Options for wireless broadband in the 26 GHz band

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Thank you for the opportunity to comment on the considerations as set out in the 'Wireless broadband in the 26 GHz band, Options paper, September 2018' (Options Paper) that will inform the ACMA's views on progressing the 26 GHz band (24.25 to 27.5 GHz) to the refarming stage.

We set out our responses below and would be happy to discuss further.

Introduction

nbn's consideration of spectrum is focused on ensuring that it meets the Federal Government's expectation that all Australians have access to very fast broadband as soon as possible, at affordable prices, and at least cost to taxpayers, and that **nbn** will be able to ensure upgrade paths are available as required.

In this respect, **nbn**'s submission on options for wireless broadband in the 26 GHz band is informed by the following requirements relevant to the Government's expectations[1]:

- The need to manage the potential for interference, and avoid the risk of service disruptions, to **nbn**'s SkyMuster™ satellite service by any terrestrial services coexisting with any of **nbn**'s 10 satellite gateways which utilise frequencies at and above 27.0 GHz.
- The need to provide upgrade paths, including for **nbn**'s Fixed Wireless (FW) network, potentially by the acquisition of additional spectrum. **[C-i-C] [C-i-C]**.
- **[C-i-C] [C-i-C]**

nbn submits that the incorporation of **nbn**'s requirements as set out above in the exercise of ACMA's spectrum management functions is consistent with the objectives of the *Radiocommunications Act 1992* to maximise, by ensuring the efficient allocation and use of the spectrum, the overall public benefit derived from using the radiofrequency spectrum.

[C-i-C] [C-i-C]

[1] https://www.communications.gov.au/publications/nbnstatementofexpectations

Summary

nbn submits that coexistence between **nbn**'s SkyMuster™ satellite service and 5G mobile networks is unlikely to be feasible in all reasonably anticipated 5G mobile deployment scenarios. Therefore, **nbn** submits that licensing arrangements for spectrum in the 26 GHz band must proactively prevent the potential for 5G mobile network deployment to significantly interfere with the SkyMuster™ satellite service to avoid the risk of service disruptions. This proactive approach is required given the limited ability to practically change the conditions of licences once issued.

nbn submits that the SkyMuster™ satellite service use of 27.0 – 27.5 GHz at each of the 10 satellite gateways must be protected from the risk of interference from terrestrial services. A 33% reduction of the effective available spectrum would severely limit the capacity and in the worst-case scenario, a consequent lack of service.

On the information currently available, **nbn** supports the implementation of Option 2d ("24.25* - 27.5 GHz in metro + major regional centres") amended as follows:

- Spectrum licensing arrangements be implemented for the frequencies from 27.0 to 27.5 GHz, including conditions as set out below, to protect SkyMuster™ satellite service from the risk of interference from terrestrial services.
- The 'defined areas' described in the Options Paper (that would ultimately be made available for spectrum licensing) be expanded to cover the entire **nbn** FW footprint.
- Allocation not take place until such time as certainty is reached on the lower guard band required to protect the lower adjacent Earth Exploration Satellite Services (EESS).

* As *noted in the Options Paper, the lower frequency limit may be higher than 24.25 GHz depending on further considerations regarding coexistence with adjacent band passive EESS services.*

nbn notes:

- that the merits of the related options enabling apparatus licences to be issued in the defined areas (Options 3d and 5d) would be informed by, among other things, the outcomes of domestic consideration of how to manage coexistence between wireless broadband and EESS in the 23.6–24 GHz band;
- that the related options enabling use of a class licence 'underlay' (Options 4d and 5d) would need to ensure that spectrum and apparatus licence holders are protected from interference; and
- the potential for type 3 users to operate outside the confines of a physical building which could raise the same potential interference issues identified in respect of 5G mobile network coexistence with **nbn**'s SkyMuster™ satellite gateways.

***nbn**'s position on frequencies between and including 27.0 to 27.5 GHz*

nbn submits that arrangements must be made to fully protect **nbn**'s SkyMuster™ satellite service from potential interference, including by applying specific licence conditions for coexistence:

- In the area co-incident with each of **nbn**'s 10 dedicated satellite gateway beams (Gateway Zones) licence conditions (in spectrum and apparatus licences as relevant) limiting terrestrial network operation to appropriate operating parameters agreed with **nbn** in respect of each of:
    - minimum UE antenna gain, to allow panel antennas with high directivity;
    - maximum UE antenna boresight elevation, to minimise possible radiation above the horizon; and
    - maximum BS antenna boresight elevation, to prevent possible radiation above the horizon.

