Project Report

October 27, 2023

Sun Cable

Australia-Asia PowerLink

Community Operational Noise Technical Assessment

			[p.p] MR	[p.p] MR		
2023-10-27	1	Approved for Use	J. Vairo	M. Choy R. Morizzi	M. Winfield-Lesk	J. Sheridan
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1. Introduction

Sun Cable is proposing Australia Asia PowerLink - the development of a 17-20 GW solar farm, battery storage facilities and overhead transmission line (OHTL) system to export high voltage direct current (HVDC) power from Powell Creek, Northern Territory (NT), Australia with offtakes in Darwin and Singapore (the 'Project').

This Report provides noise modelling results that were prepared in accordance with the Northern Territory Noise Management Framework Guideline for the cumulative impact of the operational activity of the Solar Precinct, Darwin Converter Site, and various operating configurations of the OHTL component of the Project. This work builds upon the airborne noise assessment methodology used in prior noise assessment work to support the Draft Environmental Impact Statement (Draft EIS; April 2022) and Supplement to the EIS (SEIS; November 2022). This Report responds to additional information requests issued by the NT EPA in March 2023.

2. NT EPA Comment #14

The NT EPA provided the following comments in March 2023:

Community and economy *– Noise and vibration from operation of the proposed action.*

The TOR required that noise and vibration during construction and operation of all components of the proposed action need to be addressed.

The EIS included a prediction of the average level of audible noise for the OHTL based on the Chartier method produced by CIGRE (2009)[1]. The estimated average sound power (75 dBA, single band, 125 Hz), was compared to the Northern Territory Noise Management Framework Guideline (2018) night time noise criteria for residential land uses to identify predicted impacts. However, the EIS assessment is not in accordance with section 3.2 – Commercial and Industrial Noise of the framework (including use of averages rather than (LAeq (15 minute)) and it is not clear if intrusive noise and tonal adjustments were accounted for).

The EIS states that the noise estimate considered worst-case scenario (all equipment operating at once in the worst-case climatic conditions). It is not clear whether other operational configurations have been accounted for, and whether the noise emissions from those scenarios may be worst-case and what the potential significant impacts are associated with those. Noise generation from transmission lines is dependent on conductor bundle design and operating configuration and each of these scenarios should be discussed separately.

The EIS indicates operational noise criteria will not be met at several sensitive receptors. No mitigation has been suggested for the identified residual impacts to residual receptors.

[1]CIGRE (2009). Technical brochure 388 – Impacts of HVDC Lines on the Economics of HVDC Projects.

2.1 Direction to Provide Additional Information

In addition to addressing the March 2023 comments, the NT EPA has directed Sun Cable to provide the following information:

1. Provide a noise impact assessment in accordance with the Northern Territory Noise Management Framework Guideline for the following operational configurations of the OHTL:
   a. Both bipoles in operation
   b. One bipole in operation
   c. Monopolar operation – various permutations
   d. Differential sag on conductor due to unbalanced operation
2. The noise impact assessment is to address cumulative impacts of operational noise e.g. noise from the converter site combined with the OHTL noise on future Murrumujuk residential development.
3. Identify mitigation measures for operational noise emission exceedances from the proposed action. Discuss the consideration of alternatives (available technologies, best practicable mitigation technology, methods such as underground in proximity to residences) and reasons for either selecting or not selecting the option. If the option is not selected because it was considered not economically feasible, a comparison of the environmental / effectiveness of the options should still be included.
4. Identify the total number of land parcels (include NT Portion numbers or section numbers and maps at an appropriate / local scale) where the operational noise is predicted to exceed / not meet the noise limit (at sensitive receptors).

The response to the above comments and the March 2023 comments are addressed in the assessment provided below and summarized in Table 2-1.

Table 2-1: Summary of NT EPA Comments and Direction

Paraphrased NT EPA Comment	Addressed in
1. To include noise and vibration during construction and operation of all components	Operation: Section 3 Construction: Refer to SEIS
2. Address application of *LAeq (15 minute) in the assessment and provide clarity on intrusive adjustments, including tonality*	Section 3.2.2
3. *Noise generation from transmission lines is dependent on conductor bundle design and operating configuration. Each of these scenarios should be discussed prior to identifying and assessing the worst case condition*	Table 3-3
4. Provide mitigation recommendations for sensitive receptors found to have exceedances	Section 3.4.2
5. *Provide impact assessments of:* a. Both bipoles in operation b. One bipole in operation c. Monopolar operation – various permutations d. Differential sag on conductor due to unbalanced operation	Section 3.4 a. Variant 1A/B b. Variant 2A/B c. Not in design (Table 3-3) d. Not in design (Table 3-3)
6. Provide a cumulative noise assessment of the converter site combined with the OHTL	Section 3.4
7. Identify noise mitigation technologies (See Item 4 above)	Section 3.4.2
8. Identify total number of parcels predicted to exceed noise limits	Section 3.4.1 para 1.

3. Noise Impact Assessment

3.1 Noise Baseline Setting

Baseline noise measurements are not currently available for the assessment area. The Project has adopted the minimum assumed rating background levels (RBL) from the Northern Territory Noise Management Framework Guideline (2018) (the Guideline) for the purposes of this assessment.

Should impacts on a receptor be expected to exceed the identified applicable noise criteria as described in Section 3.2 of this report, it is recommended that further baseline noise measurement be considered.

The undertaking of baseline noise measurements in this scenario would aim to further refine the rating background level (RBL) to be used in the noise criteria selection at selected receptor locations and provide a more definitive understanding of likelihood of impact in scenarios where potential impact is identified.

3.2 Industrial Noise Limits and Project Noise Criteria

The Northern Territory Noise Management Framework Guideline (2018) (the Guideline) Section 3.2 Commercial and Industrial Noise provides the framework for the assessment and management of commercial and industrial noise. The below Project noise criteria has been established consistent with these guidelines and requirements.

3.2.1 Amenity

The combined (total) noise level from all industrial noise sources is to remain below the Maximum Assigned Amenity Noise Levels shown in Table 3-1. The Project Specific Amenity Noise Level shall be below the Maximum Assigned Amenity Noise Level to ensure the cumulative noise impact from all industrial noise sources in the area does not exceed these limits. Typically, the Project Specific Amenity Noise Level is the maximum assigned amenity noise levels minus 5 dB as shown in Table 3-1.

Table 3-1: Recommended assigned amenity noise levels for operational airborne noise at sensitive land uses

Receptor	Noise Amenity Area	Time of Day	Maximum Assigned Amenity Noise Level, L_{Aeq} dBA	Project Specific Amenity Noise Level, L_{Aeq} dBA
Residential	Rural	Day* (7 am to 6 pm)	50	45
		Evening** (6 pm to 10 pm)	45	40
		Night*** (10 pm to 7 am)	40	35
	Suburban	Day* (7 am to 6 pm)	55	50
		Evening** (6 pm to 10 pm)	45	40
		Night*** (10 pm to 7 am)	40	35
	Urban	Day* (7 am to 6 pm)	60	55
		Evening** (6 pm to 10 pm)	50	45
		Night*** (10 pm to 7 am)	45	40
Hotels, motels, caretakers quarters, holiday accommodation, permanent resident caravan parks	See Column 4	See column 4	5 dBA above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day	5 dBA below the Maximum assigned Amenity Noise Level
Classrooms at schools and other educational institutions	All	Noisiest 1-hour period when in use	35 (internal)	30 (internal)
Hospital Wards and operating theatres	All	Noisiest 1 hour	35 (internal) 50 (external)	30 (internal) 45 (external)
Places of worship	All	When in use	40 (internal)	35 (internal)
Active Recreation Areas	All	When in Use	55 (external)	50 (external)
Passive Recreation Areas	All	When in Use	50 (external)	45 (external)
Industrial Premises	All	When in Use	70 (external)	65 (external)
Commercial Premises	All	When in Use	65 (external)	60 (external)

*Day is 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holiday
**Evening is 6 pm to 10 pm Monday to Sunday including public holidays
***Night is 10 pm to 7 am Monday to Saturday or 10 pm to 8 am on Sundays and public holidays

3.2.2 *Intrusiveness*

The Project Intrusiveness noise level seeks to protect against significant changes to ambient noise levels caused by the Project. The Intrusiveness constraint requires that the L_{Aeq} measured over a 15 minute period shall not exceed the background noise level by more than 5 dB. Where the background noise levels are unavailable, minimum background levels are identified in the Guideline. The project intrusiveness criteria is the greater of either the measured rating background level (RBL) plus 5 dB or the minimum assumed RBL plus 5 dB as shown in Table 3-2.

As measured RBL for the Project are not available, for the purposes of this assessment the minimum assumed RBL identified in the Guideline has been adopted.

Intrusive noise levels are only applied to residential receptors; for all other receptor types, the limits outlined in Table 3-1 shall be used.

Table 3-2: Recommended assigned Project Intrusiveness noise levels for operational airborne noise at residential land uses

Receptor	Noise Amenity Area	Time of Day	Project Intrusiveness noise levels, LAeq, 15 min dBA
Residential	All	Day**	Higher of 40 dBA OR RBL* + 5 dB
		Evening***	Higher of 35 dBA OR RBL* + 5 dB
		Night****	Higher of 35 dBA OR RBL* + 5 dB

*RBL represents the measured background level to be used for assessment purposes, as determined by the method outlined in Fact Sheets A and B in the NSW EPA Noise Policy for Industry.
**Day is 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holiday;
***Evening is 6 pm to 10 pm Monday to Sunday including public holidays;
****Night is 10 pm to 7 am Monday to Saturday or 10 pm to 8 am on Sundays and public holidays

3.2.3 *Project Specific Assigned Noise Level*

The Project Specific Assigned Noise Level is the lower value of the Project intrusiveness noise level and Project amenity noise level as determined by the NSW EPA Noise Policy for Industry 2017 and reproduced in section 3.2 of the Guideline.

Per the Guideline, the Project Specific Assigned Noise Levels differentiate between noise impacts during the day, evening and night, with more stringent levels applied during the more sensitive evening and night-time periods. As the operations at all Project sites are considered continuous 24-hours, seven days per week, only the more stringent nighttime noise levels have been considered for the purposes of this assessment and in establishing the Project Specific Assigned Noise Levels.

Where a premise, operation or proposed project exceeds or is expected to exceed the Project Specific Assigned Noise Levels at existing sensitive receivers, the Guideline requires that reasonable and feasible mitigation measures be considered to reduce the actual or predicted noise level.

The process outlined in Figure-3-1, and as described in the Guideline has been used to determine the Project Specific Assigned Noise Level. The nighttime period Project intrusiveness noise level has been identified as the lowest of the values from Table 3-1 (Amenity noise levels) and Table 3-2 (Project intrusiveness noise level) and has been assigned as the Project Specific Assigned Noise Level for the purposes of this assessment.

Given that the Solar Precinct, Darwin Converter Site, and various operating configurations of the OHTL component of the Project are designed to operate continuously for 24-hours on any given day, the Project Specific Assigned Noise Level has been determined to be 35 dBA.

