COPPABELLA WIND FARM RADIO LINK EXCLUSION ZONES COMPARISON BETWEEN GW 121 and GW 140 TURBINES

Coppabella Wind Farm Pty Ltd (CWFPL) proposes the construction of a wind farm in NSW approximately 35 Km west of Yass and 10 Km south west of the hamlet of Binalong. The Development Consent for the project, granted on 30 March 2016, allows for a wind farm with up to 79 wind turbines, as well as on-site infrastructure in the way of access tracks, a 33kV/132kV substation and, internal 33kV collection circuits involving 33kV underground cables and 33kV overhead power lines.

This Report considers the change in potential impacts of the wind facility on radiocommunications as a result of a proposed modification of the Development Consent for the project. This assessment supports a Modification Application that proposes the use of Goldwind GW140 turbines based on a 100m hub height and a rotor diameter of 140m resulting in a blade tip height of approximately 170m. The assessment compares the impact of the GW140 turbine, proposed for the modification, to the GW121 turbine which can be installed in accordance with the existing Development Consent.

A previous report covered the potential impacts of the wind farm on radio communications and TV/Radio Broadcasting and discussed the necessary clearances required to be maintained between radio sites and the radio path between point to point and other radio facilities. This report focuses on the impact of using the larger rotor GW140 turbines relative to the GW121 turbine that has dimensions which are consistent with the Development Consent. The same layout is used for assessing the potential interference associated with each turbine and as a result of the modification. Any proposed micrositing for the final layout would need to give further consideration to telecommunications impacts.

To enable assessment, CWFPL provided the Coppabella wind farm development boundary, consented turbine locations and turbine dimensions. The turbine grid coordinates are shown in Attachment 1. Data was also obtained from the Australian Communications & Media Authority's (ACMA) RRL and Spectra Databases. This information allowed for an investigation into the potential impacts of the proposed wind facility on radiocommunication services within a 50km radius, as well as determining whether the wind turbine locations would obstruct line-of-sight paths or have any likely detrimental effect on these services. Clearance criteria for ray lines have been indicated for any point to point radio paths encroaching or traversing the Coppabella site.

A number of point to point links are registered for operation within 50km of the proposed wind farm. Attachments 2, 3 and 4 show the locations of the link paths relative to turbine locations.

- Attachment 2 – Microwave links (>1 GHz)
- Attachments 3 and 4 – VHF/UHF links (<1 GHz)

The source ACMA database contains data for sites in the GDA 94 coordinate set. However the maps in Attachments 2, 3 and 4 are derived from MapInfo maps which are displayed in the AMG 66 coordinate set due to Mapping software conversions as to the ACMA data coordinate set only recently been changed from AMG 66.

As shown in Attachment 2 there are no microwave links (> 1GHz) that traverse the wind farm site in close proximity (< 1km) to wind turbine sites. There are specific clearance requirements from ray lines to mitigate any turbine interference on microwave links, however the proposed turbines are located well outside these exclusion areas and therefore are not going to impact these links.

As shown in Attachment 3 and 4, there are three UHF/VHF links that traverse the boundaries of the wind farm site. There are also another two link paths known to exist between site 9542 and Jugiong and a Harden Council Site which are not shown as a point to point link in the ACMA data. The paths presumably do not appear on the link mapping as they are part of a Point to Multipoint system where the remote ends are not listed. Path profiles were generated for each of these 5 links with turbines with blade tip heights of 170 m superimposed at representative positions along the link. As shown in each of the 5 link path profiles (Attachments 5, 6, 7, 8 and 9) the link paths do not have vertical clearance for the first 2 turbines from site 9452, where the links originate, and therefore horizontal clearances are required. Based on the potentially affected links operating at UHF/VHF frequencies, sufficient clearance between the link ray lines and the centreline of the wind turbine towers must be greater than 0.6 X 1st Fresnel zone + wind turbine blade length for each link (required clearance).

Calculations were made for the UHF links crossing the wind farm to determine the acceptable Fresnel zone horizontal clearances for each link and are shown in Attachments 10 and 11.

- Attachment 10 shows the '*Required Clearance*' required from the link path to the centreline of the wind turbine towers are based on UHF frequency, distance to the site boundary and a turbine blade length of 70.15 metres for the GW140 turbine and the '*Actual Clearance'* <<horizontal>> for each turbine. Using the site boundary distances rather than the turbine tower distance from the site 9452 is conservative and allows for coordinate accuracy and micrositing
- Attachment 11 similarly shows '*Required Clearance'* for the GW121 based on same link path frequency and applicable blade length of 60.5 metres. The actual clearances being are derived from the link mapping or by calculation.

The Actual Clearances are based on mapping in the horizontal plane separate from the consideration of Vertical clearance.

It is noted that there are 6 turbines that are too close to the link paths for the smaller GW121 turbine and 7 turbines are too close for the GW140 turbines. 6

of the turbines involved are the same in both cases with an additional one (T68) for the GW140 wind turbine.

Attachment 12 shows the differences in actual clearance for the consented wind farm and modified wind farm based on GW121 and GW140 turbines respectively. Where clearance is inadequate it is shown in red and as a negative distance. The use of the GW140 turbine rather than GW121 turbine increases the '*Required Clearance*' for the UHF links by 9.65 metres. Where insufficient clearance was available for the GW121, the use of GW140 exacerbates the inadequate clearance. In one case, Turbine 68, there was adequate clearance for the consented design and deficient clearance for the modified design.

It is noted that adequate clearance to avoid interference is assessed by consideration of both horizontal and vertical clearances.