[C-i-C] [C-i-C]

The protection of nbn's SkyMuster™ satellite service

The 27.0-27.5 GHz frequency range is the lower 500 MHz of the 27.0-28.5 GHz forward uplink spectrum used by **nbn**'s SkyMuster™ satellite service at each of **nbn**'s 10 satellite gateways.

The SkyMuster™ satellite service is in active use currently providing broadband access to more than 92,900 subscribers across Australia, with approximately 0.4M traditionally underserved premises within the footprint ready to connect[2]. Utilisation of this band, is already intensive and often critical to provide health, education and other essential services to regional and remote Australians (some of whom have no other practical option). Utilisation will only increase with further take up of the SkyMuster™ satellite service.

The potential for coexistence

nbn understands that the ACMA considers that coexistence between incumbent services in the 26 GHz band is possible, including the fixed satellite service (earth-to-space) and 5G mobile deployment, based on ITU-R sharing and compatibility studies conducted for the 2019 World Radiocommunications Conference, including an Australian study indicating that the aggregate interference level would be at least 31 dB below the satellite system noise level.[3]

nbn considers that the results of these ITU-R sharing studies cannot be used solely or in isolation to inform planning decisions for the 26 GHz spectrum band in Australia as the studies did not consider an appropriately full range of likely 5G mobile deployment scenarios. In **nbn**'s view the full range of likely conditions that would be faced by satellite networks where 5G mobile networks coexist in an Australian setting was not considered.

nbn has replicated the Australian ITU-R study with assumptions that reflect **nbn**'s existing high throughput SkyMuster™ satellite network, and conducted a sensitivity analysis of likely 5G mobile network deployment scenarios affecting Australia. The results indicate that coexistence with 5G mobile deployment is not likely to be feasible when all reasonably anticipated 5G mobile network deployment scenarios are considered.

nbn's study is set out at Attachment A.

The key differences between the analysis considered by **nbn** and the Australian ITU-R study, and relevant implications are set out in the following table:

[2] https://www.nbnco.com.au/content/dam/nbnco2/2018/documents/weekly-progress-reports/25102018.pdf

[3] As referenced at footnote 35 of the Options Paper.

Parameter	nbn's study	Australian ITU-R study	Rationale for using different parameter	Impact on findings
Satellite characteristics and path losses				
1. Satellite G/T	30 dB/K	20.6 dB/K	G/T –A value ~9 dB higher is more representative of current and future VHTS system characteristics. **nbn**'s existing SkyMuster 1 and 2 satellites are high throughput satellites and future satellites will likely be at least as high in gain.	Lower-gain satellites are much less susceptible to interference than high throughput satellites. Therefore the Australian ITU-R study result significantly underestimates the potential interference risk to **nbn**'s existing satellite network.
2. Interference location	Satellite main beam	Visible earth	**nbn**'s satellite receivers are designed to be highly sensitive to signals in the intended area of service, and to suppress signals outside this area.	The Australian ITU-R study does not specifically consider the interference that would be caused to **nbn**'s satellite network in the geographical area of most concern (i.e. the area in which **nbn**'s satellite would be most sensitive to interference).
3. Satellite receiver interference threshold I/N (Interference benchmark)	-12.2 for 50% of time	-10 dB	This translation is necessary since the Australian study deals with averaged values for most parameters, while satellite protection requirements are specified for 20% of time.	Increased potential for interference.
4. Body loss (reduction in emissions due to a human between a UE and BS)	0 dB	4 dB	One of the more speculative parameters in the Australian study with no clear reason for the value used or its relevance, if any, to Earth-to-space paths – also note that numerous 5G use cases involve no body and	Increased potential for interference.