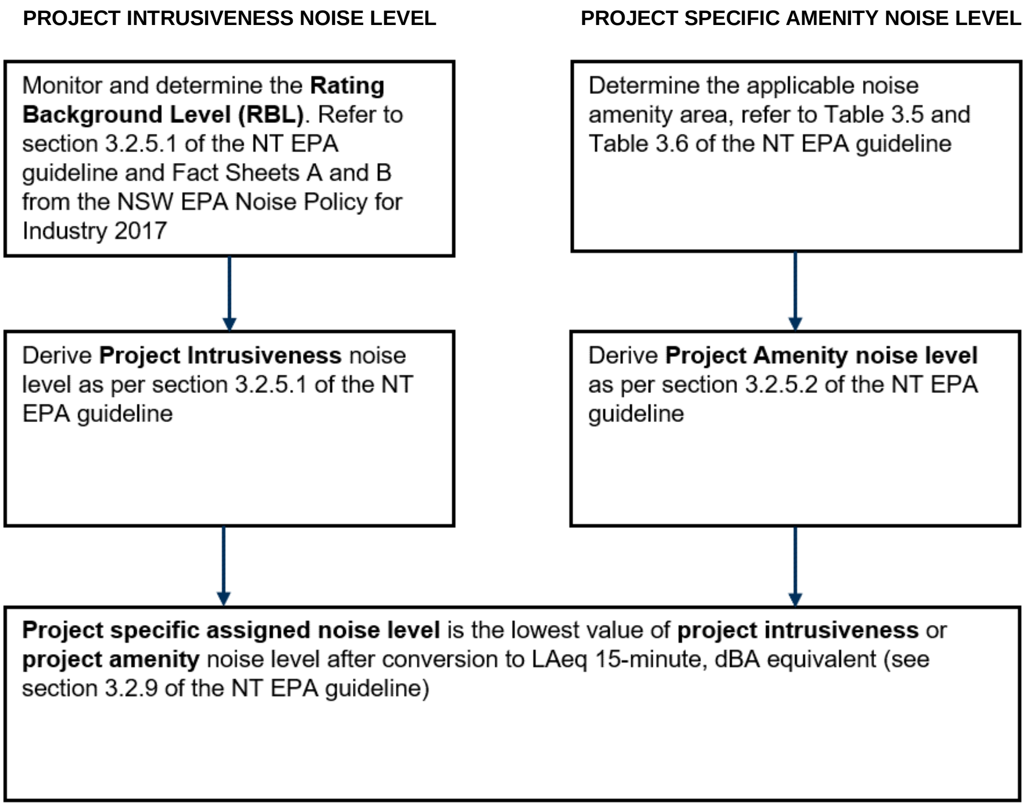


Figure-3-1: Procedure to derive Project Specific Assigned Noise Level (reference: the Guideline)

3.3 Operational Noise Modelling Approach

3.3.1 Modeling Inputs

Noise modeling was carried out for the cumulative impacts of the Solar Precinct, Darwin Converter Site, and various operational configurations of the OHTL. The noise assessment aims to identify land parcels where operational noise is predicted to exceed noise limits, to assess cumulative impacts of operational noise on sensitive receptors (including potential future residential development), and to identify the need for mitigation measures where exceedances are identified. The results for a community noise impact assessment for all nearby noise-sensitive locations (i.e., recreational, residential, and institutional uses) during the operations phase of the Project is presented herein.

The impacts of noise from operational activity were assessed using the CadnaA software application developed by DataKustik. CadnaA models atmospheric sound propagation following the ISO 9613-2 standard. The model considers geometrical dispersion, atmospheric decay, ground absorption and ground topography.

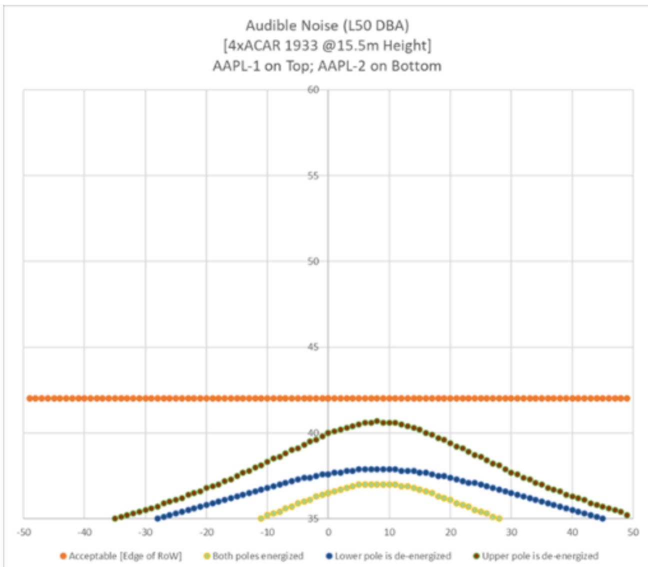
Modeling for the following Project components and noise sources during operations phase are shown in Table 3-3.

Table 3-3: Operational Noise Sources – Modeling Inputs

Project Component	Operational Noise Source	Comments
Solar Precinct	Inverters	- 1,423 3.4 MVA inverters modelled as an area source over the Solar Precinct project area - Area source located 2 m above grade
	Transformers	- 1,423 3.4 MVA 33/0.69 kV Zone Transformers (1 per inverter station) modelled as an area source over the Solar Precinct project area - 36 100/125 MVA 275/33 kV Field Transformers (one per field) modelled as an area source over the Solar Precinct project area - All area sources located 2 m above grade
	Voltage Source Converter (VSC) / Substation	- Solar Precinct will include a 3GW Bipole VSCs exporting at +/- 525kV DC. - DC reactor halls 1 and 2 and converter halls 1 and 2 are assumed to be indoors and provide insignificant noise - Converter coolers (2 per pole) estimated based on Hatch Repository of sound power data for a 2 GW Converter Station. Sound Power prorated for a 3 GW facility - 3 500 MVA single phase converter transformers per pole - Switching station and harmonic filter noise is negligible - All sources modelled as an area source located 2 m above grade
	Battery Energy Storage System (BESS)	- 27,037 2.3 MWh batteries modelled as an area source over the Solar Precinct project area - Area source located 2 m above grade
	Central Energy Storage System (CESS)	- 864 250 MW/1000 MWh Tesla Megapack batteries and 216 3.8 MVA 33kV transformers. Each CESS contains 432 Tesla Megapack batteries and 108 transformers. The battery enclosure includes the inverter and its associated noise. - Area source modelled 2 m above grade

Project Component	Operational Noise Source	Comments
OHTL	Corona Discharge	- Corona noise is to be assessed for two operational configurations of the OHTL. The modeling cases are as follows: a. Both bipoles in operation b. One bipole in operation The base-case configuration of the OHTL is both bipoles in operation (except during maintenance when only one bi-pole is operational). To be conservative, both configurations are modelled. The 'one bipole in operation' scenario is the louder of both (on average 3 dB louder than the 'two-bipole under normal operation conditions' scenario). The NT EPA has requested an additional two scenarios to be modelled and assessed: a. Monopolar operation – various permutations b. Differential sag on conductor due to unbalanced operation **Monopolar operation – various permutations** Monopolar operation occurs when only one pole of a bi-pole configuration is operating; this typically is immediately following system faults (or for operational reasons) when an individual pole needs to be taken out of service. Based on professional experience and benchmarked against typical industry data, the engineering design team estimates, that outages such as this are infrequent (i.e., 5 x's per year with a total average duration of 18hrs, or less than 1% of the year). During this operation mode, the total capacity of the bipole is reduced by 50% (and the overall system by 25%). There are two main permutations of one bipole in operation and the second bipole in monopolar (excluding whether it be the upper or lower bipole in monopolar mode). These are: • Monopolar bipole using negative pole – this scenario is expected to generate the same noise levels as a single bipole in operation (because noise emissions from a negative pole are minimal) • Monopolar bipole using positive pole – this scenario is anticipated to generate the same noise as the scenario when both bipoles are operating normally (which modelling has shown to generate less noise than the single bipole in operation scenario).

Project Component	Operational Noise Source	Comments
		Based on the rare occurrence of this operating scenario, and considering the noise generated by the above permutations of monopolar operation are expected to be the same as, or less than, the worst-case scenario modelled (single bipole in operation), this monopolar operation scenario was excluded from further assessment. **Differential sag on conductor due to unbalanced operation** Differential sag on conductors due to unbalanced operation occurs when bipole 1 and bipole 2 are not equally loaded. This results in a variation of distance between the upper bi-pole and lower bi-pole. This variation in distance results in a change to noise cancellation properties of the configuration. As the impact of differential sag is a change in possible cancellation of noise only (and not an increase of maximum noise emitted), the noise generated in this scenario would not exceed the worst-case scenario modelled (one bi-pole operational where there is no second bipole to cancel noise properties). Based upon the above (i.e., differential sag will result in noise emissions that are less than the worst-case scenario of one bipole operating), this scenario was excluded from further assessment. The approach to the identification of the scenarios and configurations modelled is consistent with the approach taken for proposals for similar energy transmission projects, where standard practise is generally to model impact based on the worst-case normal operating conditions. Accordingly, the results of this assessment provide a high degree of confidence that the predicted noise levels are a conservative representation of the potential noise impacts associated with the OHTL operation, including assessment of worst-case scenario. - The OHTL sound power level is determined based on the predicted audible noise from the chart below. The audible noise for 'both bipole in operation' is referred to as '**Both Poles Energized'** and the worst case 'one bipole in operation' is referred to as the '**Upper Pole De-energized'** state. The chart identifies another one bipole operation state ('Lower pole De-energized') however it is quieter than the 'upper pole de-energized' state and does not need to be considered. - The maximum noise is generated at the mid-point between every two consecutive towers. The separation between these midpoints is conservatively applied as

Project Component	Operational Noise Source	Comments
		minimum 250 m spacing with a source height of 15 m above grade. In reality, corona noise will be generated throughout the full length of the line with a maximum level at the centre and decreasing towards the towers. To simplify the model, the corona noise will be modelled as a point source representing the maximum noise level at the midpoint between towers. - A reference noise spectrum for HVDC Corona noise was estimated through literature (Long-term evaluation of HVDC transmission line audible noise and its correlation with background noise, 2019) and has been scaled accordingly to represent the audible noise in the chart below. - According to NSW Noise Policy for Industry Fact Sheet C and the ISO1996.2-2007 method tonality is applied when the one-third octave band exceeds the level of the adjacent bands on each side by: o 5 dB or more if the centre frequency of the band containing the tone is in the range 500–10,000 Hz o 8 dB or more if the centre frequency of the band containing the tone is in the range 160–400 Hz o 15 dB or more if the centre frequency of the band containing the tone is in the range 25–125 Hz. Noise modelling predicts a 6 dB tone in the 315 Hz band for the OHTL audible noise. This falls short of the tonality definition. However, to be conservative in the modelling assumptions used, a 5 dB correction shall be applied to the predicted noise levels at the receptors. Noise Level at 1.5m above grade (L_{50}, dBA)  Distance from HVDC Pole centreline (m)

Project Component	Operational Noise Source	Comments
Darwin Converter Site (DCS)	Inverters	- 76 4.2 MVA inverters modelled as an area source over the DCS battery container area - Area source located 2 m above grade
	Transformers	- 38 8.4 MVA / 33/0.69 kV transformer modelled as an area source over the DCS battery container area - Area source located 2 m above grade
	Voltage Source Converter (VSC) / Substation	- DCS will operate with up to four VSC substations, - Converter coolers (2 per pole) estimated based on Hatch Repository of sound power data for a 2 GW Converter Station. Sound Power prorated for a 3 GW facility - 3 500 MVA single phase converter transformers per pole - Switching station and harmonic filter noise is negligible - All sources modelled as a point source located 2 m above grade
	Battery Energy Storage System (BESS)	- 456 batteries (estimated to be 0.25P SolBank batteries) modelled as an area source over the battery container area - Area source located 2 m above grade
Cable Transition Facilities	None	- No operational noise is anticipated for the Cable Transition Facilities as the cabling will be buried underground

The total sound power for each Project Component modelled can be found in Table 3-4

Table 3-4: Project Component Overall Sound Power Data

Project Component	1/1 Octave Band Frequencies, Sound Power, dB									Overall
	31	63	125	250	500	1k	2k	4k	8k	dBA
OHTL – One Bipole (Worst-case Rare Operation)	80	82	76	73	71	74	73	73	72	81
OHTL – Two Bipole (Normal Operation)	78	80	74	71	69	72	71	71	70	78
Solar Precinct	149	148	142	154	145	138	132	130	120	148
DCS Battery, Inverter, and Transformer Area Source	111	112	112	114	110	105	102	107	104	114
DCS 500 MVA Substation Transformer	107	113	115	110	110	104	99	94	87	110
DCS Converter Cooler	112	113	110	108	103	100	92	89	85	105

The calculation configurations to be applied in the model are shown in Table 3-5.