The vertical path profiles for the link paths show that at least one turbine close to Station 9452 would intrude into the clearance zone in each case. The fall of blade tip height for turbines not directly under the link paths has not been taken into account and for variation of ground level where relevant however more detailed examination will be made when any micrositing is required for other reasons. The accuracy of the vertical profiles depend on a number of factors including the averaging in 3 sec Digital Elevation Models (DEM) used for the ground profile, the constructed height of the tower foundations and the assumptions about earth curvature. Radio link design usually assumes an earth radius of 1.33 times the actual earth radius to represent average propagation conditions however for fading conditions due the changes in weather patterns an earth radius of 0.6 times actual is used to check ray line ground clearance.

The following turbines have potentially inadequate vertical clearance and insufficient horizontal clearance and require further mitigation measures:

- Consented design (GW121) – Turbines T129, T66, T32, T38, T56, T58, T68
- Modified design (GW140) – Turbines T68, T129, T66, T32, T38, T56, T58,

In summary both rotor size proposals require the same number of Turbines to be microsited or dealt with by other means to comply with theoretical clearance requirements

As a result of the assessment, mitigation methods identified to avoid interference for the proposed turbines are as follows:

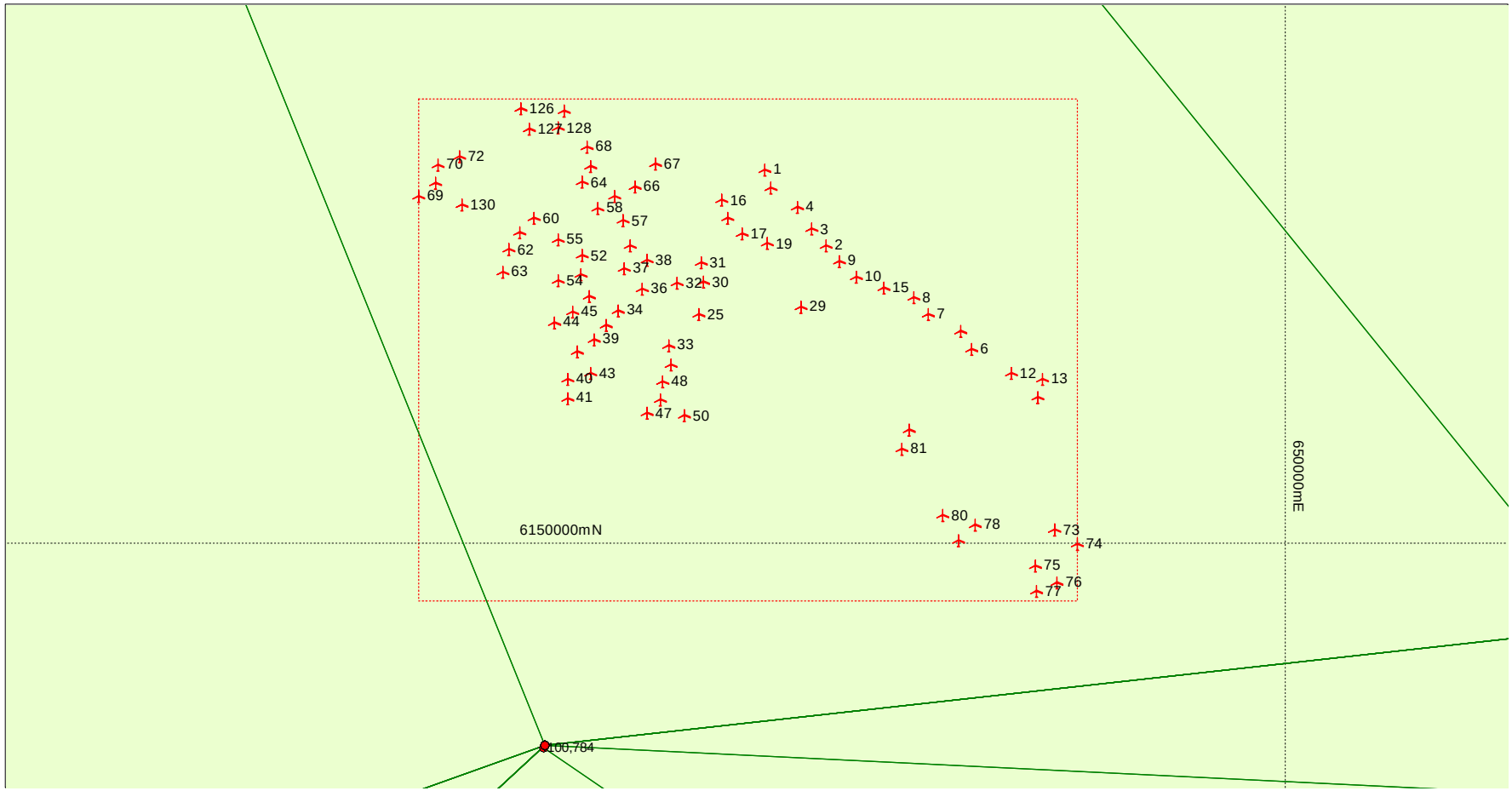
- for turbines to be microsited within the 100 metre allowance or, if not practical;
- negotiations could occur with the affected link operator(s) to re-route their links or to install repeaters. or to tolerate small intrusion of blades into the clearance zones
- Replacement microwave links may also be an option as they require less clearance distance.