Parameter	nbn's study	Australian ITU-R study	Rationale for using different parameter	Impact on findings
			therefore no body loss.	
5. Polarisation isolation	1.5 dB	3 dB	Off-axis to off-axis polarisation loss is zero. On-axis to on-axis emissions can be as high as 3 dB but usually lower.	Overestimate of polarisation losses leads to underestimate of interference.
Aggregate interference level will be 10 dB below the SkyMuster™ satellite system noise level based on a change in the parameters below (1 to 5) alone (with all other parameters the same as that assumed in the Australian study).				
5G mobile deployment scenarios				
6. UE antenna dimensions	2x2	4 x 4	A review of 5G standardisation activities indicates that the most likely implementation of phased arrays on UE terminals will include a total of four elements, either 1 x 4 or 2 x 2. Although it will be possible to design UE antennas with more elements, these are expected to be used as multiple 4-element radiators.	This would result in a 'double hit' of interference through more transmitted power and worse antenna performance.
7. IMT deployment density	BS: 100/km2 UE: 400/km2	BS: 30/km2 UE: 100/km2	5G station density: research conducted by the small cell forum indicates that many operators will aim for BS densities of 100 to 350 per square kilometre. Furthermore, UE densities are by their nature uncontrollable and unpredictable. Therefore modest increases to 5G station densities are reasonable to assume.	A greater number of simultaneous interferers would result in greater interference levels.

Parameter	nbn's study	Australian ITU-R study	Rationale for using different parameter	Impact on findings
8. BS antenna height	30 m	6 m	BS height will be dictated by infrastructure height, and is expected to range from ground level to building tops. The standard 30-metre height of many communications infrastructure platforms is a reasonable assumption to make for the purpose of conducting sensitivity analyses.	A higher uptilt of user device antenna beams would result in higher upward radiation and more interference to satellite receivers.
9. BS segmentation	4 x 4	8 x 8	BS array size: From available literature it is reasonable to assume that 8 x 8 element arrays will be used at the IMT-2020 BS, however these can be, and most likely will often be, used as multiple smaller sized arrays transmitting simultaneously.	This would result in a 'double hit' of interference through more transmitted power and worse antenna performance.
10. TDD downlink factor	60%	80%	It is difficult to state conclusively that upload-intensive applications will not exist, or that the proportion of upload traffic will not vary with time.	If user devices dominate aggregate interference as studies show, a greater proportion of upload traffic will result in higher interference levels
11. BS/UE activity factor	50%	20%	It does not appear reasonable to state conclusively that, at all times, no more than 20% of cells will be active – noting that it is not a controllable parameter in any event.	More simultaneous emissions would result in higher interference levels
12. BS transmit power	10 dBm/MHz	2 dBm/MHz	A modest increase in IMT-2020 BS power is assumed to align more closely with the standards under development and systems already trialled and licensed in Australia	Higher IMT transmitted powers result in higher interference levels
The use of a different set of assumptions regarding satellite network operation reflective of nbn's SkyMuster™ satellite service in conjunction with a sensitivity analysis of 5G mobile network deployment scenario shows that aggregate interference level will be 11 dB above the SkyMuster™ satellite network noise level.				

nbn submits that coexistence between nbn's SkyMuster™ satellite service and 5G mobile networks (base stations and user equipment) is not likely to be feasible in all reasonably anticipated 5G mobile network deployment scenarios as informed by its replication of the Australian ITU-R study, and notes the following:

- An assessment of the maximum power radiated by 5G mobile base stations and user equipment shows that only a very small number of emissions could exceed satellite receiver protection thresholds. In the case of 5G mobile base stations, a single emission could exceed the interference threshold.
- The interference is expected since 5G base stations and mobile phones form directional beams which can cause interference when pointed towards a satellite.

Potential impact of unconstrained 5G mobile network deployment

The options identified in the Options Paper include making spectrum available in 27.0 – 27.5 GHz, with ACMA's preferred option including spectrum licensing in 27.0 – 27.5 GHz within the proposed defined areas (and apparatus licensing elsewhere).

nbn considers that coexistence with terrestrial services in 27.0 – 27.5 GHz in the area aligning with each of the 10 dedicated satellite gateway beams could result in no service in the worst case scenario (i.e. capacity being reduced up to approximately 33%).