Table 3-5: Modelling Calculation Configurations

Inputs	Value	Comments
Ground Absorption	0.7 Or 0.5	Ground absorption is measured on a scale from 0 to 1. An absorption of 0 indicates the ground is fully reflective (e.g., body of water) and an absorption of 1 indicates the surface is fully absorptive. 0.7 will be used to model a softer ground (rainy season) and an absorption of 0.5 will be used to model a harder ground (dry season).
Topographical Data	1 m resolution	Topographical elevation data with a 1 m resolution extending 1 km on all sides of the project boundaries.
Order of Reflection	1	The maximum order up to which reflections are taken into account. Higher orders of reflection result in more accurate models with higher calculation times. Generally, 1 order of reflection is sufficient.
Temperature / Humidity	Dry Season: (May – October): Temperature 17°C Humidity 35% Wet Season: (November – April): Temperature 32°C Humidity 80%	Air absorption is calculated based on the temperature and the relative humidity according to ISO 9613-1 standard.
Noise Contour Maps	Produced for 4.5 m above grade	Noise contour maps will be calculated at a noise sensitive receptor height of 1.5 m for the daytime and 4.5 m for the night-time and evening scenarios. Noise contours will be overlaid with sensitive land uses (as listed in Table 3-1) and land parcel data to visually identify locations that exceed the criteria. As operational activity occurs continuously over 24 hrs, only the more stringent night-time scenario will be plotted and assessed.

3.3.2 Modelling Scenarios

Four modelling scenarios (variants) were completed to support the assessment of the operational noise impact of the Project as shown in Table 3-6. Each modelling scenario accounts for all noise sources that would contribute to cumulative noise impacts at all sites under normal and worst-case operating conditions, and under dry and wet seasonal conditions. Variant 1 models the OHTL with both bipoles operating and Variant 2 models only one bipole operating. Each variant considers temporal conditions for operation during the rainy season “A” and dry season “B”.

Table 3-6: Operational Noise Impact Assessment Modeling Variants

<table>
<tr><th rowspan="2">Noise Source Scenario</th><th colspan="2">Temporal Conditions</th></tr>
<tr><td>Rainy Season
- Ground absorption 0.7
- 32°C / 80% RH</td><td>Dry Season
- Ground absorption 0.5
- 17°C / 35% RH</td></tr>
<tr><td>- Cumulative impact of Solar Precinct, OHTL, and DCS
- OHTL both pole energized operation
- Worst case temperature and ground conditions for calculation configuration</td><td>Variant 1A</td><td>Variant 1B</td></tr>
<tr><td>- Cumulative impact of Solar Precinct, OHTL, and DCS
- OHTL one upper pole de-energized operation
- Worst case temperature and ground conditions for calculation configuration</td><td>Variant 2A</td><td>Variant 2B</td></tr>
</table>

3.4 Modelling Results

3.4.1 Cumulative Noise Impact of Solar Precinct, DCS and OHTL for All Variants

Modeling results are summarized at sensitive receptors listed in table 3-7 below. A total of 129 Sensitive receptors including dwellings and communities were identified up to 5 km away from the Project. All receptors are residential land uses and have been assessed for potential impact in line with with the Project Specific Assigned Noise level of 35 dBA consistent with Section 3.2.

Even with an adjusted 5 dB tonality penalty, exceedances are identified at two sensitive receptor locations of the 129 assessed. These sensitive receptors (POR 128 and POR 129) are indicative locations and representative of the zoning for the proposed future Murrumujuk residential development (both located on the same land parcel). Cumulative noise levels are not expected to impact any of the other 127 receptors for any of the other modeling configurations assessed.

The modelling results show that the Project is 0-3 dB noisier in the dry season compared to the rainy season and that receptors close to the project footprint would not see a change in noise regardless of the season.

The one bipole operation scenario was found to be on average 3 dB louder than the two-bipole normal operation conditions. The exceedances identified at POR 128 and POR129 are dominated by DCS noise and the 3 dB differential in operating configurations of the OHTL is not a contributing factor to the exceedances identified.

Table 3-7: Operational Nighttime Noise Impact (OHTL +DCS + Solar Precinct) at Sensitive Receptors for all Variants

POR	Land Use	Variant 2A/1A Noise Impact (dBA)		Variant 2B/1B Noise Impact (dBA)		Limit (dBA)	Easting Northing	
		One Bipole + DCS + Solar Precinct	Two Bipole + DCS + Solar Precinct	One Bipole + DCS + Solar Precinct	Two Bipole + DCS + Solar Precinct		X	Y
POR01	R	34	31	34	31	35	726958	8590461
POR02	R	32	29	33	30	35	726190	8598024
POR03	R	31	28	32	29	35	776976	8508117
POR04	R	31	28	32	29	35	806703	8471713
POR05	R	30	27	31	28	35	725301	8597789
POR06	R	29	26	30	27	35	729123	8598253
POR07	R	29	26	29	26	35	850204	8393309
POR08	R	28	25	29	26	35	726501	8592125
POR09	R	28	25	28	25	35	728984	8598303
POR10	R	28	25	28	25	35	729739	8598297
POR11	R	27	24	28	25	35	845938	8402502
POR12	R	26	23	28	25	35	724697	8597770
POR13	R	26	23	27	24	35	729600	8598341
POR14	R	26	23	27	24	35	728666	8598348
POR15	R	26	23	27	24	35	726367	8592544
POR16	R	26	23	27	24	35	846045	8402371
POR17	R	25	22	27	24	35	725390	8597592
POR18	R	25	22	27	24	35	730127	8583813
POR19	R	25	22	26	23	35	725390	8597510
POR20	R	25	22	26	23	35	846116	8402315
POR21	R	24	21	25	22	35	845644	8403466
POR22	R	24	21	25	22	35	726253	8592861
POR23	R	24	21	25	22	35	726025	8593896
POR24	R	24	21	25	22	35	725326	8597319
POR25	R	24	21	25	22	35	726964	8593541
POR26	R	24	21	25	22	35	807865	8469034
POR27	R	24	21	25	22	35	806735	8470418
POR28	R	24	21	25	22	35	726253	8592709
POR29	R	23	20	25	22	35	727568	8590455
POR30	R	23	20	25	22	35	846278	8396427
POR31	R	23	20	25	22	35	846196	8402299
POR32	R	23	20	24	21	35	727549	8588086
POR33	R	23	20	24	21	35	728622	8598507
POR34	R	22	19	24	21	35	725669	8597573
POR35	R	23	20	24	21	35	729879	8598507
POR36	R	23	20	24	21	35	733972	8598807
POR37	R	22	19	24	21	35	846833	8397361
POR38	R	22	19	24	21	35	846156	8402530
POR39	R	22	19	23	20	35	846287	8402244
POR40	R	21	18	23	20	35	827536	8429099

POR	Land Use	Variant 2A/1A Noise Impact (dBA)		Variant 2B/1B Noise Impact (dBA)		Limit (dBA)	Easting Northing	
		One Bipole + DCS + Solar Precinct	Two Bipole + DCS + Solar Precinct	One Bipole + DCS + Solar Precinct	Two Bipole + DCS + Solar Precinct		X	Y
POR41	R	21	18	23	20	35	846573	8401541
POR42	R	21	18	23	20	35	762281	8510218
POR43	R	21	18	23	20	35	725504	8597192
POR44	R	21	18	23	20	35	847754	8396300
POR45	R	20	17	22	19	35	846299	8402446
POR46	R	20	17	22	19	35	846577	8401744
POR47	R	20	17	22	19	35	846414	8402216
POR48	R	20	17	22	19	35	848773	8395491
POR49	R	20	17	22	19	35	848010	8394474
POR50	R	20	17	22	19	35	725504	8597014
POR51	R	20	17	22	19	35	738119	8610772
POR52	R	20	17	22	19	35	726178	8591452
POR53	R	19	16	21	18	35	848151	8394312
POR54	R	19	16	21	18	35	738040	8605097
POR55	R	19	16	21	18	35	729923	8598716
POR56	R	19	16	21	18	35	846763	8401402
POR57	R	19	16	21	18	35	726628	8594874
POR58	R	19	16	21	18	35	725809	8597198
POR59	R	19	16	21	18	35	846430	8402399
POR60	R	19	16	21	18	35	726317	8590493
POR61	R	19	16	21	18	35	846616	8401962
POR62	R	18	15	21	18	35	725567	8596843
POR63	R	18	15	20	17	35	726177	8590867
POR64	R	18	15	20	17	35	726272	8595332
POR65	R	18	15	20	17	35	725567	8596722
POR66	R	18	15	20	17	35	848093	8396273
POR67	R	18	15	20	17	35	846978	8400946
POR68	R	18	15	20	17	35	847987	8396395
POR69	R	18	15	20	17	35	846565	8402280
POR70	R	18	15	20	17	35	837976	8411550
POR71	R	18	15	20	17	35	728692	8588874
POR72	R	18	15	20	17	35	846819	8401569
POR73	R	18	15	20	17	35	724145	8597789
POR74	R	17	14	20	17	35	729587	8598856
POR75	R	17	14	20	17	35	846724	8401946
POR76	R	17	14	20	17	35	727263	8593985
POR77	R	17	14	20	17	35	728622	8598881
POR78	R	17	14	20	17	35	728450	8589693
POR79	R	17	14	19	16	35	730311	8584263
POR80	R	17	14	19	16	35	737174	8604827
POR81	R	17	14	19	16	35	848207	8396268
POR82	R	17	14	19	16	35	847849	8396684
POR83	R	17	14	19	16	35	846795	8401871
POR84	R	17	14	19	16	35	792856	8500220
POR85	R	17	14	19	16	35	728869	8588080
POR86	R	17	14	19	16	35	727263	8594125
POR87	R	17	14	19	16	35	847017	8401224
POR88	R	17	14	19	16	35	726901	8594792

POR	Land Use	Variant 2A/1A Noise Impact (dBA)		Variant 2B/1B Noise Impact (dBA)		Limit (dBA)	Easting Northing	
		One Bipole + DCS + Solar Precinct	Two Bipole + DCS + Solar Precinct	One Bipole + DCS + Solar Precinct	Two Bipole + DCS + Solar Precinct		X	Y
POR89	R	16	13	19	16	35	729987	8598938
POR90	R	16	13	19	16	35	848119	8396440
POR91	R	16	13	19	16	35	846743	8402164
POR92	R	16	13	19	16	35	729993	8584740
POR93	R	16	13	19	16	35	849042	8395663
POR94	R	16	13	19	16	35	737278	8604978
POR95	R	16	13	19	16	35	837148	8412361
POR96	R	16	13	18	15	35	846807	8402077
POR97	R	16	13	18	15	35	847113	8401121
POR98	R	16	13	18	15	35	837225	8412202
POR99	R	16	13	18	15	35	847152	8400986
POR100	R	16	13	18	15	35	846934	8401768
POR101	R	16	13	18	15	35	846966	8401672
POR102	R	16	13	18	15	35	727187	8594544
POR103	R	15	12	18	15	35	737813	8610518
POR104	R	15	12	18	15	35	727701	8584962
POR105	R	15	12	17	14	35	846914	8402061
POR106	R	15	12	17	14	35	732657	8570386
POR107	R	15	12	17	14	35	730317	8584429
POR108	R	14	11	17	14	35	850169	8394784
POR109	R	5	5	5	5	35	728727	8560238
POR110	R	5	5	5	5	35	730404	8559116
POR111	R	5	5	7	5	35	806118	8466133
POR112	R	5	5	5	5	35	852489	8397381
POR113	R	5	5	5	5	35	851394	8399368
POR114	R	5	5	5	5	35	735707	8582422
POR115	R	5	5	5	5	35	906872	8134959
POR116	R	21	18	23	20	35	806325	8470892
POR117	R	12	9	15	12	35	787945	8503465
POR118	R	5	5	5	5	35	736026	8582590
POR119	R	5	5	5	5	35	844949	8392566
POR120	R	5	5	5	5	35	782401	8503116
POR121	R	5	5	5	5	35	906264	8134654
POR122	R	5	5	5	5	35	804894	8465617
POR123	R	5	5	5	5	35	729768	8557192
POR124	R	5	5	5	5	35	810783	8466177
POR125	R	17	14	20	17	35	806280	8470287
POR126	R	5	5	5	5	35	851873	8398324
POR127	R	24	21	25	22	35	807120	8468699
POR128	R*	48	48	50	50	35	722268	8643322
POR129	R*	50	50	52	52	35	724666	8642734

Exceeds Noise Criteria
*Potential future Noise Sensitive Receptor based on the 2020 Litchfield Regional Land Use Plan

The cumulative noise impacts for Variant 2B for one bipole + DCS + solar precinct operating in the dry season is considered the worst-case modelled scenario. The following dry season conditions were considered:

- 17ºC temperature
- 35% humidity
- Ground absorption of 0.5

Noise contours for the cumulative impacts of Variant B operating in the dry season are shown in Figure 3-2 to Figure 3-12.