ATTACHMENT 1 – COPPABELLA FARM TURBINE COORDINATES

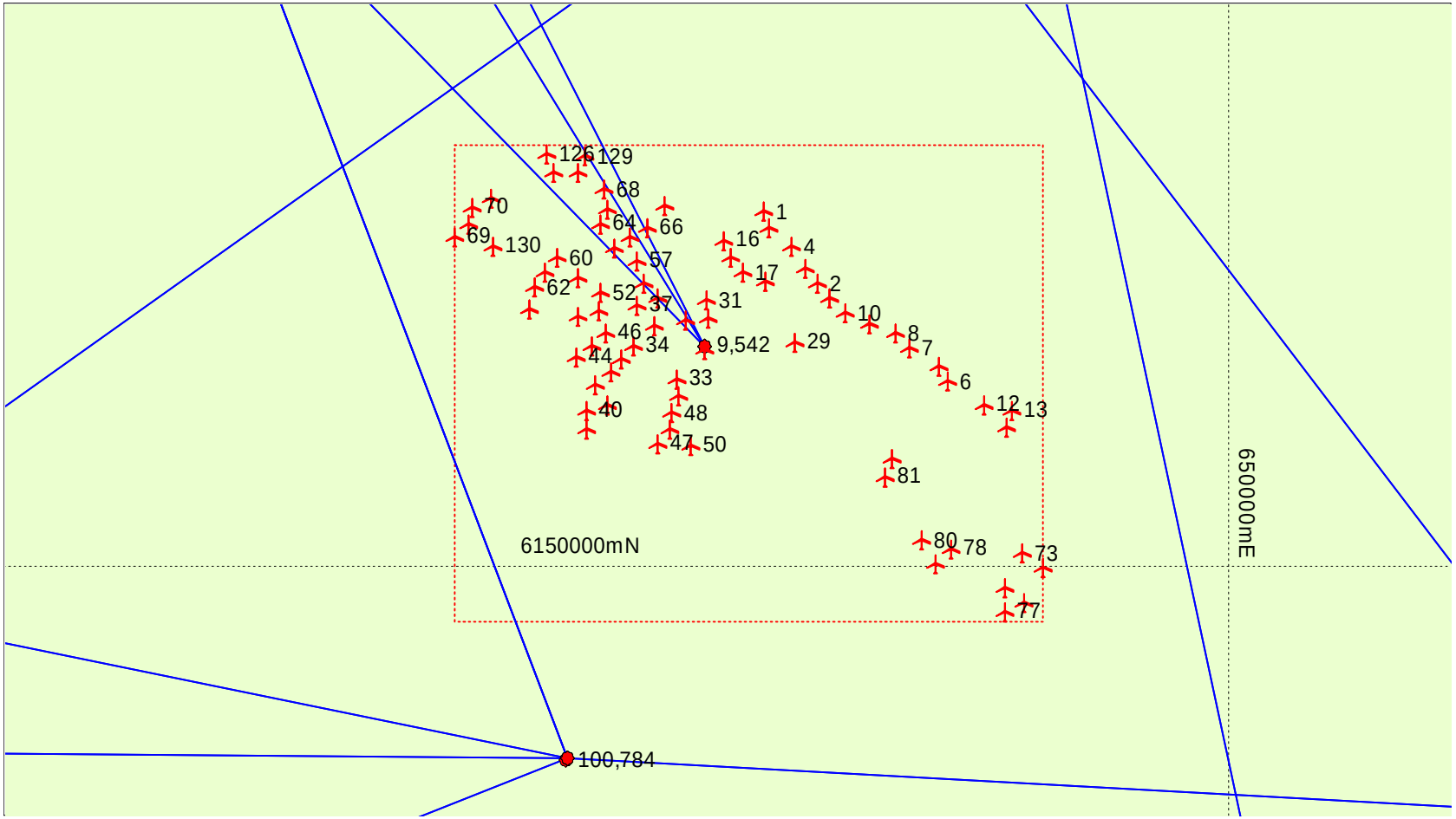
WTG ID	**Approval Locations** GDA94 Zone 55	
	Easting	Northings
1	641,135	6,156,615
2	642,183	6,155,309
3	641,934	6,155,584
4	641,683	6,155,973
5	641,228	6,156,306
6	644,704	6,153,528
7	643,949	6,154,128
8	643,690	6,154,400
9	642,410	6,155,033
10	642,697	6,154,767
11	644,507	6,153,820
12	645,386	6,153,102
13	645,920	6,153,005
14	645,844	6,152,689
15	643,186	6,154,579
16	640,374	6,156,085
17	640,731	6,155,502
18	640,494	6,155,780
19	641,174	6,155,340
25	639,997	6,154,114
29	641,753	6,154,245
30	640,070	6,154,676
31	640,038	6,155,010
32	639,618	6,154,648
33	639,464	6,153,582
34	638,607	6,154,188
35	638,391	6,153,940
36	639,022	6,154,556
37	638,704	6,154,914
38	639,088	6,155,044
39	638,176	6,153,691
40	637,724	6,153,002
41	637,724	6,152,676
42	637,890	6,153,483
77	645,814	6,149,346
78	644,751	6,150,491
79	644,471	6,150,212
80	644,204	6,150,650
81	643,496	6,151,799
82	643,622	6,152,119
43	638,123	6,153,103

44	637,501	6,153,978
45	637,821	6,154,164
46	638,091	6,154,423
47	639,088	6,152,412
48	639,374	6,152,965
49	639,508	6,153,251
50	639,733	6,152,377
51	639,315	6,152,655
52	637,982	6,155,133
53	637,955	6,154,807
54	637,553	6,154,697
55	637,558	6,155,411
56	638,814	6,155,310
57	638,692	6,155,728
58	638,239	6,155,953
59	638,546	6,156,147
60	637,143	6,155,777
61	636,904	6,155,521
62	636,707	6,155,235
63	636,604	6,154,848
64	637,973	6,156,390
65	638,118	6,156,671
66	638,884	6,156,320
67	639,241	6,156,706
68	638,060	6,157,008
69	635,163	6,156,152
70	635,491	6,156,697
71	635,449	6,156,374
72	635,867	6,156,842
73	646,131	6,150,401
74	646,521	6,150,162
75	645,789	6,149,787
76	646,174	6,149,496
126	636,929	6,157,657
127	637,065	6,157,311
128	637,560	6,157,324
129	637,674	6,157,619
130	635,896	6,156,000