As each satellite gateway services different areas using different frequencies, the potential impact from coexistence would not be evident as a reduction in capacity spread evenly across services - rather, some end users could potentially be severely impacted, and others less so.

nbn notes that there is limited ability to change the operating conditions of spectrum and apparatus licences once issued and that on this basis, the need to protect **nbn**'s SkyMuster™ satellite network from the potential of interference from terrestrial services must be addressed before making spectrum available for 5G mobile network deployment.

nbn's position on 27.0 to 27.5 GHz

nbn submits that arrangements must be made to ensure the full protection of **nbn**'s SkyMuster™ satellite service from potential interference, including by applying specific licence conditions for terrestrial services:

- In the area co-incident with each of **nbn**'s 10 dedicated satellite gateway beams (**[C-i-C] [C-i-C]** an approximately 250 km radius circle around each gateway site) (Gateway Zones) licence conditions (in spectrum and apparatus licences as relevant) limiting terrestrial network operation to appropriate operating parameters agreed with **nbn** in respect of each of:
    - minimum UE antenna gain, to allow panel antennas with high directivity;
    - maximum UE antenna boresight elevation, to minimise possible radiation above the horizon; and
    - maximum BS antenna boresight elevation, to prevent possible radiation above the horizon.

We look forward to engaging with the ACMA to determine the required distances and operating parameters,

[C-i-C] [C-i-C]

See Attachment B for details for Hierarchical Cell Identification Scheme (HCIS) identifiers for Gateway Zones, noting these are indicative only and subject to confirmation.

Upgrade paths for nbn's Fixed Wireless network

In accordance with the Government's expectations, **nbn** requires upgrade paths for **nbn**'s FW network **[C-i-C] [C-i-C] nbn** submits that the 26 GHz band should be planned in a manner that includes accommodation for **nbn**'s requirement to develop upgrade path options for its FW network, including by:

- expanding the proposed defined areas identified in the Options Paper so that the areas cover the entirety of **nbn**'s FW footprint **[C-i-C] [C-i-C].** The proposed expanded geography would cover areas in which **nbn** currently holds 2.3 GHz spectrum licences, 3.4 GHz spectrum licences, and 3.5 GHz apparatus licences.
- Spectrum licences being made available for the expanded 'defined area' covering the entire **nbn** FW footprint.

- Licensing arrangements for 27.0 to 27.5 GHz (spectrum and apparatus as relevant), as set out in further detail under '**nbn**'s position on 27.0 to 27.5 GHz'
- allocation not taking place until such time as certainty is reached on the lower guard band required to protect adjacent EESS, maximising the spectrum allocation and spectral efficiency by minimising defragmentation.

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[C-i-C] [C-i-C]

Issues for comment

1. *Does the three-type model constitute an appropriate high-level representation of potential usage of the 26 GHz band? If not, are there any use cases that should be included, excluded or omitted?*

   type 1: Conventional wide-area subscriber networks, served by ubiquitous (albeit very densely arranged, at mmWave frequencies) base stations operated by one or more mobile service providers.

   type 2: Limited market subscriber networks, including—but not limited to—fixed wireless broadband services (including WISPs) and fleet-oriented mobile services.

   type 3: Business enterprise services operated by private entities within the confines of their own premises or land estate.

   nbn notes that:

   - it may be the case that type 3 users could operate outside the confines of a physical building which could raise the same potential interference issues identified in respect of more general 5G mobile network coexistence with **nbn**'s SkyMuster™ satellite gateways;
   - the range of use cases covered by 'limited market subscriber networks' is unclear, including the nature of fleet-oriented mobile services; and
   - the model does not appear to include the potential **nbn** FW network use case which should be included, given the need for **nbn** to provide an upgrade path for **nbn**'s FW network, including potentially by the acquisition of additional spectrum.

2. *What are the implications for 26 GHz wireless broadband in Australia of the Electronic Communication Committee of CEPT (ECC) decision on emission limits to protect passive EESS?*

   Allocation should not take place until such time as certainty is reached on the lower guard band required to protect adjacent EESS.

3. *Are the proposed defined geographic areas for wide-area licensing appropriate?*

   nbn submits that the 26 GHz defined areas be expanded to cover the entire **nbn** FW footprint and spectrum licences be made available across this entire area.

4. *What is the expected proliferation of—or demand for—services deployed under type 2 (apparatus-licensed) and/or 3 (class-licensed) models?*

   nbn notes, and agrees with, the ACMA's comments regarding the lack of any commercial mmWave 5G deployments. On the information currently available, **nbn** has no further comment on the expected proliferation of, or demand for, services deployed under type 2 and / or 3 models

In respect of a class-licensed model, **nbn** notes the potential for type 3 users to operate outside the confines of a physical building which could raise the same potential interference issues identified in respect of more general 5G mobile network coexistence with **nbn**'s SkyMuster™ satellite gateways.