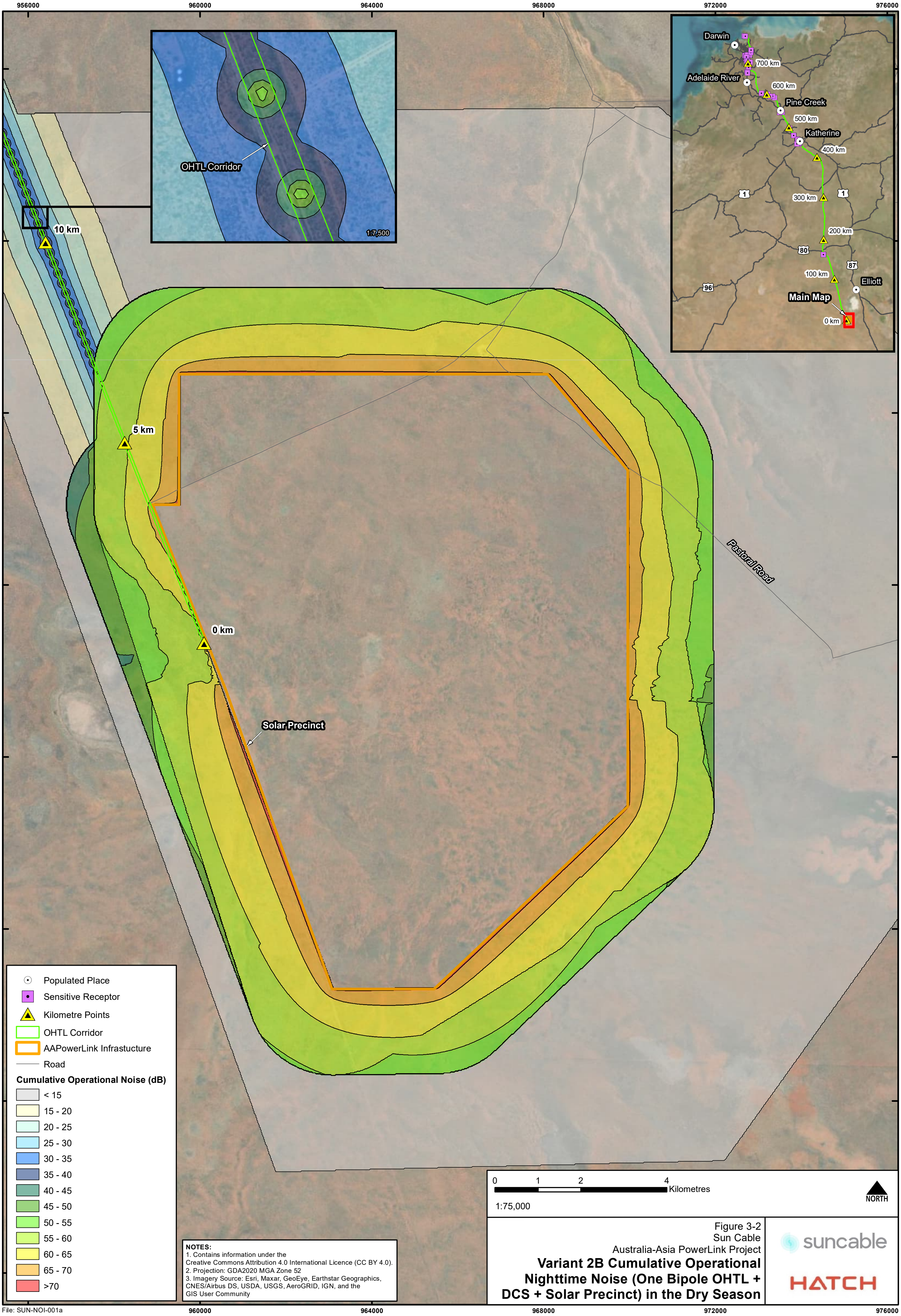
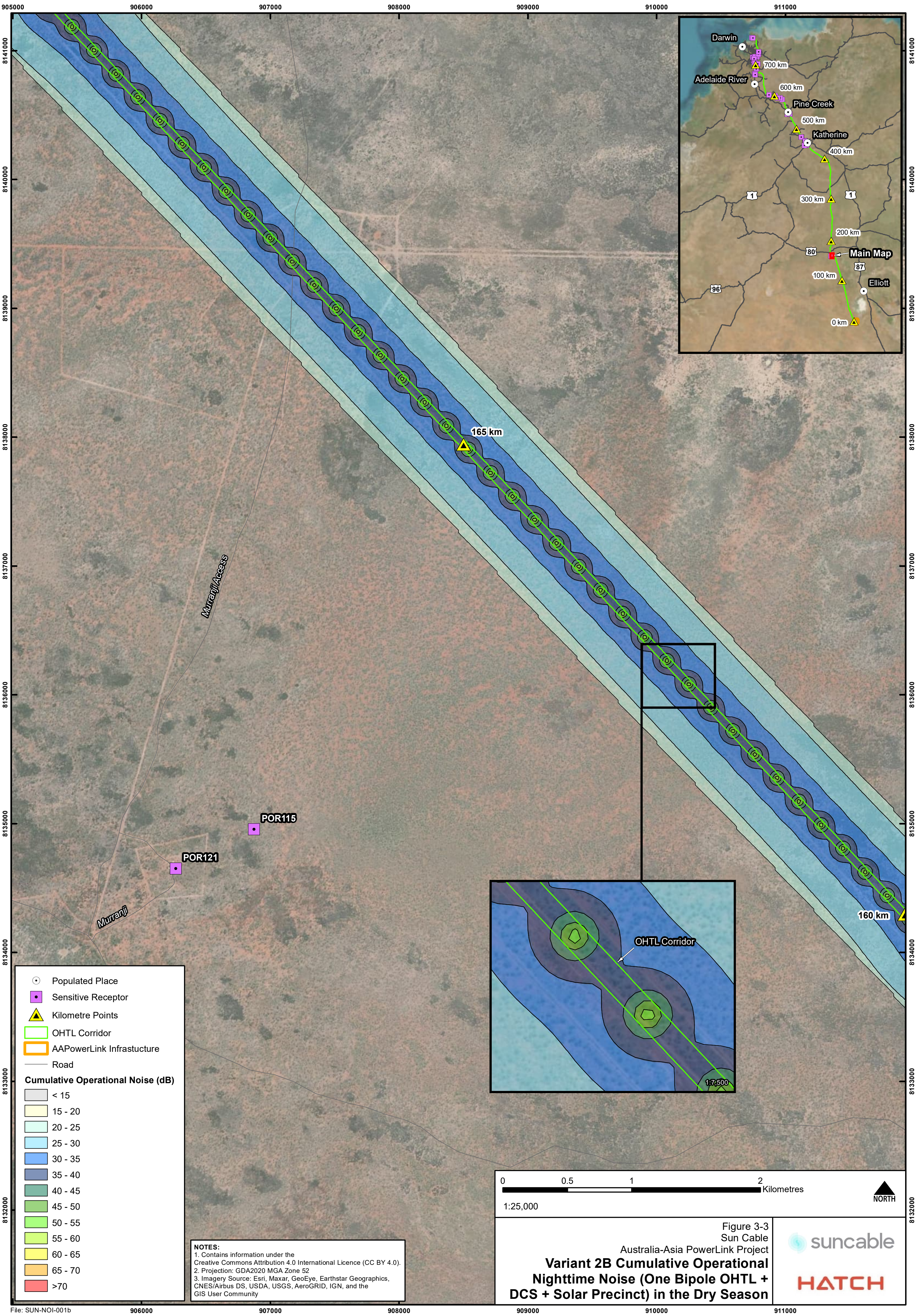


Figure 3-2
Sun Cable
Australia-Asia PowerLink Project
Variant 2B Cumulative Operational Nighttime Noise (One Bipole OHTL + DCS + Solar Precinct) in the Dry Season



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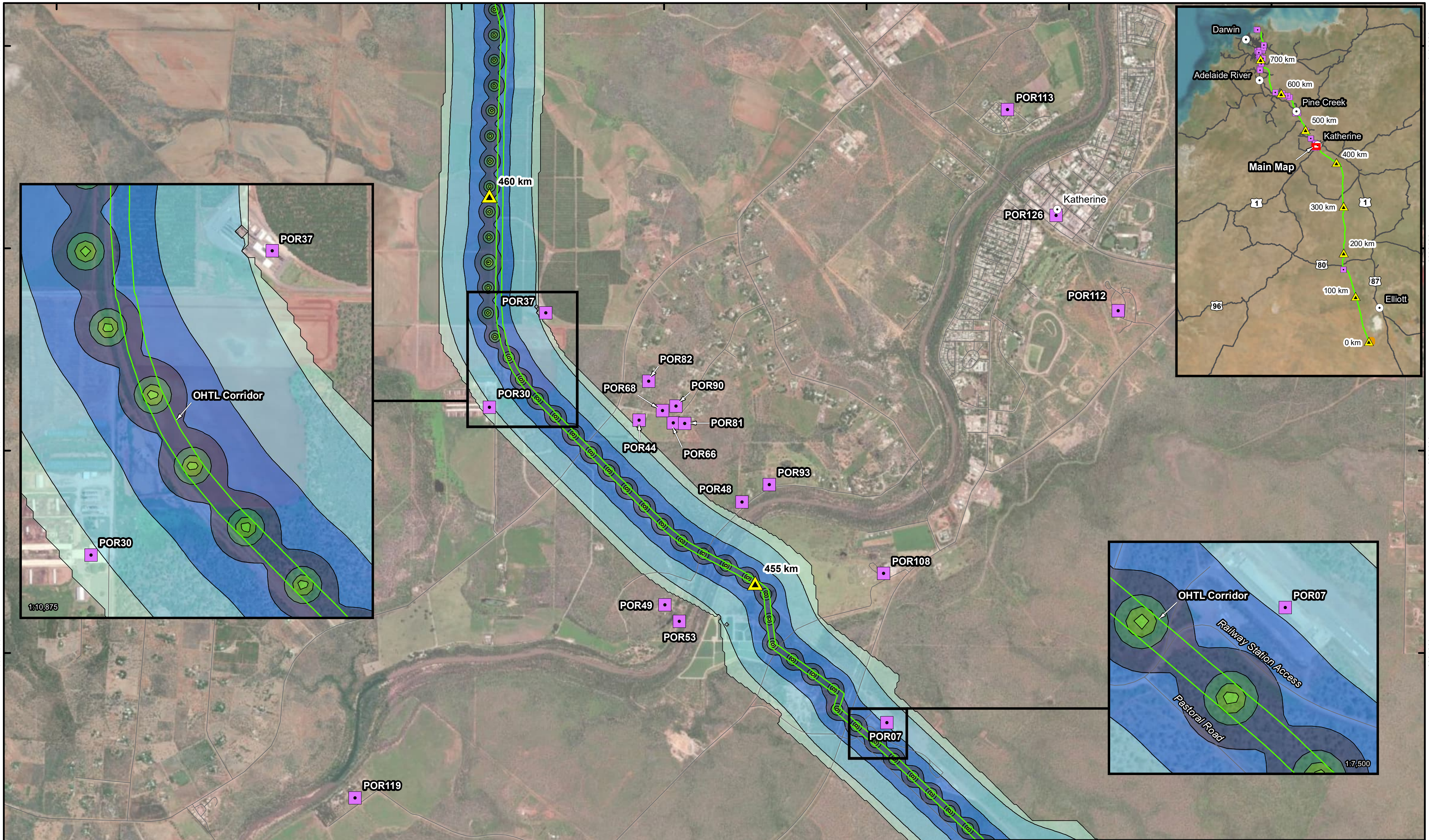
2. Projection: GDA2020 MGA Zone 52
3. Imagery Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3-3
Sun Cable
Australia-Asia PowerLink Project
Variant 2B Cumulative Operational Nighttime Noise (One Bipole OHTL + DCS + Solar Precinct) in the Dry Season