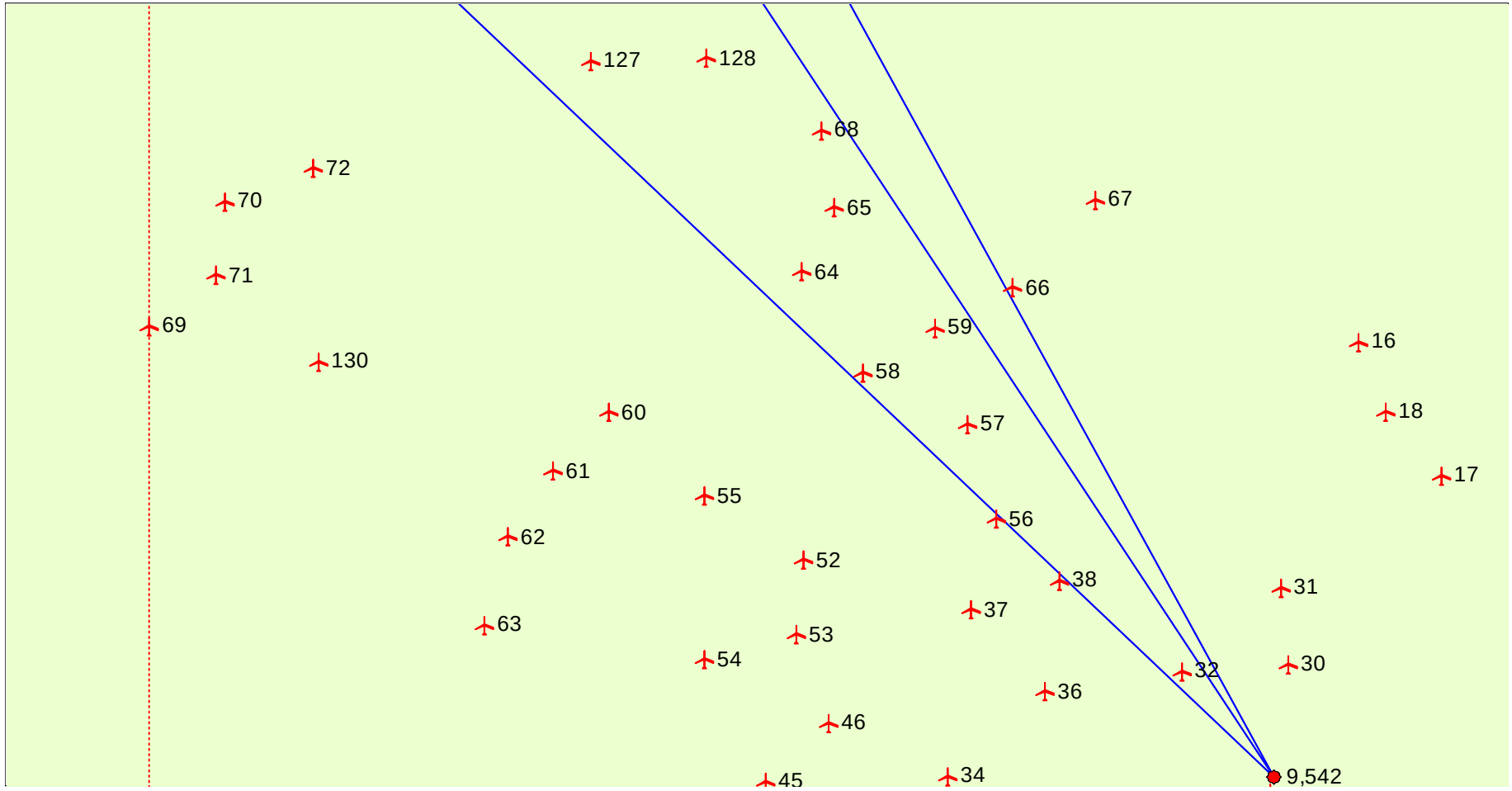
ATTACHMENT 2 MICROWAVE RADIO LINK PATHS NEAR WIND TURBINES COPPABELLA WIND FARM



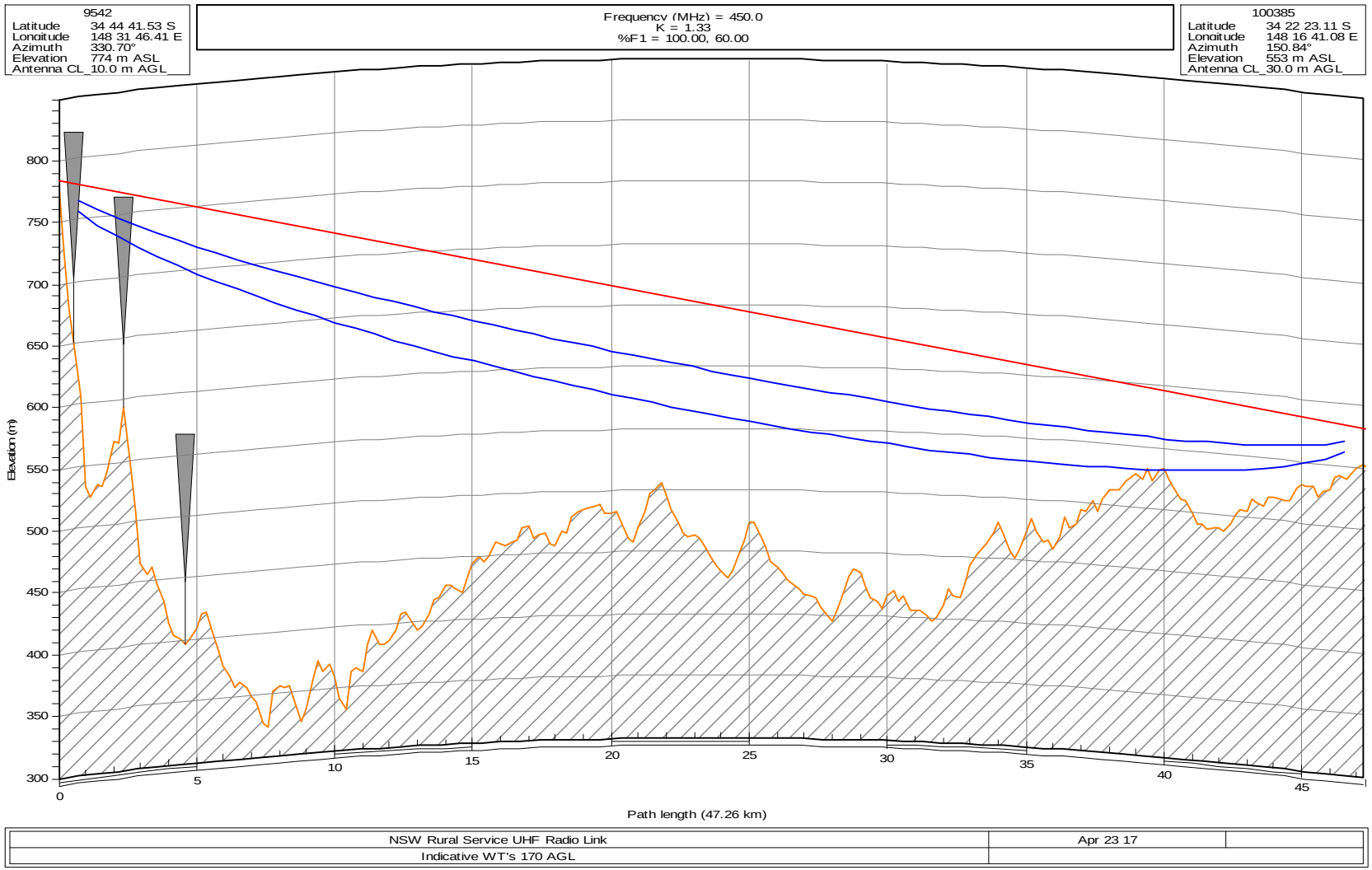
ATTACHMENT 3 VHF/UHF RADIO LINK PATHS