5. *Comment is sought on preferred option(s) for configuring and licensing the 26 GHz band.*

   - *Option 1 – no change*
   - *Option 2 –Spectrum licensing of whole (available) band in defined areas*
   - *Option 3 – Part-band spectrum licensing + part band apparatus licensing in defined areas*
   - *Option 4 – Spectrum licensing of whole (available) in defined areas + co-frequency class licensing of whole (available) band*
   - *Option 5 – Part-band spectrum licensing + part band apparatus licensing in defined areas + co frequency class licensing of whole (available) band*

   See 'Summary' section above for **nbn**'s response.

6. *If options 3 or 5 (all variants) are preferred, how much of the band should be available for spectrum licensing and apparatus licensing?*

   See 'Summary' section above for **nbn**'s response.

7. *If options 4 or 5 (all variants) are preferred, how much of the band should be available for class licensing?*

   In respect of a class-licensed model, **nbn** notes that type 3 users could operate outside the confines of a physical building which could raise the same potential interference issues identified in respect of more general 5G mobile network coexistence with nbn's SkyMuster™ satellite gateways.

   In circumstances where the type 3 users are not operating within the confines of a physical building, it is unclear how the potential for interference to **nbn**'s SkyMuster™ satellite service could be managed in a satisfactory manner.

   nbn notes that a spectrum licence holder may not be able to identify the type 3 users in circumstances where they are causing interference to the spectrum licence holder given the nature of class licence arrangements.

   nbn's view is that a class licensing arrangement does not appear to be suitable for this use case based on the information available.

8. *If options 4 or 5 (all variants) are preferred, what conditions should be applied to a class licence to protect co-frequency spectrum-licensed operations (in defined areas)? Would it be appropriate to define a means of making class-licensed use visible (for example, through a form of voluntary device registration)?*

   See nbn's response to Queston 7 above.

9. *Are there any other replanning options that should be considered?*

   See 'Summary' section above for **nbn**'s response.

10. *Is there likely to be sufficient demand for type 1 services in regional centres outside metropolitan areas, and if so, what centres (either explicitly listed or by population threshold) should be included in the expanded licence areas?*

    nbn notes the need to provide an upgrade path for the **nbn**'s FW network across the entire footprint, including potentially by the acquisition of additional spectrum.

Attachment A nbn's coexistence study

See separate attachment.

Attachment B HCIS indicators for Gateway Zones

HCIS indicators are indicative only and subject to confirmation.