File: SUN-NOI-001b



Populated Place
Sensitive Receptor
Kilometre Points
OHTL Corridor
AAPowerLink Infrastucture
Road

Cumulative Operational Noise (dB)

< 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40 - 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
>70

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Figure 3-4
Sun Cable
Australia-Asia PowerLink Project

Variant 2B Cumulative Operational Nighttime Noise (One Bipole OHTL + DCS + Solar Precinct) in the Dry Season

suncable
HATCH

File: SUN-NOI-001c

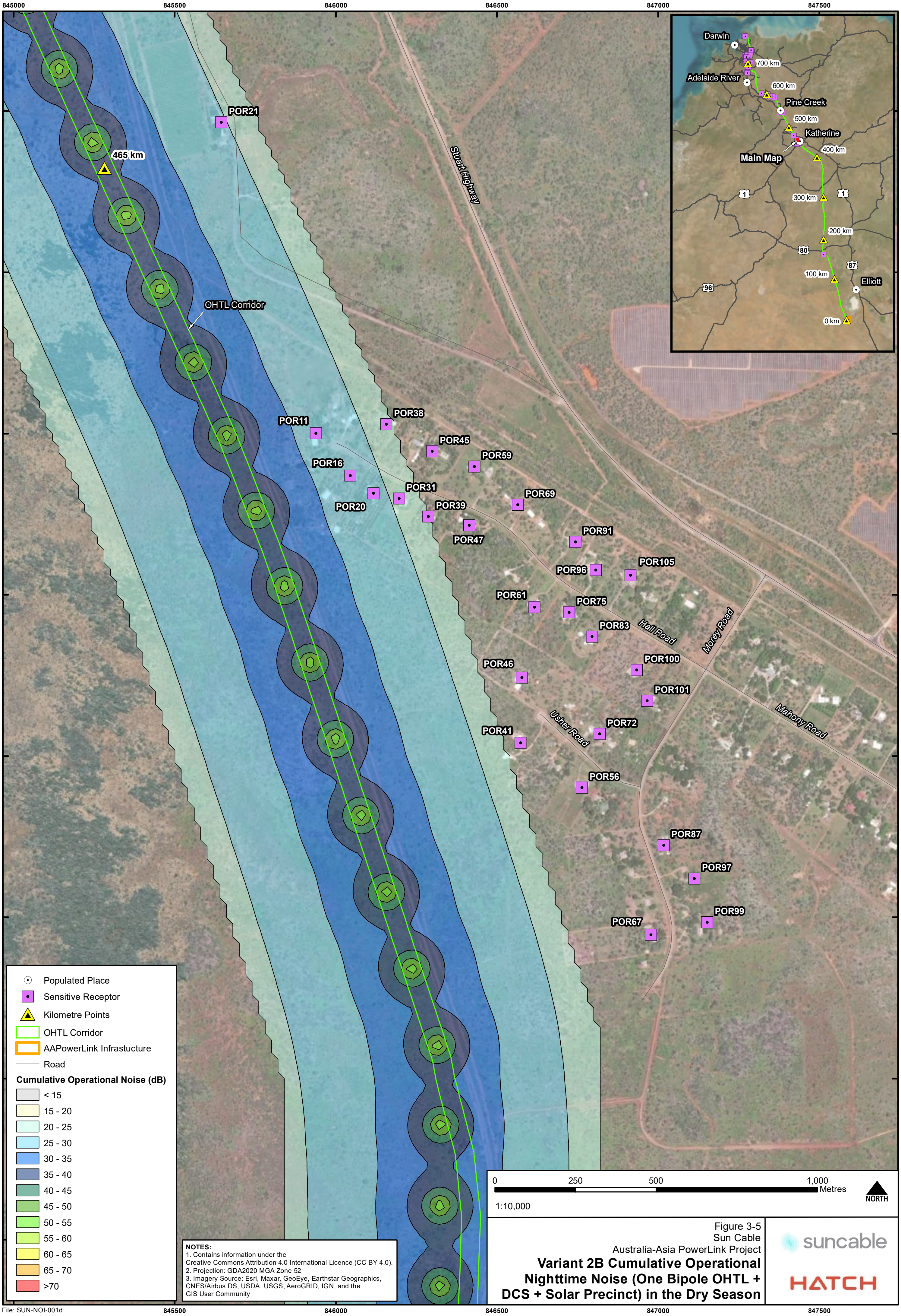

Figure 3-5
Sun Cable
Australia-Asia PowerLink Project
Variant 2B Cumulative Operational Nighttime Noise (One Bipole OHTL + DCS + Solar Precinct) in the Dry Season

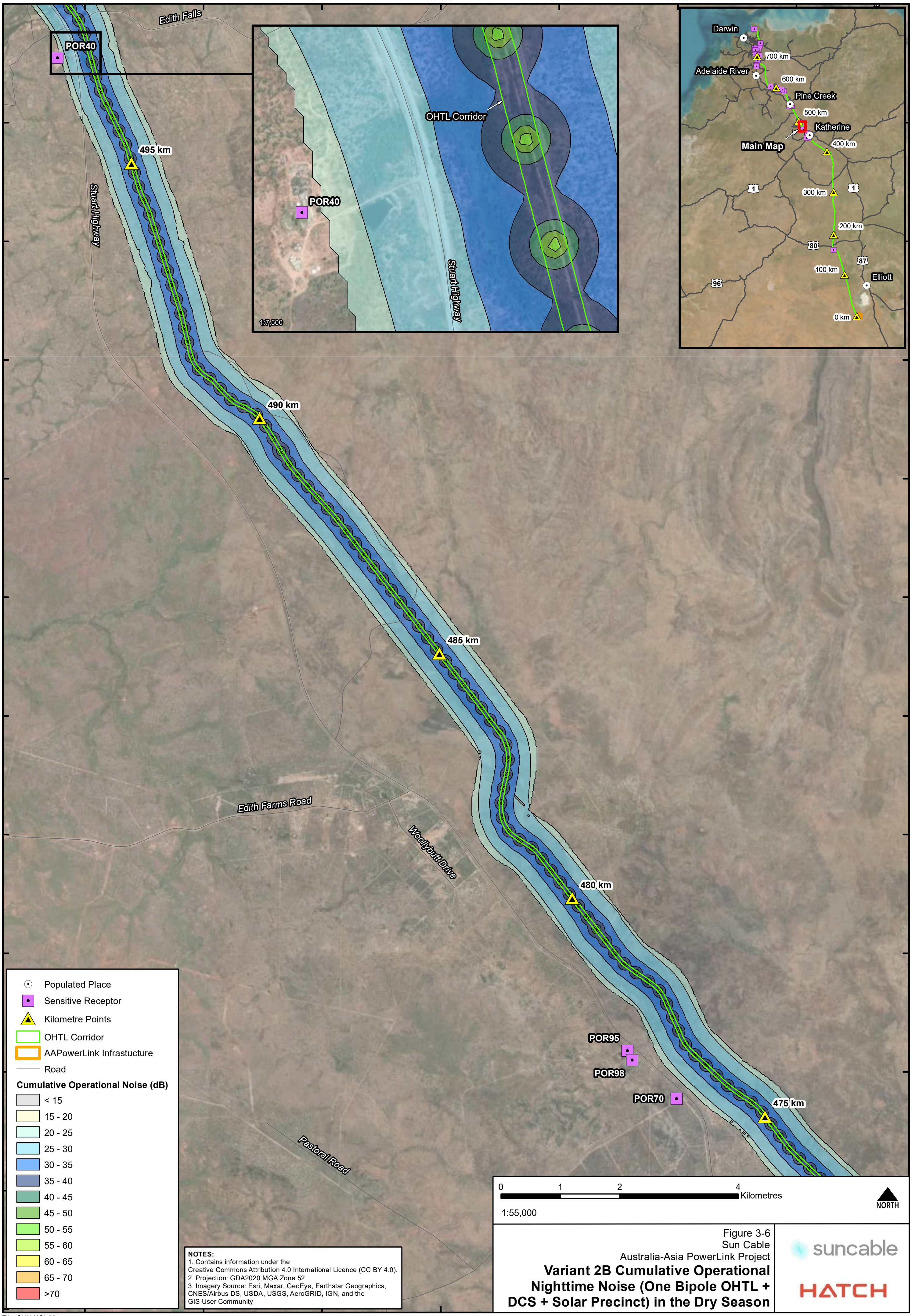

Figure 3-6
Sun Cable
Australia-Asia PowerLink Project
Variant 2B Cumulative Operational Nighttime Noise (One Bipole OHTL + DCS + Solar Precinct) in the Dry Season