NEAR WIND TURBINES COPPABELLA WIND FARM



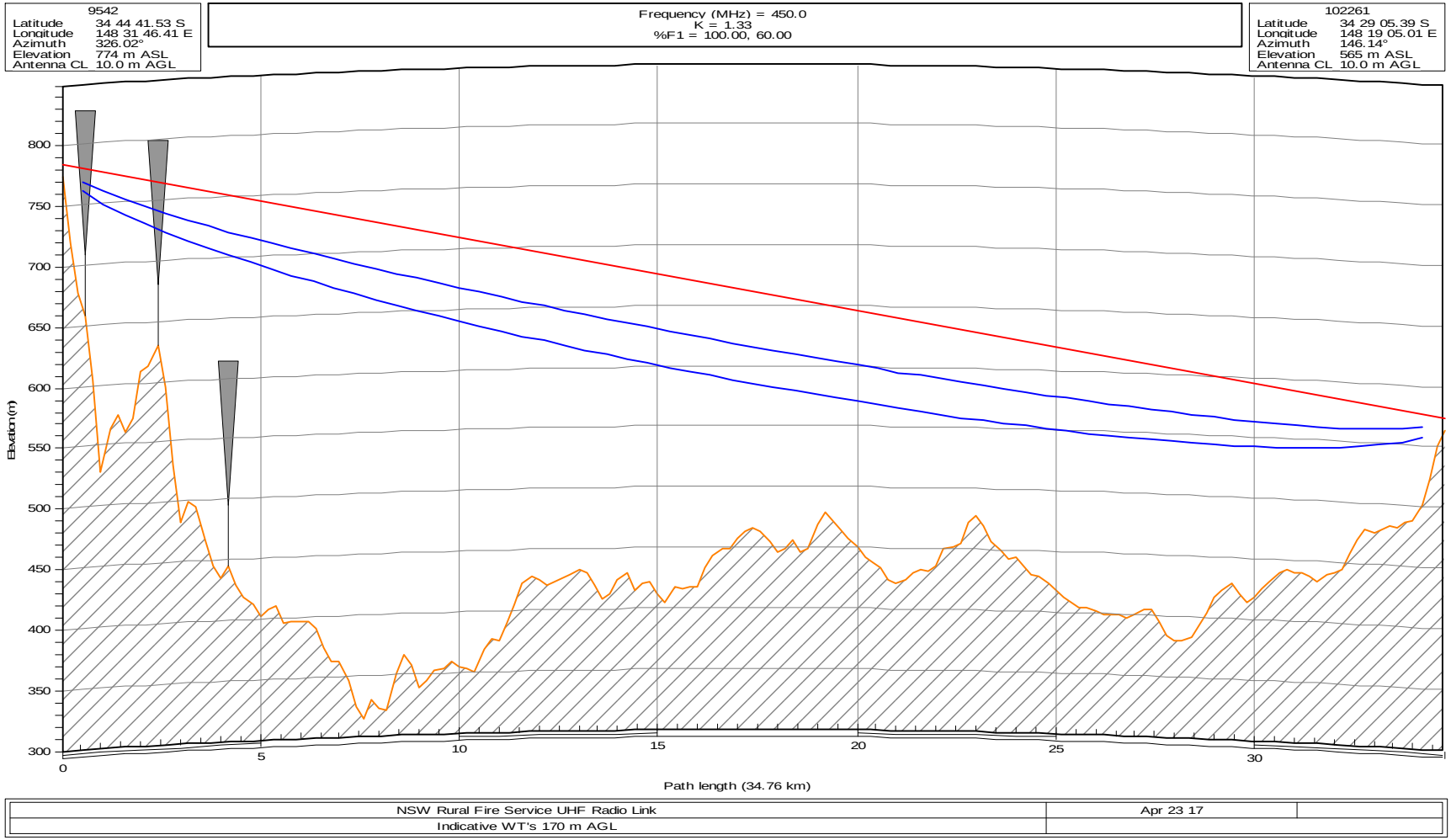
ATTACHMENT 4 – Map of VHF/UHF Radio Links near Coppabella Wind Farm Zoomed Up View
Turbines shown in red. GDA94 datum



