Impact of exclusion zone policies on siting base stations

Australian case study analysis

Prepared for GSMA by Evans Planning,
in association with Manidis Roberts and Piconet Consulting
August 2012

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Executive summary

In the context of mobile communications infrastructure deployment planning-based exclusion zones, sometimes referred to as 'Buffer Zones'or 'Cordon Sanitaires' are geographic areas generally imposed by local governments and their agencies around community facilities where a radio base station cannot be established. These areas are generally distance based and are applied without regard for the nature or operation of radio base stations or existing sources of radio-frequency exposure in the environment.

Typically, exclusion zones are imposed by government policy makers in residential areas around community facilities such as primary and secondary schools, pre-schools or medical facilities including hospitals. However, there is no science-based rationale for their introduction, the specified facilities or the zone size.

A policy of planning-based exclusion zones has the potential to impact significantly upon the siting and deployment of mobile network radio base stations. This in turn impacts on delivery of quality mobile network services, including mobile broadband, to consumers whom are increasingly reliant upon these services.

In Australia the radiofrequency (RF) exposure limits are consistent with international recommendations and there are no mandatory planning exclusion zone policies though some local authorities have proposed their adoption. Therefore, this report examines the hypothetical impact upon existing networks of radio base stations in the Melbourne metropolitan area and the potential for such a policy (if applied) to negatively impact the future enhancement of these networks.

Melbourne, a city in the southern State of Victoria in Australia, has a population in excess of four million people, and its citizens are highly reliant on mobile technology. Drawing upon radio base station data for Melbourne from the Australian industry, as well as geographic information system (GIS) data on community facilities, a GIS model was developed and analysed. This report examines the wider metropolitan impacts as well as the impact in a local context in two case study areas of Melbourne.

The inner Melbourne suburb of South Yarra is examined to determine the policy impact on a built-up inner urban context. South Yarra is one of Melbourne's higher density suburbs and it also contains a number of existing community facilities including schools.

The outer metropolitan suburb of Berwick is also examined to determine the impact of exclusion zones in a lower density suburban context. Berwick is an established suburb with rapid growth on its fringes. A planning-based exclusion zone policy could restrict the ability to locate both future base stations and community facilities.

The main findings of the analysis include:

- Across the Melbourne metropolitan area, 54.1% of all existing radio base stations would be impacted by a 500 m exclusion zone around community facilities (schools, pre-school and medical facilities), and it follows that more than half of all new base stations could not be established to supplement coverage in the same areas.
- In the (inner urban) suburb of South Yarra, an exclusion zone of 500 m around all community facilities would cover 87.5% of the total geographic area of that suburb, affecting virtually all existing antennas sites and making it nearly impossible to improve mobile network services.
- If a policy of planning-based exclusion zones was applied in the (inner urban) suburb of South Yarra, the commercial areas along Chapel Street and Toorak Road would not receive sufficient mobile network services into the future, because radio base stations would not be able to be established in close enough proximity.
- A policy of planning-based exclusion zones in the (outer urban) suburb of Berwick would not achieve the intended policy outcomes, because 39.1% of all community facilities (schools, pre-school, medical) are already within 500 m of a radio base station. A retrospective policy would render mobile networks unworkable.
- If a policy such as this is to be applied uniformly then there will also be many unintended consequences, including severe limitations on where the radio transmitters used by emergency services could be located.

In conclusion planning-based exclusion zones are proposed ostensibly in the interests of local communities, however, the analysis demonstrates that such a policy is unworkable and may actually have an adverse effect on community development both in regard to access to mobile services and the ability to locate new community facilities.