suncable
HATCH

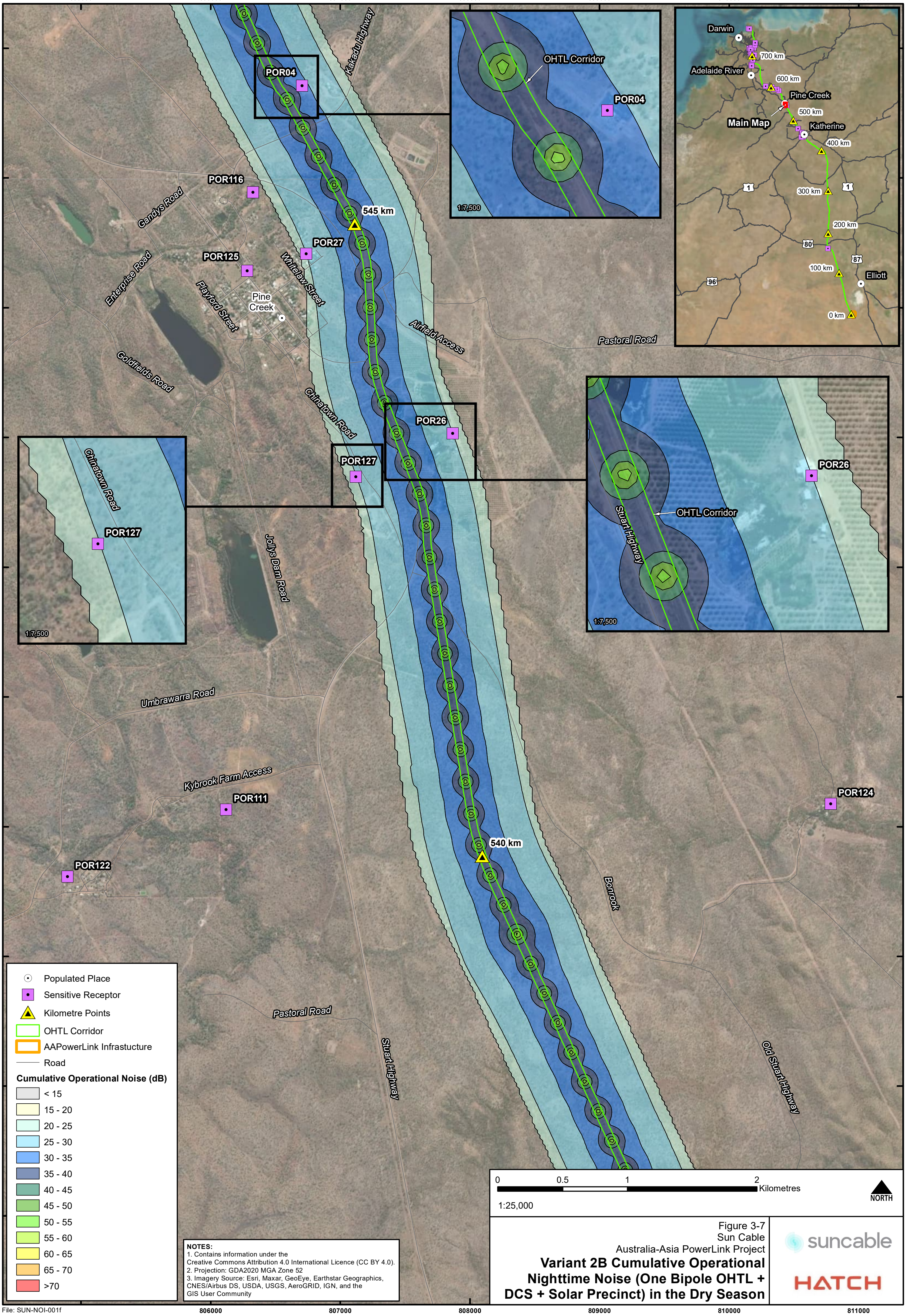

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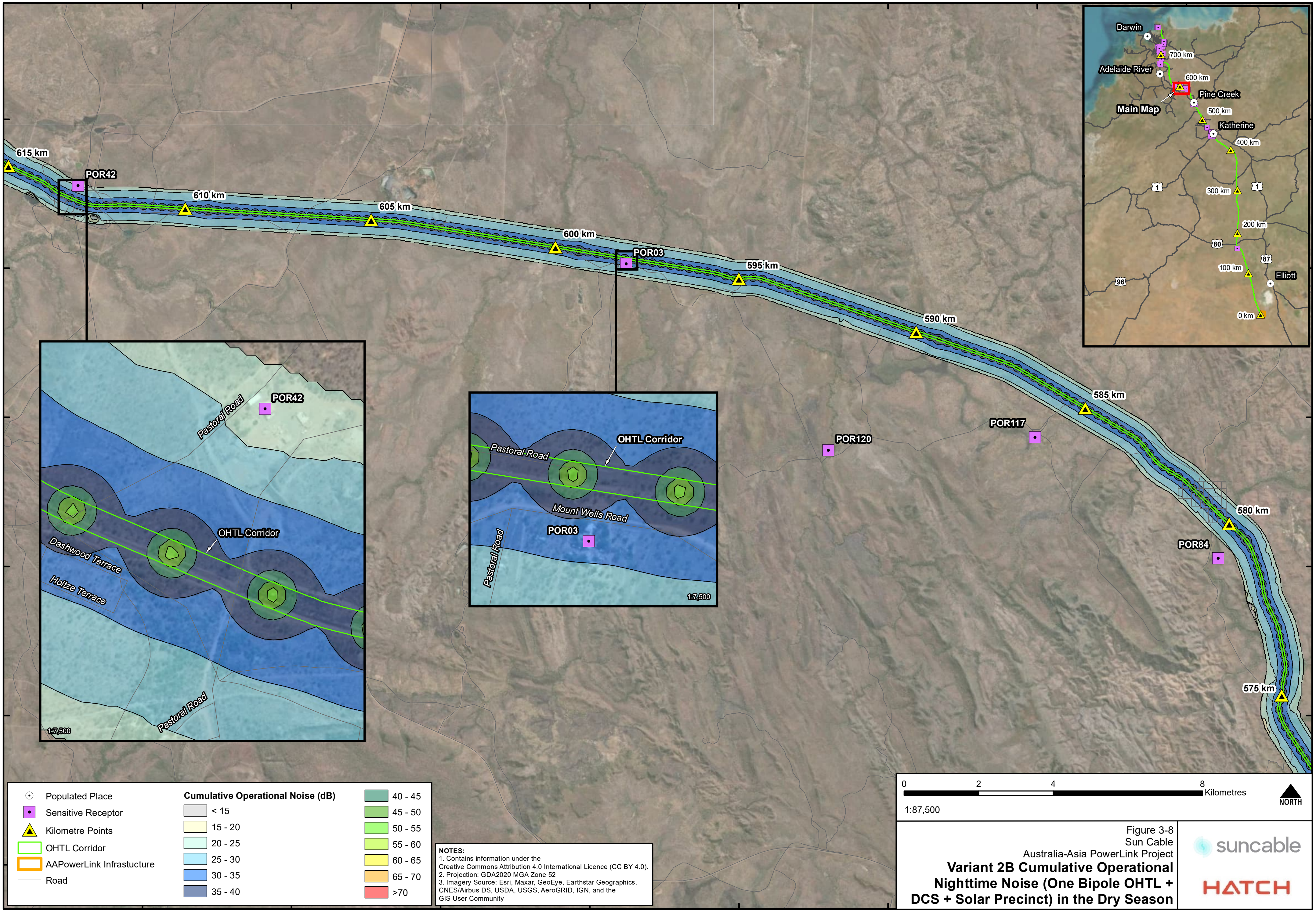
Figure 3-7
Sun Cable
Australia-Asia PowerLink Project
Variant 2B Cumulative Operational Nighttime Noise (One Bipole OHTL + DCS + Solar Precinct) in the Dry Season



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2. Projection: GDA2020 MGA Zone 52
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Figure 3-8
Sun Cable
Australia-Asia PowerLink Project
Variant 2B Cumulative Operational Nighttime Noise (One Bipole OHTL + DCS + Solar Precinct) in the Dry Season

suncable

HATCH

File: SUN-NOI-001g

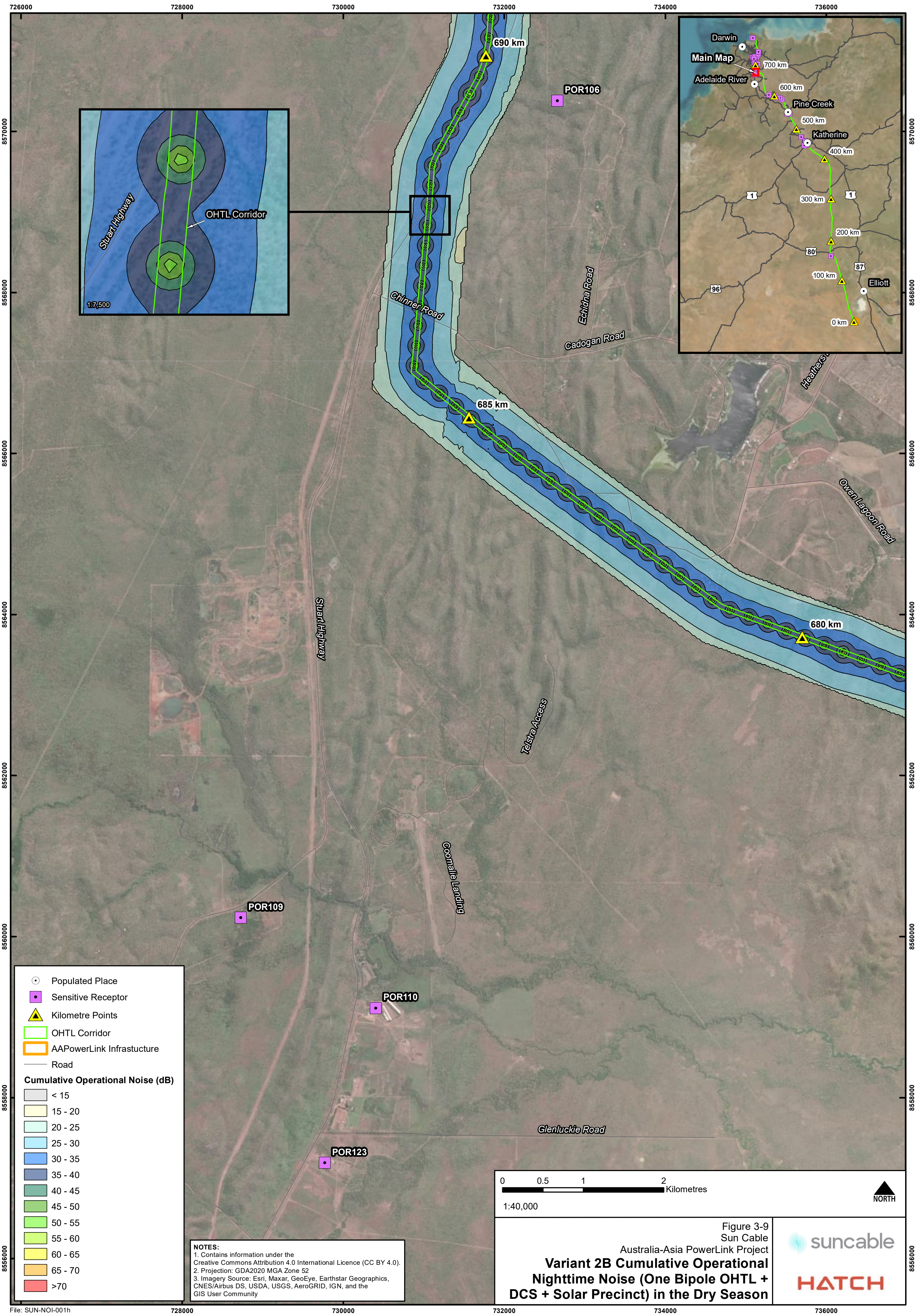

Figure 3-9
Sun Cable
Australia-Asia PowerLink Project
Variant 2B Cumulative Operational Nighttime Noise (One Bipole OHTL + DCS + Solar Precinct) in the Dry Season

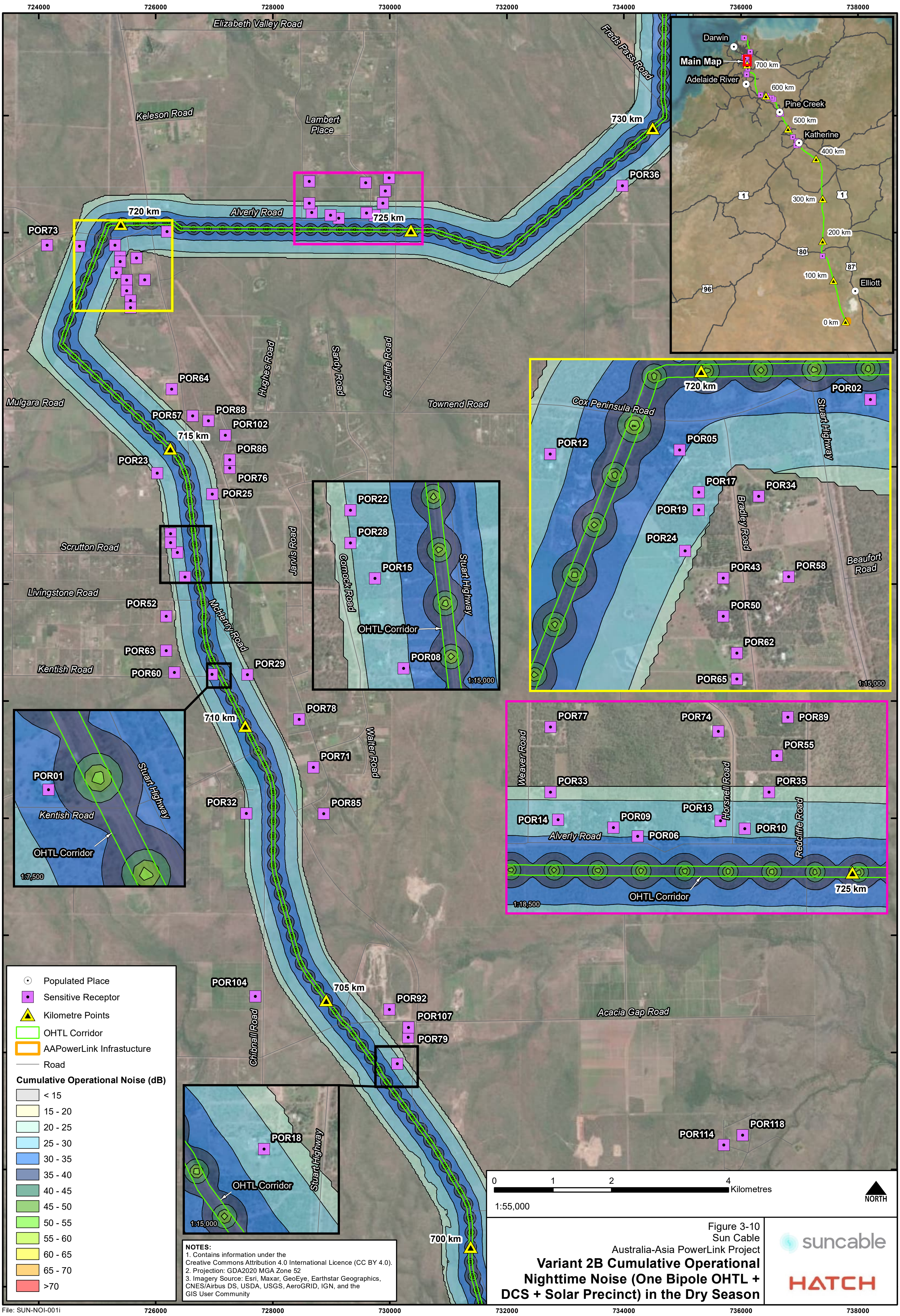

Figure 3-10
Sun Cable
Australia-Asia PowerLink Project

Variant 2B Cumulative Operational Nighttime Noise (One Bipole OHTL + DCS + Solar Precinct) in the Dry Season