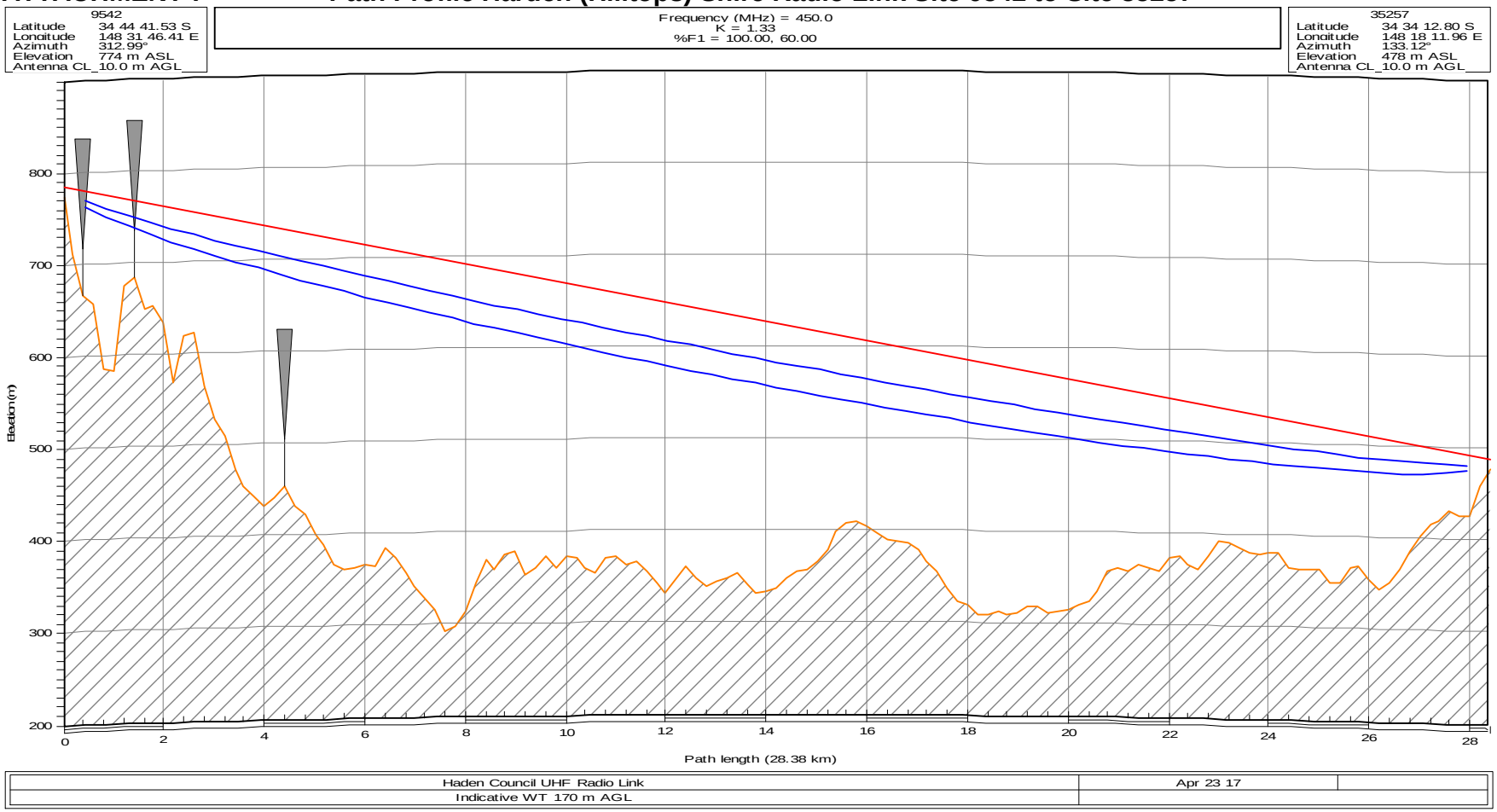
ATTACHMENT 5 Path Profile RFS Radio Link Site 9542 to Site 100385