Table of abbreviations

3G	Third Generation
4G	Fourth Generation
ACMA	Australian Communications and Media Authority
AM	Amplitude Modulation
AMTA	Australian Mobile Telecommunications Association
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
CARS	Compliance and Reporting System
CBD	Central Business District
EMF/EME/EMR	Electromagnetic Fields/Energy/Radiation
ERP	Estimated Resident Population.
FM	Frequency Modulation
GIS	Geographic Information System
GSM	Global System for Mobile Communications
ICNIRP	International Commission on Non-Ionizing Radiation Protection
LTE	Long Term Evolution
MBB	Mobile Broadband
POI	Points of Interest
RBS	Radio Base Station
RF	Radio Frequency
RFNSA	Radio Frequency National Site Archive
RPS	Radiation Protection Standard
SD	Statistical Division
WCDMA	Wideband Code Division Multiple Access

1

Introduction and background

This report presents the results of an analysis of the impacts of planning-based exclusion zones on the ability to site mobile communication base stations. In the context of mobile communications infrastructure deployment planning-based exclusion zones are distance-based restrictions on the siting of base stations generally imposed by local governments around community facilities. The Australia radiofrequency (RF) exposure limits are consistent with international recommendations and there are no mandatory planning exclusion zone policies. The analysis is based the impacts of a range of hypothetical distances and uses information from public sources on the locations of base stations and community facilities.

Australian mobile networks

The Australian mobile telecommunications market comprises three operators, each with its own physical network infrastructure. The operators use multiple technologies including GSM, 3G-WCDMA and LTE at different frequencies allocated by Australia's national telecommunications regulator, the Australian Communications and Media Authority (ACMA). The three mobile network operators in Australia each operate third generation (3G) networks that have undergone progressive enhancements to increase capacity and allow customers to access faster mobile internet speeds. Each operator has either commenced construction or announced plans for fourth generation (4G) networks using Long Term Evolution (LTE) technology. Each operator has also previously formed a joint venture arrangement with another for the sharing of radio base station equipment.

According to the ACMA 2010-11 Annual Report, there were 29.3 million mobile services operating in Australia. Given Australia's population of 22.7 million, this means that there is a mobile penetration rate (mobile phone services per head of population) of 129%.

The three operators servicing these subscribers have over 18,000 radio base stations and provide 3G coverage to between 94% and 99% of Australia's population. However, with a high proportion of Australia's population living in coastal regions, coverage to 99% of the Australian population equates to around 25% of the Australian landmass.

Mobile broadband is in high demand throughout the Australian economy with growth projections[1] in the order of 280% to 2014. Advanced mobile data services, including mobile broadband, are widely regarded as central to the development of Australia's digital economy. The ACMA[2] recently noted:

> *There is widespread recognition that mobile broadband services are an economic enabler within society and the provision of these services, technologies and applications in the wider community is in the public interest.*

With the emergence of 4G technology the use of mobile broadband will only continue to grow with a recent forecast[3] stating:

> *Projections suggest that by 2020 there will be almost 20 million mobile broadband subscriptions on handsets, together with another 6.3 million data-cards (under a moderate growth scenario). The corresponding mobile traffic volumes are forecast to increase at a compound annual growth rate of 95% to 2014.*

1 Access Economics – 2010 Economic Contribution of Mobile Telecommunications in Australia
2 ACMA 2011 Towards 2020—Future spectrum requirements for mobile broadband
3 2011 Telsyte's Australian Smartphone Market Study 2011-2015

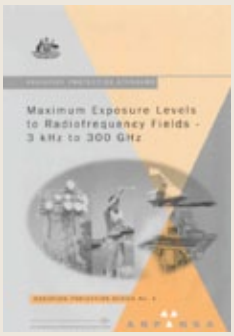
Overview of Australian regulatory requirements for antenna siting

To establish new radio base stations an operator must comply with the Australian States and Territories planning legislation and regulations, and local council planning instruments and policies[4]. National government exemptions from local council planning approval are usually available for infrastructure with a reduced visual impact. These exemptions are contained in the Telecommunications Act 1997 and Telecommunications (Low-impact Facilities) Determination 1997 (Amendment No.1, 2011). Examples of exempt activity include the siting of new antennas on existing structures and buildings but not at heritage places.