Carnarvon / Geraldton / Waroona	BV, AS5, AS6, AS8, AS9, AT1, AT2, AT3, AT5, AT6, AT8, AT9, AU2, AU3, AU6, AU9, AV9, AW3, BS7, BT1, BT4, BT7, BU1, BU2, BU4, BU5, BU7, BU8, BW1, BW2, AS2E, AS2F, AS2G, AS2H, AS2I, AS2J, AS2K, AS2L, AS2M, AS2N, AS2O, AS2P, AS3E, AS3F, AS3G, AS3I, AS3J, AS3K, AS3L, AS3M, AS3N, AS3O, AS3P, BS1I, BS1M, BS1N, BS4A, BS4B, BS4C, BS4E, BS4F, BS4G, BS4H, BS4I, BS4J, BS4K, BS4L, BS4M, BS4N, BS4O, BS4P, BS5M, BS8A, BS8E, BS8I, BS8M, BT2A, BT2E, BT2I, BT2M, BT5I, BT5M, BT5N, BT8A, BT8B, BT8C, BT8E, BT8F, BT8G, BT8H, BT8I, BT8J, BT8K, BT8L, BT8M, BT8N, BT8O, BT8P, BT9I, BT9M, BU3A, BU3E, BU3I, BU3M, BU6A, BU6E, BU6I, BU6M, BU9I, BU9M, BU9N, BU9O, BW3A, BW3B, BW3C, BW3D, BW3E, BW3F, BW3G, BW3H, BW3I, BW3J, BW3K, BW3L, BW3M, BW3N, BW3O, BW5A, BW5B, BW5C, BW5D, BW5E, BW5F, BW5G, BW6A, BW6B, CV1I, CV1M, CV4A, CV4B, CV4E, CV4F, CV4I, CV4J, CV4M, CV4N, CV7A, CV7B, CV7E, CV7F, CV7I, CV7J, CV7M, CV7N, CW1A, CW1E
Kalgoorlie	CU6, CU8, CU9, CV2, CV3, CV6, DU4, DU5, DU7, DU8, DU9, DV1, DV2, DV4, DV5, CU2L, CU2O, CU2P, CU3F, CU3G, CU3H, CU3I, CU3J, CU3K, CU3L, CU3M, CU3N, CU3O, CU3P, CU5B, CU5C, CU5D, CU5E, CU5F, CU5G, CU5H, CU5I, CU5J, CU5K, CU5L, CU5M, CU5N, CU5O, CU5P, CU7D, CU7H, CU7L, CU7P, CV1D, CV1H, CV1L, CV5A, CV5B, CV5C, CV5D, CV5F, CV5G, CV5H, CV5K, CV5L, CV5P, CV9A, CV9B, CV9C, CV9D, CV9H, DU1E, DU1F, DU1G, DU1H, DU1I, DU1J, DU1K, DU1L, DU1M, DU1N, DU1O, DU1P, DU2E, DU2F, DU2I, DU2J, DU2K, DU2L, DU2M, DU2N, DU2O, DU2P, DU3M, DU6A, DU6B, DU6E, DU6F, DU6G, DU6I, DU6J, DU6K, DU6M, DU6N, DU6O, DV3A, DV3B, DV3C, DV3D, DV3E, DV3F, DV3G, DV3H, DV3I, DV3J, DV3K, DV3L, DV3M, DV3N, DV3O, DV6A, DV6B, DV6C, DV6E, DV6F, DV6I, DV7A, DV7B, DV7C, DV7D, DV7E, DV7F, DV7G, DV7H, DV8A, DV8B, DV8C
Ceduna	GU9, GV3, GV6, HU7, HU8, HV1, HV2, HV3, HV4, HV5, HV6, HV8, GU6L, GU6N, GU6O, GU6P, GU8H, GU8K, GU8L, GU8N, GU8O, GU8P, GV2B, GV2C, GV2D, GV2F, GV2G, GV2H, GV2I, GV2J, GV2K, GV2L, GV2M, GV2N, GV2O, GV2P, HU4I, HU4J, HU4K, HU4L, HU4M, HU4N, HU4O, HU4P, HU5I, HU5J, HU5K, HU5M, HU5N, HU5O, HU5P, HU6M, HU9A, HU9B, HU9E, HU9F, HU9G, HU9I, HU9J, HU9K, HU9L, HU9M, HU9N, HU9O, HU9P, HV9A, HV9B, HV9C, HV9D, HV9E, HV9F, HV9G, HV9H, HV9I, HV9J, HV9K, HV9L, HV9M, HV9N, HV9O, HW3A, HW3B, IV1A, IV1E, IV1I, IV1M, IV4A, IV4E, IV4I, IV4M, IV7A