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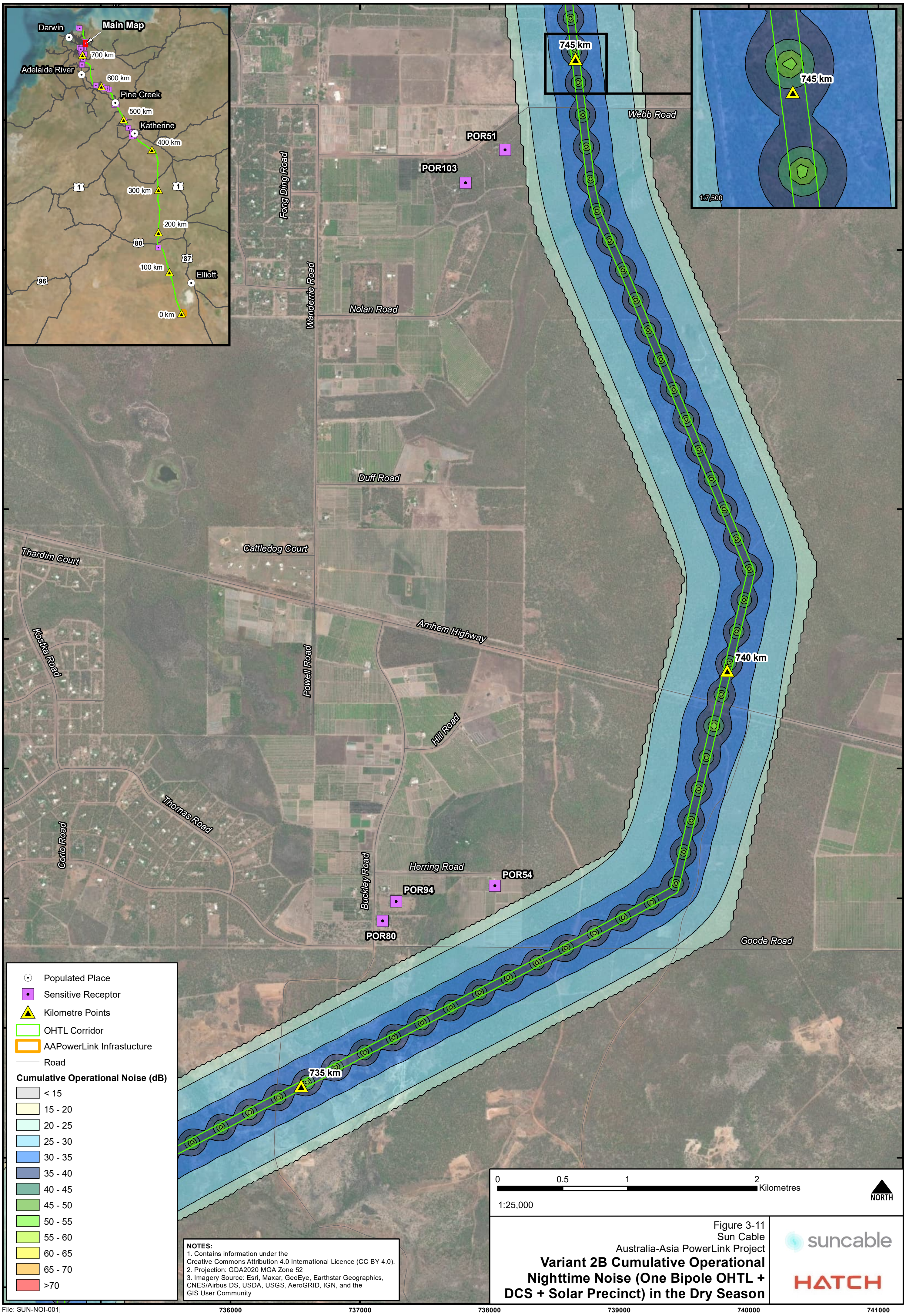
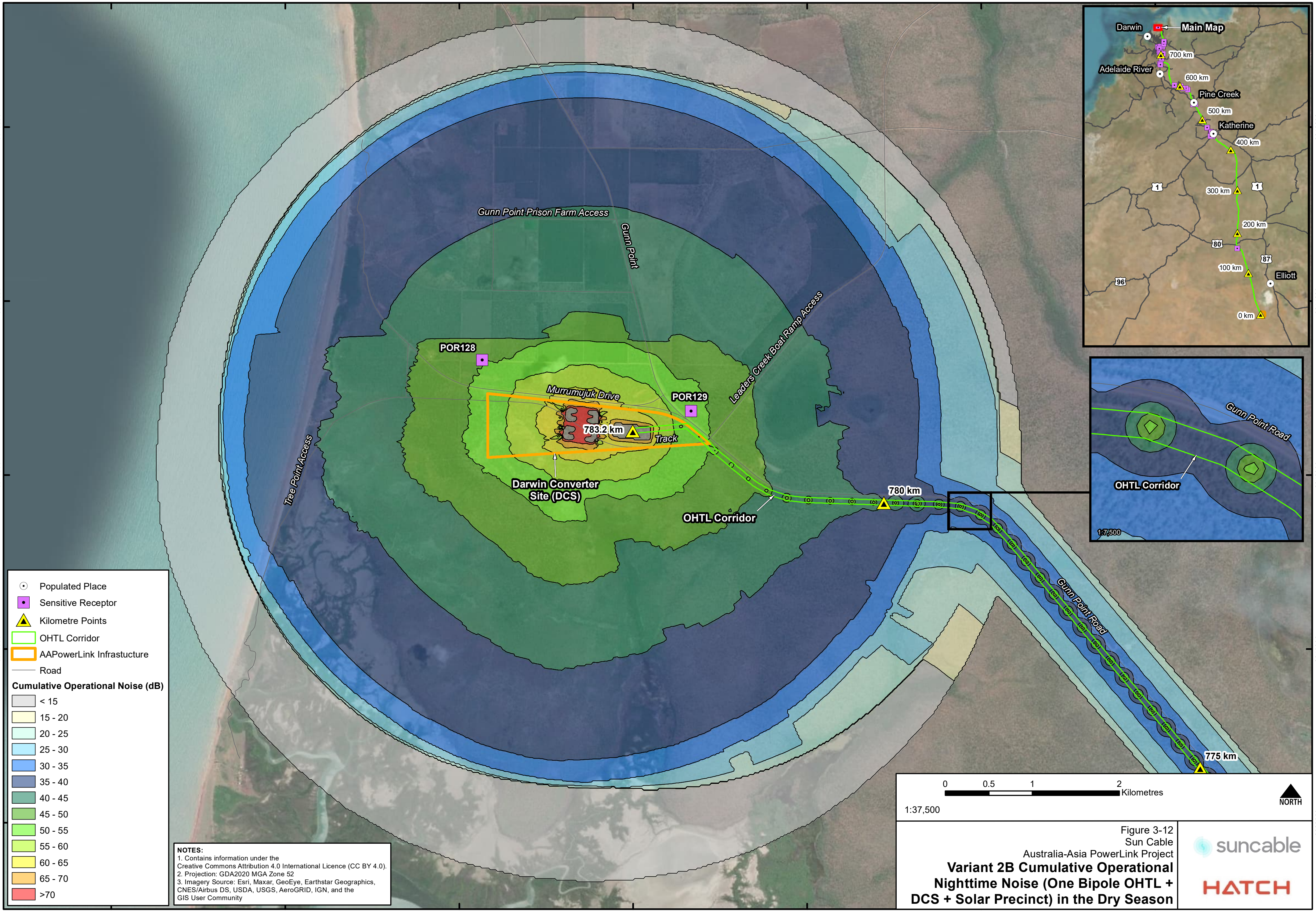


Figure 3-11
Sun Cable
Australia-Asia PowerLink Project
Variant 2B Cumulative Operational Nighttime Noise (One Bipole OHTL + DCS + Solar Precinct) in the Dry Season



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2. Projection: GDA2020 MGA Zone 52
3. Imagery Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3-12
Sun Cable
Australia-Asia PowerLink Project

Variant 2B Cumulative Operational Nighttime Noise (One Bipole OHTL + DCS + Solar Precinct) in the Dry Season

suncable

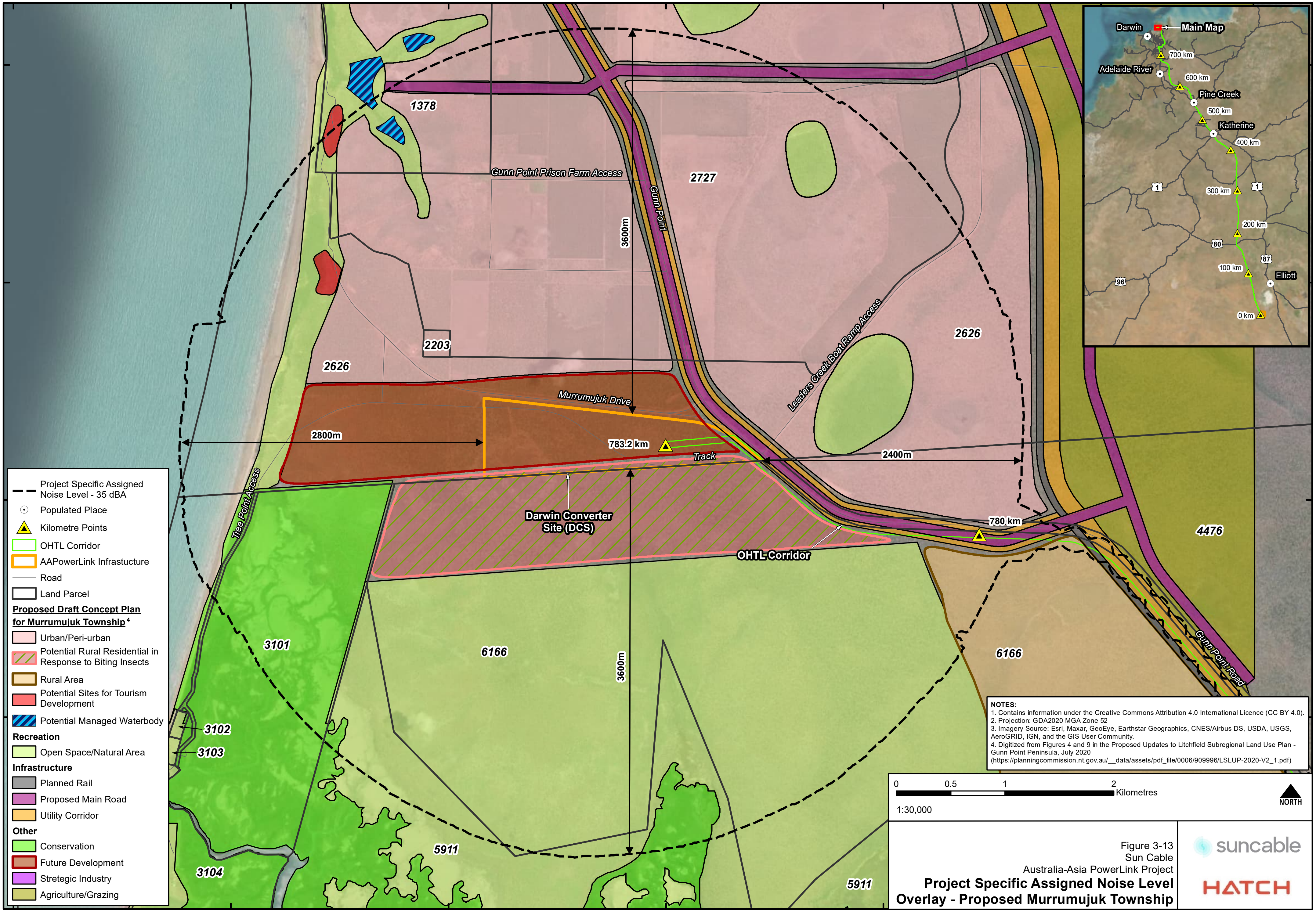
HATCH

3.4.2 *Cumulative Impact on potential future residential development*

Modelling identified exceedances of the Project Specific Assigned Noise level for the worst-case scenario at sensitive receiver locations POR 128 and POR 129. Both of these receptors were selected as indicative and conceptual locations to be representative of the receivers within the proposed future Murrumujuk Township as identified in the Litchfield Subregional Land Use Plan 2016 (Version 6, March 2023).