For proposals that are subject to a 'low impact' exemption, the Australian operators must also comply with a mandatory consultation code (the 'Code') *C564:2011 Mobile Phone Base Station Deployment*[5]. Under the Code, a new radio base station requires a comprehensive consultation strategy to be devised by the operator in conjunction with the council and then executed by the operator. The consultation is undertaken to ensure that community stakeholders have an opportunity to obtain information and engage with the operator. The consultation is mandatory and regulated by the ACMA. Where council planning approval is required, which is usually the case for new masts; local councils will assess a proposal against a council policy and approve or refuse it.

The legislative authority to control radiofrequency (RF) exposures from radiocommunications facilities derives from the federal Radiocommunications Act 1997 and the applicable limits are set out in the Radiocommunications (Electromagnetic Radiation – Human Exposure) Standard 2003. This standard is based on the public and occupational limits that have been set in RPS3 by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA[6]). The limits are based on the recommendations of the International Commission for Non-Ionizing Radiation Protection (ICNIRP[7]). Under the Code operators must prepare an Environmental RF (EME[8]) Report which is uploaded onto the industry's publicly accessible RF National Site Archive[9].

Australia's Radiation Protection Standard No. 3 (RPS3) for Maximum Exposure Levels to Radiofrequency Fields - 3 kHz to 300 GHz (2002) specifies limits of human exposure to radiofrequency fields in the range 3 kHz to 300 GHz to prevent adverse effects. It specifies restrictions for occupational exposure, general public exposure, and equipment and usage parameters. The standard includes:



- mandatory basic restrictions for both occupational and general public exposure involving all or part of the human body
- reference levels for measurable quantities derived from the basic restrictions
- approaches for verification of compliance with the standard
- requirements for management of risk from occupational exposures and measures for protection of the general public.

4 For additional details see the Mobile Carriers Forum (http://www.mcf.amta.org.au/)
5 Produced by the Communications Alliance, an industry forum that aims to promote the growth of the Australian communications industry and the protection of consumer interests by fostering the highest standards of business ethics and behaviour through industry self-governance (http://commsalliance.com.au/)
6 http://www.arpansa.gov.au/
7 http://www.icnirp.org/
8 In Australia, the term 'RF Electromagnetic Energy' (EME) is more commonly used, but Electromagnetic Radiation (EMR) and Electromagnetic Fields (EMF) are also used interchangeably.
9 http://www.rfnsa.com.au/nsa/index.cgi

2

Base station planning policies

Context

In recognition of the importance of mobile communications infrastructure, many governments have adopted planning policies on the siting of radio base stations. These policies typically address matters such as RF exposure, notification, consultation, visual design and infrastructure sharing. These policies may be adopted at local or national level and have mandatory or voluntary weight, dependent on the regulatory framework of the country.

Increasingly, land use planning and development system embrace public participation in the decision-making process. Communities (sometimes referred to as 'third parties') together with the governmental authority (often the local council), and a project proponent (such as a mobile network operator) engage in a process whereby a change in the use of land or a proposed development are scrutinised. As with all forms of development, the scrutiny can sometimes be objective or subjective, with legal instruments and the political process playing a part in a decision to varying degrees.

Pockets of community resistance against the location of radio base station facilities can be due to concerns about possible adverse health effects of electromagnetic fields (EMF), in particular in respect of children and people who are thought to be more vulnerable; possible effects on property values; visual amenity and other environmental concerns. These concerns may be heightened when a radio base station is to be sited near a community facility such as a school. Where a community perceives itself to be unable to influence a decision, this may provide a focus for opposition.

Planning-based exclusion zone policies

In response to the perceived public opposition to the siting of base stations, some planning authorities or other agencies have proposed to establish planning-based exclusion zones as one policy response, see Figure 1. Once adopted, such policies may provide the basis for a council refusing a planning proposal. Typically, these exclusion zones are imposed in areas around community facilities such as primary or secondary schools, pre-schools, or medical facilities including hospitals.