Broken Hill / Bourke / Roma	LU, MT, JU8, JU9, JV1, JV2, JV3, JV4, JV5, JV6, JV8, JV9, KU3, KU6, KU7, KU8, KU9, KV1, KV2, KV3, KV4, KV5, KV7, LT3, LT6, LT9, LV1, LV2, MS7, MU1, MU2, JU4P, JU5H, JU5J, JU5K, JU5L, JU5M, JU5N, JU5O, JU5P, JU6E, JU6F, JU6G, JU6H, JU6I, JU6J, JU6K, JU6L, JU6M, JU6N, JU6O, JU6P, JU7C, JU7D, JU7F, JU7G, JU7H, JU7J, JU7K, JU7L, JU7M, JU7N, JU7O, JU7P, JV7B, JV7C, JV7D, JV7F, JV7G, JV7H, JV7K, JV7L, JV7P, JW2A, JW2B, JW2C, JW2D, JW2G, JW2H, JW3A, JW3B, JW3C, JW3D, JW3E, JW3F, JW3G, JW3H, KT9L, KT9N, KT9O, KT9P, KU2H, KU2L, KU2O, KU2P, KU4E, KU4I, KU4J, KU4K, KU4L, KU4M, KU4N, KU4O, KU4P, KU5C, KU5D, KU5F, KU5G, KU5H, KU5J, KU5K, KU5L, KU5M, KU5N, KU5O, KU5P, KV6A, KV6B, KV6C, KV6D, KV6E, KV6H, KV8A, KV8B, KV8C, KV8D, KV8E, KV8F, KV8G, KV8I, KV8J, KV8M, KW1A, KW1B, KW1C, KW1D, KW1E, KW1F, LS8P, LS9D, LS9F, LS9G, LS9H, LS9I, LS9J, LS9K, LS9L, LS9M, LS9N, LS9O, LS9P, LT2C, LT2D, LT2G, LT2H, LT2K, LT2L, LT2N, LT2O, LT2P, LT5B, LT5C, LT5D, LT5F, LT5G, LT5H, LT5J, LT5K, LT5L, LT5N, LT5O, LT5P, LT7I, LT7J, LT7K, LT7L, LT7M, LT7N, LT7O, LT7P, LT8B, LT8C, LT8D, LT8F, LT8G, LT8H, LT8I, LT8J, LT8K, LT8L, LT8M, LT8N, LT8O, LT8P, LV3A, LV3B, LV3C, LV3D, LV3E, LV3F, LV3G, LV3H, LV3I, LV3J, LV3K, LV3L, LV3M, LV3N, LV3O, LV4A, LV4B, LV4C, LV4D, LV4E, LV4F, LV4G, LV4H, LV4K, LV4L, LV5A, LV5B, LV5C, LV5D, LV5E, LV5F, LV5G, LV5H, LV5I, LV5J, LV6A, LV6B, LV6E, MS8A, MS8B, MS8C, MS8E, MS8F, MS8G, MS8H, MS8I, MS8J, MS8K, MS8L, MS8M, MS8N, MS8O, MS8P, MS9E, MS9I, MS9J, MS9K, MS9M, MS9N, MS9O, MS9P, MU3A, MU3B, MU3C, MU3D, MU3E, MU3F, MU3G, MU3I, MU3J, MU3M, MU4A, MU4B, MU4C, MU4D, MU4E, MU4F, MU4I, MU4J, MU4M, MU4N, MU5A, MU5B, MU5C, MU7A, MU7B, MU7E, MU7F, MU7I, MU7J, MU7M, MU7N, MV1A, MV1E, NT1E, NT1I, NT1M, NT1N, NT4A, NT4B, NT4E, NT4F, NT4I, NT4J, NT4M, NT4N, NT7A, NT7B, NT7E, NT7F, NT7I, NT7M
Wolumla	MW4, MW5, MW6, MW7, MW8, MW9, MX1, MX2, MX3, MX4, LW6D, LW6G, LW6H, LW6K, LW6L, LW6N, LW6O, LW6P, LW9B, LW9C, LW9D, LW9F, LW9G, LW9H, LW9J, LW9K, LW9L, LW9N, LW9O, LW9P, LX3B, LX3C, LX3D, LX3F, LX3G, LX3H, LX3J, LX3K, LX3L, LX3N, LX3O, LX3P, LX6C, LX6D, LX6H, LX6L, MW1H, MW1J, MW1K, MW1L, MW1M, MW1N, MW1O, MW1P, MW2E, MW2F, MW2G, MW2H, MW2I, MW2J, MW2K, MW2L, MW2M, MW2N, MW2O, MW2P, MW3E, MW3F, MW3G, MW3H, MW3I, MW3J, MW3K, MW3L, MW3M, MW3N, MW3O, MW3P, MX7C, MX7D, NW1I, NW1M, NW1N, NW1O
Geeveston	LY5, LY6, LY7, LY8, LY9, LZ1, LZ2, LZ3, MY7, MZ1, KY6L, KY6O, KY6P, LY1O, LY1P, LY2I, LY2J, LY2K, LY2L, LY2M, LY2N, LY2O, LY2P, LY3I, LY3J, LY3K, LY3M, LY3N, LY3O, LY3P, LY4B, LY4C, LY4D, LY4E, LY4F, LY4G, LY4H, LY4I, LY4J, LY4K, LY4L, LY4M, LY4N, LY4O, LY4P, MY1M, MY1N, MY4A, MY4B, MY4C, MY4E, MY4F, MY4G, MY4H, MY4I, MY4J, MY4K, MY4L, MY4M, MY4N, MY4O, MY4P

[C-i-C] [C-i-C]