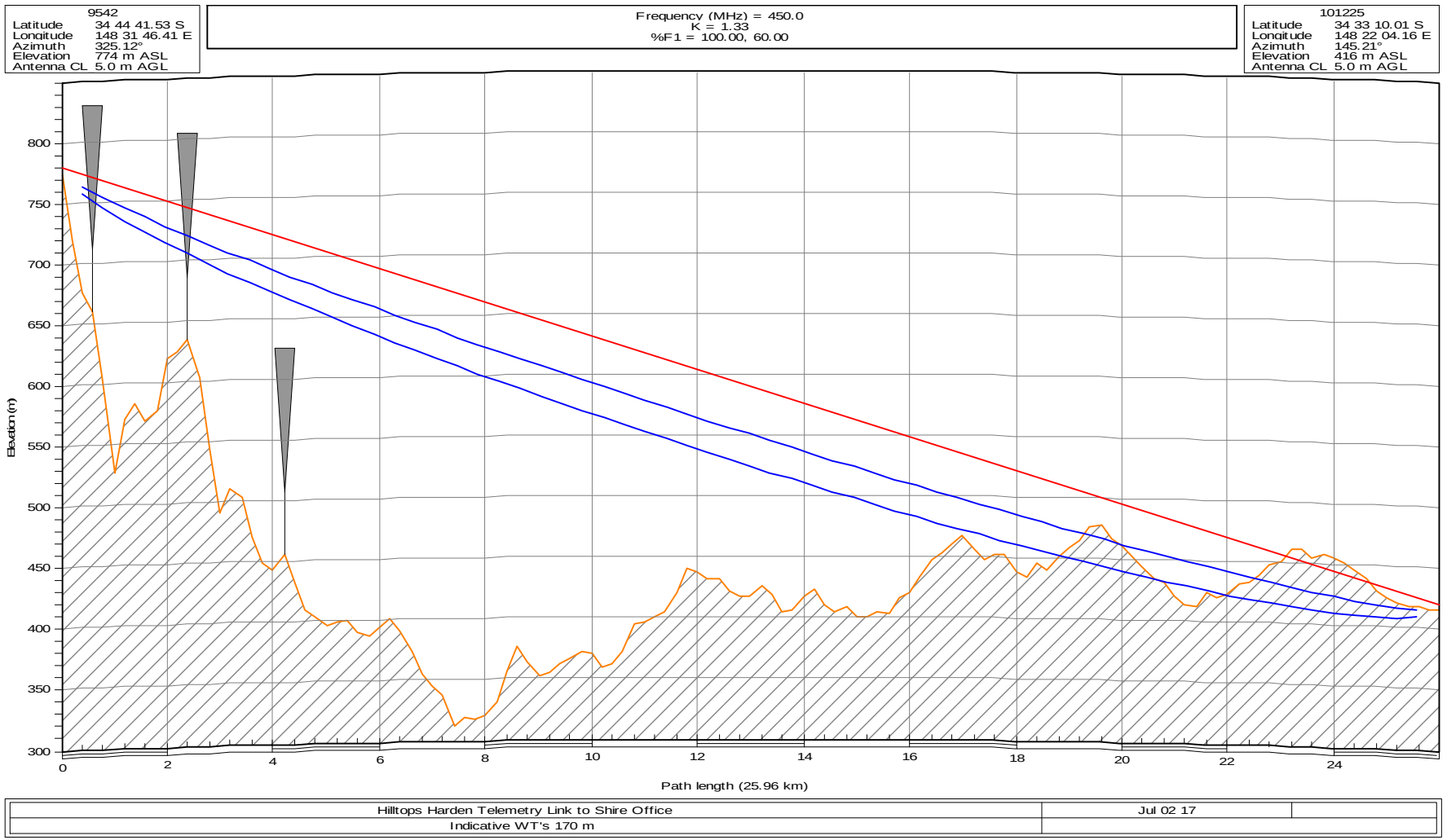
ATTACHMENT 6 **Path Profile RFS Radio Link Site 9542 to Site 102261**



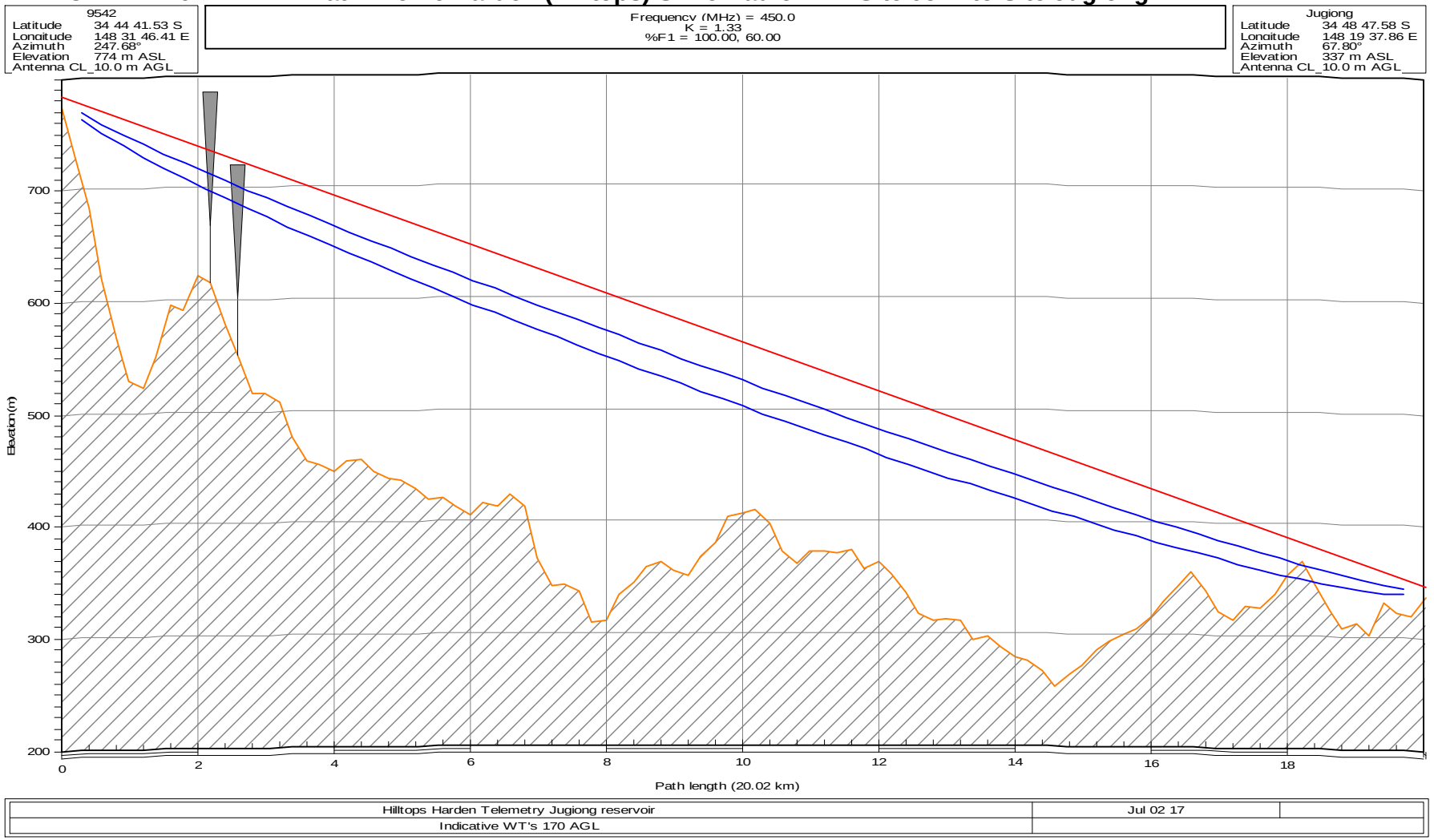
ATTACHMENT 7 **Path Profile Harden (Hilltops) Shire Radio Link Site 9542 to Site 35257**