Planning-based exclusion zones, sometimes referred to 'Buffer Zones' or 'Cordon Sanitaires', are geographic areas generally imposed by local governments and their agencies around community facilities where a radio base station cannot be established. These areas are generally distance-based and are applied without regard for the nature or operation of radio base stations, levels of RF exposure or existing RF sources in the environment.

Figure 1: Illustrative diagram of a planning-based exclusion zone marked as circles around pre-schools (), schools (), hospitals () and emergency services facilities (). Base station sites () within the exclusion zones would be in contravention of the policy.

The choice of distance is arbitrary and has little relationship to the actual RF exposure levels associated with mobile network antenna sites. Measurements in the UK of a sample of base stations showed that exposure levels were generally between 0.002% and 2% of the international guidelines for public exposure and even the highest measured levels did not exceed 10% of the guidelines. This led to the conclusion[10] that:

> *The measurements also demonstrate that there is no scientific basis for establishing minimal distances between base stations and areas of public occupancy, as has been suggested in some countries. There are many sources of exposure to RF fields, and it would in practice have little impact on people's overall exposure.*

10 NRPB (2004), Mobile Phones and Health 2004: Report by the Board of NRPB, Vol. 15, No. 5 available from http://www.hpa.org.uk/

Planning-based exclusion zones should not be mistaken for the compliance zones in the immediate vicinity of radio-frequency transmission equipment at base stations. These areas, see Figure 2, are typically found within a few metres of the transmitting antennas of a radio base station.

Restrictions on access to these areas are typically small in size and may be indicated by RF safety signage at a site and other restrictions. Smaller zones (shown in red) define areas where no person should access. The outer zones (shown in yellow) are areas where RF workers can access but the public should be excluded. Areas without colour are below the public exposure limit.

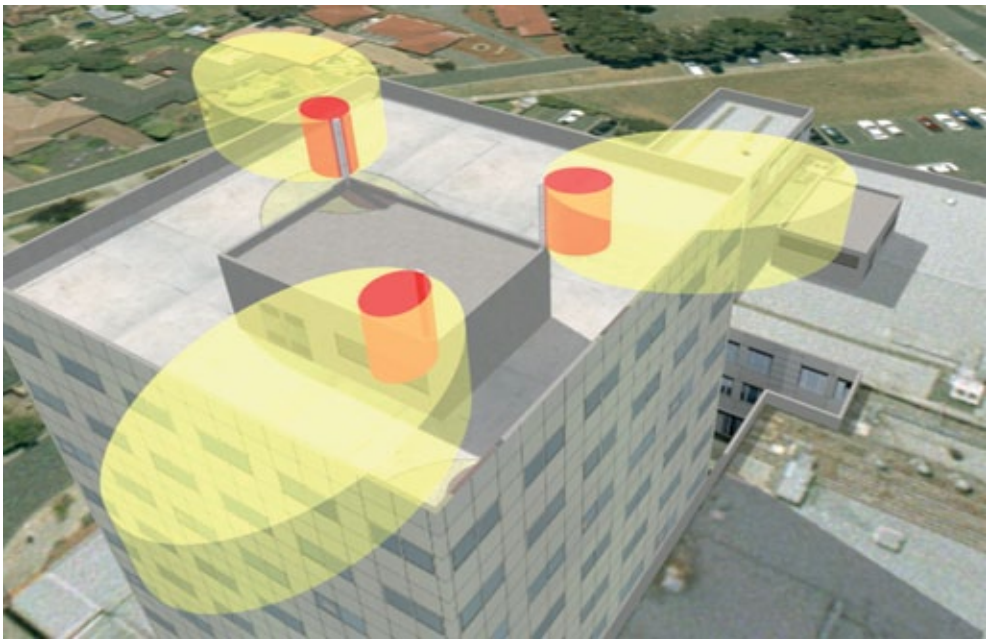


Figure 3: The term "Planning-based exclusion zones" does not include typical Compliance Zones around antennas for the public (yellow) and RF workers (red) shown in the diagram.

Policy makers may claim a number of reasons for applying planning-based exclusion zones around radio base station facilities such as:

1. A duty of care is sometimes cited by schools for the imposition of planning exclusion zones despite the WHO[11] position:

   Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects.

2. The potential for interference with equipment at medical facilities. As base station antennas transmit outwards and not directly downwards, exposures within a hospital from a base station on the roof will be very low. In Australia, there are many examples of radio base stations located on hospitals.

3. Governments may seek to treat RF from radio base stations in the same way as emissions such as airborne pollutants or noise from industry. Planning regulators and environment protection agencies can measure these emissions and can apply physical geographic zones around the source of pollutants to restrict negative externalities. Council policies may seek to treat sources of RF transmissions in the same way but use an arbitrary distance rather than a distance related to an objective assessment of risk. This policy also ignores that the radio signals are intrinsic to providing mobile services rather than by-products.

4. The need for a 'precautionary approach' to potential risks of RF exposure from mobile communication networks. As the UK authorities have noted, choosing an arbitrary planning exclusion distance has little effect on the levels of RF signals. The subject of applying precautionary approaches to RF exposures from mobile communication networks is discussed further in Appendix 9 of this report.

11 WHO, Base stations and wireless technologies, Fact sheet N°304, May 2006, www.who.int/emf

Australian planning exclusion zone policies

There is no national policy of planning exclusion zones for base stations in Australia and no mandatory exclusion zone requirements at state or local government levels. However, there are some examples of non-statutory policies. The government of Australia's most populous region, the state of New South Wales (NSW), has provided a mixed public policy response. In 2010 its State Planning Department[12] introduced a statutory State Environment Planning Policy for mobile base stations referencing the need for operators to comply with the RPS3 RF exposure (ICNIRP) limits. However, since 1997 the NSW Department of Education has applied a policy that limits the distance between the boundary of a school property and a radio base station to at least 500 metres. The Department's policy carries no statutory weight in the NSW council planning process and contains no scientific assessment of the distance. In fact the policy acknowledges that:

> *'While the Department cannot state a specific separation distance between a proposed mobile telecommunications facility and a school or TAFE campus, the Department has a preference for a distance of at least 500 metres from the boundary of the property.'*

The policy has significantly disrupted the deployment of radio base stations when the Department is called upon by communities to intervene. The policy is only applied selectively and many radio base stations continue to be built within 500 metres of schools in NSW.

At the local level, councils in the state of Western Australia have conducted somewhat of a 'bidding war' with more than a dozen metropolitan councils including planning exclusion zones for radio base stations around community sensitive sites within their local planning policies, ranging from 100 metres up to 500 metres. This is despite legal precedent from Western Australia's Planning Tribunal in regard to the City of Swan's telecommunications policy requiring a minimum 200 metre separation from residential buildings.

The Tribunal Member stated:

> *No evidence was led to establish the rationale from any field of discipline to show the basis for such a figure. Without such direct evidence it can only be seen to be arbitrary and in any event Council, as a policy, has the discretion in order to deal with the particular circumstances of each development application.*[13]

In the other Australian states, Victoria, Queensland, Tasmania and South Australia, the application of planning exclusion zones is generally not widespread. In Victoria, and to a lesser degree in the other states, the early introduction of consistent state-wide planning policies for radio base stations acted as a disincentive to local council policies.

It is a myth that exclusion zone policies have been applied consistently in Australia. Even where they exist they have been applied subjectively. There are at least six schools with radio base stations within their grounds, and certainly many more within a short distance. There are more than fifty hospitals with radio base stations within their grounds. In 2011, two Bills were introduced into the Australian national parliament. Senator Bob Brown's Telecommunications Amendment (Mobile Phone Towers) Bill 2011 sought to 'introduce the precautionary principle for the installation of mobile phone facilities, to improve consultation with communities, scrutiny of site choices and expand the opportunities for appeal.' In his second reading speech, Senator Brown sought to 'introduce a 200 metre buffer zone around sensitive sites such as schools and hospitals' without defining 'community sensitive site.' Similarly, Mr Andrew Wilkie, Member for Denison, introduced the Telecommunications Amendment (Enhanced Community Consultation) Bill 2011 requiring that 'the proposed location is not within 100 metres of the community sensitive site.' In the Senate Committee reports on each bill, a majority recommended against adoption of either bill.

12 http://www.planning.nsw.gov.au/policy-and-legislation
13 TPAT: APP 6 of 2003 – Taylor (Hutchison 3G Australia Pty Ltd) and City of Swan, 14 July 2004.

Commentary

Students are not any more or less vulnerable simply by virtue of their congregating in one place (a school or pre-school) than they would be anywhere else in the community. The regulated RF exposure standards afford a wide margin of safety, including for the young, the sick and the elderly. In one year in Australia, students spend about 14% of their total time at a school (primary and secondary)[14], yet schools are singled out in many of the policies for planning-based exclusion zones due to the perception of children's extended periods of time at school.

A policy of singling out mobile network facilities and the need to protect community sensitive locations has little regard for other sources of RF in the community including, but not limited to, emergency services radio, broadcast AM/FM and television and many others. Table 1 shows a comparison of typical RF exposures from a range sources and demonstrates that typical levels associated with base station antennas are comparable to broadcast and many other common sources. This means singling out radio base stations would have little impact on typical levels of exposure to radio signals.

Australia's Radiation Protection and Nuclear Safety Agency (ARPANSA[16]), commenting on so-called buffer zones says:

'…arbitrary distances do not necessarily reflect a precautionary approach. In fact, infrastructure sited further from a community sensitive area may need to operate at a higher power and may result in higher EME exposures in that sensitive area. Furthermore, it must be remembered that evidence gathered by ARPANSA confirms that exposure levels in public areas are typically hundreds or thousands of times less than the exposure limit set by ACMA'

When considering mobile phones, good network quality results in lower output power from the handset and hence lower exposure to the user. Measurements conducted on a live 3G network showed that the most significant factor affecting the mobile phone transmit power was the quality of network coverage.[17]

Source	Approximate Transmitted Power (W)	Exposure Levels (V/m)
Wireless LAN – 2.45 GHz	0.1	3.9 (at 20 cm)
Wireless LAN – 5 GHz	0.2	3.9 (at 20 cm)
Baby monitors	0.5	8.5 (at 20 cm)
Array of base station antennas	1,200	0.1–0.3 (average urban levels)
Typical AM radio station transmitter	50,000	0.4–0.7 (average urban levels)
Typical FM radio station transmitter	100,000	0.4–0.7 (average urban levels)
Typical UHF TV transmitter	1,000,000	0.4–0.7 (average urban levels)

Table 1: Comparative Source Powers and Typical Exposure Levels in Public Areas (adapted from Valberg et al, 2007[15]).

14 Calculation based on up to six hours per day for 40 weeks in school as a percentage of 365 days by 24 hours. School contact hours from Australian state education department websites.
15 Base Stations and Wireless Networks—Radiofrequency (RF) Exposures and Health Consequences Valberg et al., Environmental Health Perspectives, 115(3):416–424, March 2007
16 ARPANSA Fact Sheet Series, No 6 About Mobile Phones, www.arpansa.gov.au
17 Gati et al. Duality Between Uplink Local and Downlink Whole-Body Exposures in Operating Networks, IEEE Transactions On Electromagnetic Compatibility, 1-8, Published Online: 20 September 2010

3

Assessing the impact of planning-based exclusion zones – Methodology

The metropolitan area of Melbourne, in the state of Victoria in Australia, was chosen for the purpose of examining the impact of application of hypothetical planning-based exclusion zones on deployment of radio base stations. The city and case study locations were selected by the GSMA on the recommendation of the consultants, and based on pre-set criteria before the collection of data and analysis was undertaken.

Selection criteria (from GSMA request for proposals):

- Urban area with a population greater than about one million
- Existing comprehensive geographic information system (GIS) data on community facilities
- Existing databases of the locations of mobile base station sites
- The mobile technologies should include GSM900, GSM1800 and 3G/WCDMA (2100 MHz or other bands)
- The city should not have any existing planning-based exclusions on the siting of base stations and the RF exposure limits should be consistent with ICNIRP
- The analysis should distinguish the impacts in dense urban and sub-urban areas.

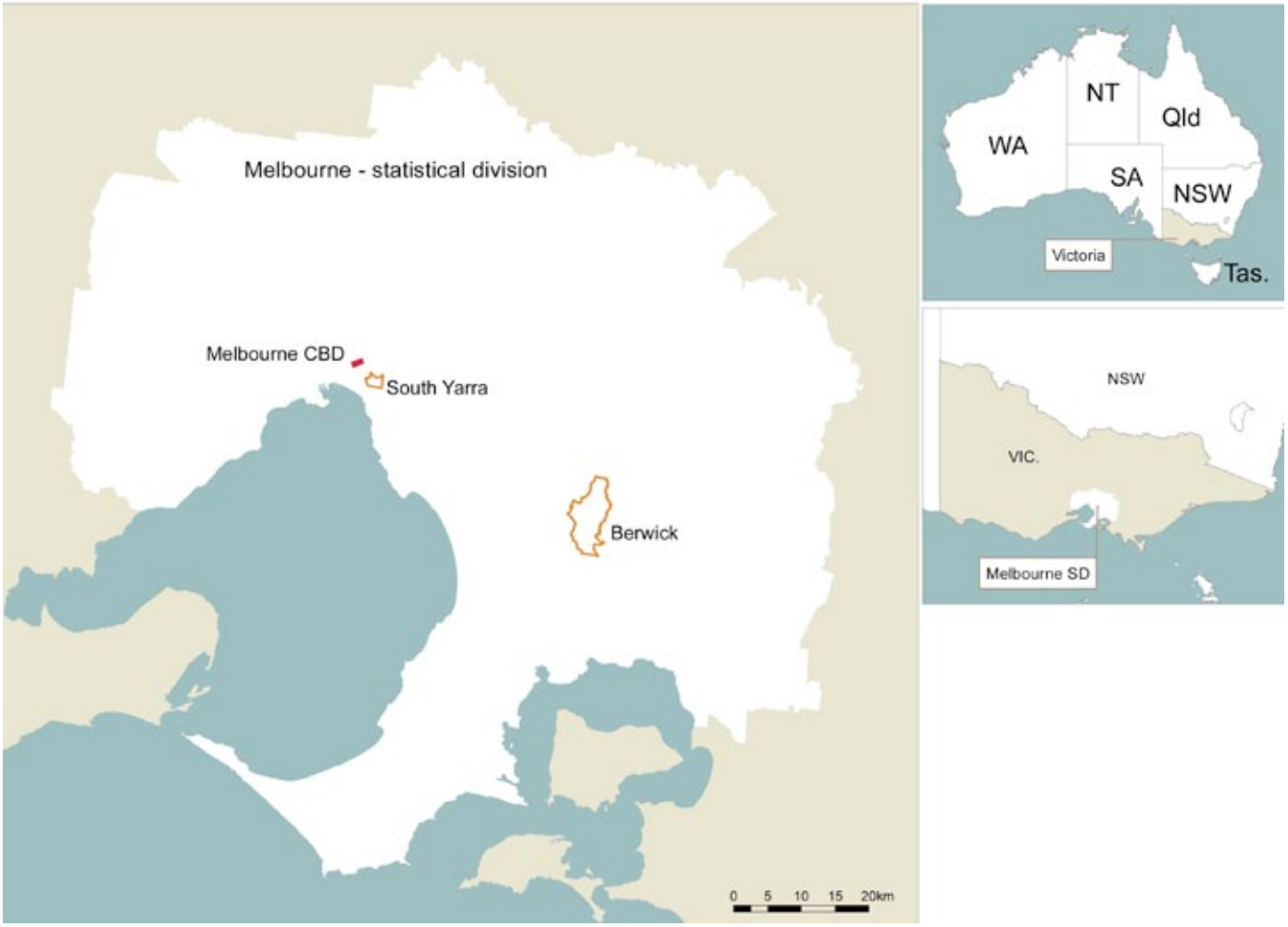
Melbourne metropolitan area

Melbourne is the capital city of the State of Victoria and Australia's second largest city after Sydney. In 2012 Melbourne was ranked as the "world's most liveable city" according to the Economist Intelligence Unit[18]. The Melbourne metropolitan area has a population of 4,077,036 people[19] and has a geographic area of 7,693.82 square kilometres. Figure 4 shows the location of Victoria, Melbourne and the case study locations. Table 2 shows the population, land area and densities of the Melbourne metropolitan area and the two case study locations, South Yarra and Berwick.

	Melbourne	South Yarra	Berwick
Population	Statistical Division	Postcode 3141	Postcode 3806
ERP (30/06/2010)	4,077,036	19,135	50,015
Area sq km	7,693.82	3.5834	41.7490
Population Density (persons/sq. km)	530	5,340	1,198

Table 2: Summary characteristics of Melbourne, South Yarra and Berwick from the Australian Bureau of Statistics National Regional Profile (2010)[21].

18 http://www.eiu.com/liveability2012
19 http://www.abs.gov.au/ausstats/abs@nrp.nsf/lookup/205Main+Features12006-2010



1. Through the Australian industry's Radio Frequency National Site Archive[22] (RFNSA), data on operator facilities is readily available for the Melbourne metropolitan area.
2. GIS data is also available for the Points of Interest (POI) stipulated by the GSMA.
3. Operators in the Melbourne metropolitan area must comply with RPS3, which is consistent with ICNIRP.
4. Melbourne has been 'untouched' by a policy of planning exclusion zones so provides a clean slate to determine the impact of hypothetical policies.