It is noted that the proposed Murrumujuk Township would form part of a long term and larger planning vision for the region that would initially include the opportunity to encourage future industrial development and strategic industry. It is noted in the Land use Plan that the establishment of the proposed township would be as a result of this industry growth and largely contingent and subject to substantial demand for housing for these industry workforces. It is noted that this is not anticipated within the near term but may be a possibility in the medium to long term.

The exceedances identified in the modelling are caused by noise generated by the proposed DCS and are not found to be related or contributed towards by the operation of the OHTL. Figure 3-13 provides an overlay of the Project Specific Assigned Noise Level (35dB) contour over the proposed Murrumujuk Township. This has been created to demonstrate the extent of worst-case potential impact should mitigation not be implemented, and the proposed residential development proceed in the future. Opportunities for reducing the extent of the potential impact through mitigation and further assessment are identified in Section 3.5. A revised overlay of the Project Specific Assigned Noise Level (35dB) contour with mitigation measures implemented over the proposed Murrumujuk Township is provided in Figure 3-14.



File: SUN-NOI-002

3.5 Mitigation Measures, Noise Validation, and Follow-Up Monitoring

3.5.1 Baseline Noise Monitoring

Noise levels are predicted to exceed the Project Specific Assigned Noise Level for two indicative receptors POR 128 and POR 129. POR 128 and POR 129 are predicted locations within the proposed future Murrumujuk Township identified in the 2020 Litchfield Regional Land Use Plan. It is recommended that background noise measurements be undertaken for this location. Baseline monitoring will aim to establish the Rating Background Level (RBL), which would be used to establish a more accurate Project Intrusiveness Level; and subsequently, Project Specific Assigned Noise Level. A background noise level based Project Specific Assigned Noise Level will allow for the more accurate selection of potential noise mitigation controls.

3.5.2 Noise Mitigation

The Darwin Converter Site noise has been identified as the dominant noise source and contributing factor to predicted exceedances. It is anticipated that no mitigation is required for operational noise associated with the OHTL. Potential reasonable and feasible mitigation measures are proposed below; however, their design, specification, and selection will be undertaken during the detail design phase of the project:

- A 12m tall berm sloped 2:1 on the north side of the DCS can mitigate noise levels up to 3 dB at the proposed residential development receptor's locations to the north (Space permitting).
- Enclosing the inverters and working with the battery supplier to reduce the noise output of the batteries can result in a 15 dB reduction to the overall sound power of these sources. This will reduce the noise levels by 2-3 dB for proposed future developments to the Northeast of the converter site.
- Absorptive noise barrier walls blocking the line of site between the future developments and the battery yard (Space permitting). A 12 m tall wall will only lower the noise levels by 1-2 dB and may not be economically feasible.
- Limit the DCS substation transformer noise to 100 dBA. The transformer sound power of 110 dBA has been estimated based on the National Electrical Manufacturers Association Standards (NEMA, 2019) and is conservative compared to Hatch's repository of transformer sound power data. Working with the suppliers, the final design and specification for the 500 MVA transformers are anticipated to have a sound power of 100 dBA which is more representative of transformer noise collected by Hatch.

3.5.3 Mitigated Noise Results

Accounting for the above reasonable and feasible noise controls will result in approximate noise levels at indicative future Murrumujuk Township as shown in Table 3-8 (a 5 dB tonality penalty is included in the noise levels). Mitigated noise levels are anticipated to be 11 to 15 dB lower than the unmitigated variants. The mitigated variants would however still result in a minor exceedance of the Project Specific Assigned Noise Level of 35 dBA by up to 3dB under a worst-case operating scenario.

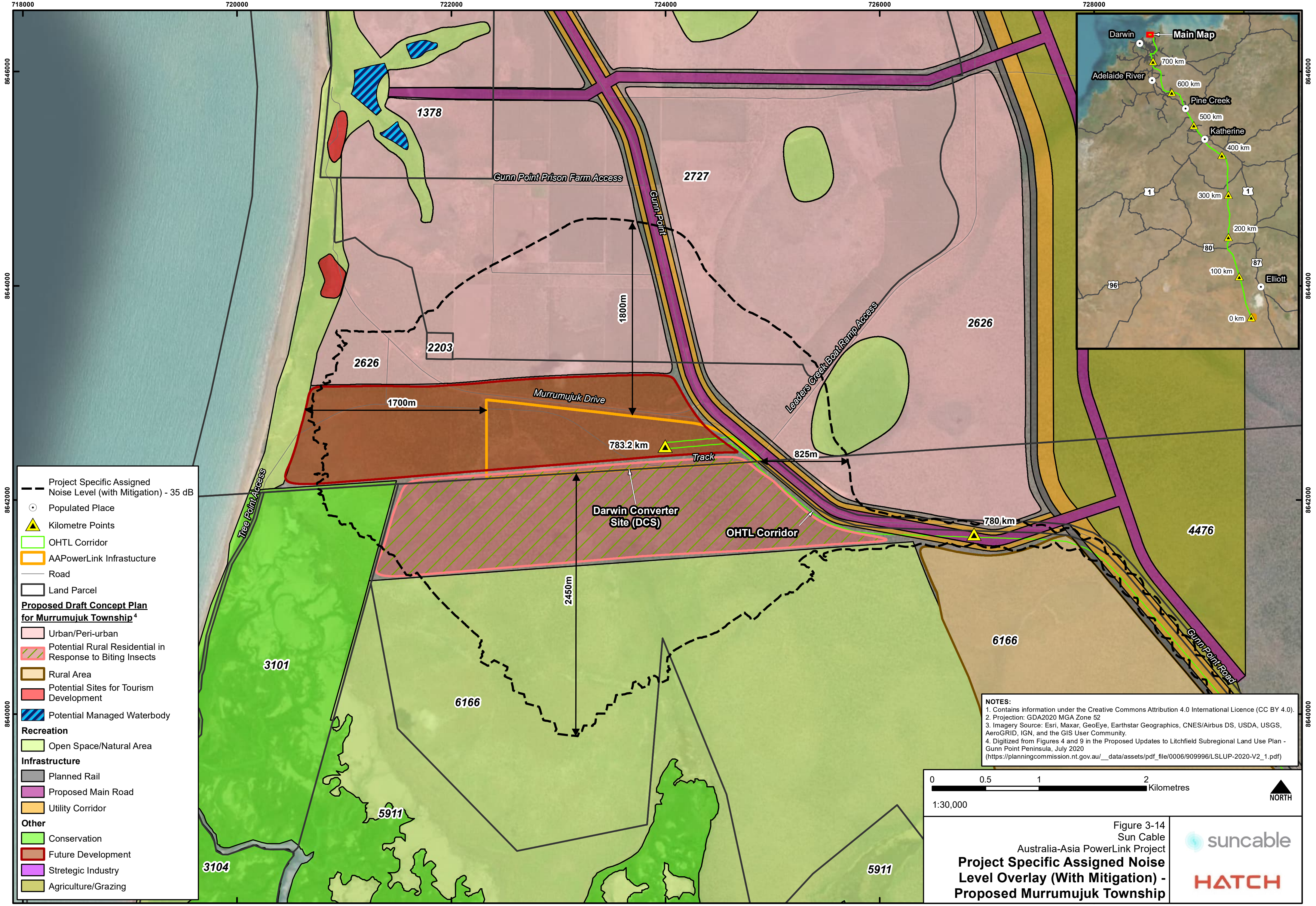
Table 3-8: Mitigated Noise Level

POR	Limit dBA	Variant 2A/1A Noise Impact (dBA) Unmitigated		Variant 2B/1B Noise Impact (dBA) Unmitigated		Variant 2A/1A Noise Impact (dBA) Mitigated		Variant 2B/1B Noise Impact (dBA) Mitigated	
		One Bipole + DCS + Solar Precinct	Two Bipole + DCS + Solar Precinct	One Bipole + DCS + Solar Precinct	Two Bipole + DCS + Solar Precinct	One Bipole + DCS + Solar Precinct	Two Bipole + DCS + Solar Precinct	One Bipole + DCS + Solar Precinct	Two Bipole + DCS + Solar Precinct
POR128*	35	48	48	50	50	37	37	38	38
POR129*	35	50	50	52	52	36	36	37	37

Exceeds Noise Criteria
*Potential future Noise Sensitive Receptor

It is anticipated that in an unmitigated scenario, potential future residential development within a noise buffer distance of approximately 3600 m North, 2400 m East, 3600 m South, and 2800 m West from the DCS and 100 m from the OHTL (as shown in Figure 3-13), should consider further mitigation to ensure noise impact on future sensitive receptors is minimised.

This noise buffer can be reduced to approximately 1800 m North, 825 m East, 2450 m South, and 1700 m West from the DCS when applying the identified mitigation controls, shown in Figure 3-14 below. These buffer distances should be re-calibrated by employing baseline monitoring to re-establish a Rating Background Level based Project Specific Assigned Noise Level should this scenario eventuate.



File: SUN-NOI-003

3.5.4 Equipment Sound Power Validation and Operational Noise Monitoring

Validating equipment noise during detailed design once a selected product is chosen is recommended to ensure the noise model is accurately predicting the potential environmental noise impact of the Project. Supplier product specifications and equipment sound powers are to be updated in the model once their values are known.

Operational noise monitoring is recommended once the Project is in operation to characterise the actual noise impacts and verify the noise model and effectiveness of mitigation measures implemented.

3.6 Conclusions

A cumulative noise impact assessment of the operational activity of the Solar Precinct, Darwin Converter Site, and various operating configurations of the OHTL has been completed consistent with the Northern Territory Noise Management Framework Guideline Section 3.2.

The assessment of 129 of the most highly impacted noise sensitive receptors surrounding the Project has concluded that there will be potentially 2 exceedances of the Project Specific Assigned Noise Level established at 35 dBA. The 2 exceedances occur at indicative potential future receptor locations intended to be representative of the proposed future Murrumujuk Township to the north and north-east of the Darwin Converter Site. The balance of the 127 noise sensitive receptors, largely lining the OHTL and to a lesser amount, the Solar Precinct, are anticipated to be in compliance with all seasonal and designed operating conditions of the Project.

Reasonable and feasible Mitigation measures have been identified that would reduce the extent of potential impact modelled in the unmitigated worst-case scenario. These include:

- Implementing a 12 m tall berm and 12 m tall noise barrier,
- Enclosing the inverters, and
- Working with the battery supplier to implement battery noise reduction options,
- Validating transformer noise and working with the supplier on transformer noise reduction options to achieve a sound power of approximately 100 dBA which is more representative of a 500 MVA transformer sound power based on Hatch's experience.

To identify additional potential future noise sensitive receptors that will be affected by the noise emissions of the Project, a noise buffer of 100 m surrounding the OHTL and 3600 m North, 2400 m East, 3600 m South, and 2800 m West surrounding Darwin Converter Site is to be established. The noise buffer surrounding the Darwin Converter Site can be reduced to 1800 m North, 1000 m East, 2500 m South, and 1700 m with the implementation of the identified and recommended project noise mitigation measures.

The completed assessment is based on a Project Specific Assigned Noise Level conservatively established at 35 dBA. As such, it would be in the interest of the Project to obtain a more representative Rating Background Level based Project Specific Assigned Noise Level by undertaking noise baseline measurements. Additionally, conducting operational noise monitoring once the Project is operational would be in the interest of the Project to characterise the actual community noise impact and to validate the noise model.