ATTACHMENT 8 Path Profile Harden (Hilltops) Shire Radio Link Site 9542 to Site 101225



ATTACHMENT 9 **Path Profile Harden (Hilltops) Shire Radio Link Site 9542 to Site Jugiong**



ATTACHMENT 10 – RADIO LINK CLEARANCES AT CLOSEST GW 140 TURBINES

GW140
ROTOR

Site 1 ACMA ID	Site 2 ACMA ID	Operator	Frequency MHz	Total Path Length Metre	Max. Path Dist. To Turbine Metre	2nd Fresnel Metre	0.6 x Ist Fresnel Metre	Blade Length Metres	Close Turbines	Required Clearance * Metre	Actual Clearance Metre
9542	102261	NSW Rural F.S.	450	34760	4370	71.37	30.28	70.15	T68	100.43	92.6
9542	102261	NSW Rural F.S.	450	34760	4370	71.37	30.28	70.15	T129	100.43	82.6
9542	100385	NSW Rural F.S.	420	47260	4150	73.54	31.20	70.15	T66	101.35	24.7
9542	35257	Harden Shire C.	450	28380	5250	75.53	32.05	70.15	T32	102.20	61.3
9542	35257	Harden Shire C.	450	28380	5250	75.53	32.05	70.15	T38	102.20	20.6
9542	35257	Harden Shire C.	450	28380	5250	75.53	32.05	70.15	T56	102.20	18.6
9542	35257	Harden Shire C.	450	28380	5250	75.53	32.05	70.15	T58	102.20	46.8
9542	101225	Harden Shire C.	450	25950	5450	75.77	32.14	70.15	T68	102.29	81.7
9542	Jugiong	Harden Shire C.	450	20020	5490	72.89	30.92	70.15	T42	101.07	119.3

ATTACHMENT 11 – RADIO LINK CLEARANCES AT CLOSEST GW 121TURBINES

GW121 ROTOR

Site 1	Site 2	Operator	Frequency	Total Path Length	Max. Path Dist. To Turbine	2nd fresnel m	0.6 x Ist fresnel m	Blade Length	Close Turbines	Required Clearance*	Actual Clearance
ACMA ID	ACMA ID		MHz	Metre	Metre	Metre	Metre	Metre		Metre	Metre
9542	102261	NSW Rural F.S.	450	34760	4370	71.37	30.28	60.5	T68	90.78	92.6
9542	102261	NSW Rural F.S.	450	34760	4370	71.37	30.28	60.5	T129	90.78	82.6
9542	100385	NSW Rural F.S.	420	47260	4150	73.54	31.20	60.5	T66	91.70	24.7
9542	35257	Harden Shire C.	450	28380	5250	75.53	32.05	60.5	T32	92.55	61.3
9542	35257	Harden Shire C.	450	28380	5250	75.53	32.05	60.5	T38	92.55	20.6
9542	35257	Harden Shire C.	450	28380	5250	75.53	32.05	60.5	T56	92.55	18.6
9542	35257	Harden Shire C.	450	28380	5250	75.53	32.05	60.5	T58	92.55	46.8
9542	101225	Harden Shire C.	450	25950	5450	75.77	32.14	60.5	T68	92.64	81.7
9542	Jugiong	Harden Shire C.	450	20020	5490	72.89	30.92	60.5	T42	91.42	119.3

* Between radio ray line and WT tower Centre line

ATTACHMENT 12 – COMPARISON of RADIO LINK CLEARANCES GW121 & GW140 TURBINES

					GW121 turbines Blade length 60.5m			GW140 turbines Blade length 70.15m			Change in required clearance GW121 & GW140
Site 1	Site 2	Operator	Freq MHz	Relevant Turbine	Required Clearance	Actual Clearance	Clearance Difference GW121	Required Clearance	Actual Clearance	Clearance Difference GW140	
					Metres	Metres	Metres	Metres	Metres	Metres	Metres
9542	102261	NSW Rural Fire Service	450	T68	90.78	92.6	1.82	100.43	92.6	-7.83	7.83
9542	102261	NSW Rural Fire Service	450	T129	90.78	82.6	-8.18	100.43	82.6	-17.83	9.65
9542	100385	NSW Rural Fire Service	420	T66	91.70	24.7	-67.0	101.35	24.7	-76.65	9.65
9542	35257	Hilltops Shire Council	450	T32	92.55	61.3	-31.25	102.20	61.3	-40.90	9.65
9542	35257	Hilltops Shire Council	450	T38	92.55	20.6	-71.95	102.20	20.6	-81.60	9.65
9542	35257	Hilltops Shire Council	450	T56	92.55	18.6	-73.95	102.20	18.6	-83.60	9.65
9542	35257	Hilltops Shire Council	450	T58	92.55	46.8	-45.75	102.20	46.8	-55.40	9.65
9542	101225	Hilltops Shire Council	450	T68	92.64	81.7	-10,94	102.29	81.7	-20.59	9.65
9542	Jugiong	Hilltops Shire Council	450	T42	91.42	119.3	27.87	101.07	119.3	18.23	0