20 ERP = Estimated resident population.
21 Data from http://www.abs.gov.au/ausstats/abs@nrp.nsf/lookup/205Main+Features12006-2010.
22 RFNSA- available at www.rfnsa.com.au.

Case study suburb – South Yarra (inner urban)

A dense urban case study location was required by the GSMA to examine the impact of exclusion zones on an inner urban suburb with higher population densities and a mix of land uses. The suburb of South Yarra and surrounds was selected. South Yarra is a mixed land-use hub located four kilometres to the south-east of Melbourne's central business district. It offers a mix of land uses and forms of development including double storey attached terraces through to apartments at 3 to 10 levels, see Figure 5. It contains a thriving commercial/retail/office area and a range of hospitals and schools. Its scale and housing stock is consistent with urban densities found in many European cities. It was recently named by Melbourne's The Age[23] newspaper as the 'most liveable location' in Melbourne.

Figure 5: Typical street views in South Yarra.

Case study suburb – Berwick (outer urban)

An outer urban case study location was selected to examine the impact of exclusion zones on developing suburbs with large expanses of residential land use and a range of carefully planned services. The suburb of Berwick and surrounds was selected as it is a typical outer suburban locality approximately 46 kilometres south-east from the centre of Melbourne. It is one of Australia's fastest growing suburbs and contains a mix of established residential areas containing low density and mainly detached dwellings, see Figure 6. As a suburb with generally younger families it contains many established and new child care centres and schools, and medical centres. It also contains a regional university and hospital.

Figure 6: Typical views in Berwick.

23 http://www.theage.com.au/victoria/our-liveable-city

Outline of the analysis

To explore the impact of hypothetical planning-based exclusion zones the following tasks have been undertaken:

1. GIS data for mobile network radio base stations and community facilities has been collected. