c) Without limitation, any traffic management associated with the telecommunication Service Works referred to in paragraph (a) does not form part of the Provisional Sum Work.

Exhibit A –
Scope of Works and Technical Criteria
Appendix 20 – Traffic Control Signals
for

Design and Construction of

Western Sydney Infrastructure Plan – The Northern Road Upgrade – Stage 3 North Project

Penrith, New South Wales

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Table of Contents

1 Traffic Control Signal Requirements

1.1 Introduction

(a) The Contractor must provide all Traffic Control Signals (TCSs) that are necessary for the construction and operation of the road network associated with the Project Works and Local Road Works, including the provision of new TCSs, the reconstruction of existing TCS and the provision of temporary TCSs.

1.2 Primary Function of Traffic Control Signals

(a) TCSs control the flow of traffic at road intersections by providing controlled access for each applicable direction of traffic flow using signal lanterns showing red, yellow and green or white aspects. TCSs operate in a coordinated manner to optimise the flow of traffic on traffic routes, under a control system responsible for the management of the traffic flow at an intersection.

1.3 Traffic Control Signal Design

(a) All new TCSs must comply with:

(i) RMS traffic signal design guidelines – RTA Publication 08.092;

(ii) Austroads Guide to Traffic Management Part 10: Traffic Control and Communication Devices;

(iii) RMS Supplement to Austroads Guide to Traffic Management Part 10: Traffic Control and Communication Devices;

(iv) Australian Standards AS1742 Manual of Uniform Traffic Control Devices Parts 1-15;

(v) RMS CADD Manual; and

(vi) RMS Supplement to AS1742 Manual of Uniform Traffic Control Devices Parts 1-15.

(b) Notwithstanding the requirements of section 1.3(a):

(i) The design must not locate any posts within median islands on local roads unless otherwise approved by RMS

(c) All existing TCSs that are reconstructed must be upgraded and constructed to comply with all current TCS design requirements stated in 1.3(a) and 1.3(b) above, including the replacement of all existing:

(i) signal lanterns;

(ii) push buttons;

(iii) controllers and housings, except for existing Tyco Eclipse, Aldridge ATSC4, or QTC Hadron controllers;

(iv) loop detector facilities with loop feeder cables to the controller housings;

(v) post mounted assemblies;

(vi) lower mounting brackets;

(vii) loop detectors that are unserviceable;

(viii) pavement junction box covers;

(ix) footpath pit covers, where they are damaged or not flush with the footpath;

(x) signal posts (including mast arms), where they are damaged, unserviceable or rusted; and

(xi) all disturbed underground ducts, pits and cables.

1.4 Traffic Control Signal Design Plans

1.4.1 General

(a) All plans and designs that are submitted to RMS must be in hard copy and in electronic CAD file format.

(b) Nominated timeframes for RMS TCS review periods included in this Appendix will apply to all TCS related submissions without exception.

1.4.2 Concept TCS Design Plans

(a) Concept TCS design plans for each temporary and permanent TCS installations and modifications, showing details of the geometry of the intersections and the proposed phasings, must be submitted to RMS for review.

(b) RMS will review and provide comment on Concept TCS design plans within 28 days of receipt. The Contractor must incorporate any amendments in the TCS plans required by RMS.

1.4.3 Detailed TCS Design Plans

(a) Detailed TCS design plans for each temporary and permanent TCS installation and modification must be submitted to RMS for review and/or approval. RMS will review and provide comment within 28 days of receipt of a submission. No modification, installation or construction must commence until RMS has approved the detailed TCS design plan.

(b) Submit a completed design plan checklist as detailed in Appendix A of *RMS Traffic Signal Design Guidelines* with each design submission.

(c) Prepare in accordance with *RMS Traffic Signal Design Guidelines* a proposed duct/boring plans showing the proposed position and size of all conduits and pits.

1.4.4 Acceptance of Detailed TCS Design Plans

(a) The final detailed TCS plans must be submitted (electronic and hard copies) to RMS for acceptance. Upon acceptance of the plans by RMS, a signed copy will be returned to the Contractor and the ownership of the hard and electronic copies of the final TCS plans will revert to RMS.

1.5 Construction

(a) Approved design plans must be submitted to RMS at least three months prior to the date the signals are required to be operational, to enable the programming of the traffic light signal configuration software (personality).

(b) All TCSs must be constructed in accordance with RMS Specification SI/TCS/8 - Installation and Reconstruction of Traffic Light Signals.

(c) RMS prequalified traffic signal contractors must carry out all work on TCSs.

(d) Without limiting the Contractor's obligation under the deed, the same traffic signal contractor must carry out all staged TCS works at a site. Unless otherwise approved by RMS, the same contractor must also carry out all resulting modifications at adjacent TCS sites, and signal modifications in each stage are completed concurrently.

(e) TCS plans for staged TCS works must be prepared for each stage of the works and submitted to RMS for review and approval.

(f) RMS will check and either accept or return the staged TCS plans for amendment within 14 days of receipt. Any amendments that are required by RMS must be incorporated in the TCS plans.

(g) Notice must be provided to RMS prior to undertaking any modifications or installations of traffic signals in accordance with RMS D&C G7.

1.6 Communications

(a) All traffic signal controllers must remain connected or be connected to the RMS's SCATS traffic signal control network.

(b) Traffic signal controllers must be supplied with data communication linking to the SCATS regional computers. The ITS Corridor Communications Network (CCN) must be used and SCATS communications devices installed for connection of each traffic signal controller to the SCATS system.

1.7 Maintenance

(a) RMS is responsible for the maintenance of all operational TCSs, including TCSs that are being re-constructed. TCSs that are being re-constructed must be safely returned to service by the Contractor at the completion of each day's work.

1.8 Speed Enforcement System Requirements

(a) For all existing speed enforcement systems within the Construction Site, the Contractor must:

(i) be kept operational during the completion of the Contractors Work;

(ii) provide the RMS Representative with at least four (4) weeks' notice of any proposed speed limit reductions, so to allow the speed enforcement system to be adjusted accordingly; and

(iii) the safety camera must be relocated to a location to be agreed with the RMS Representative if it is to be affected by the Contractors Work.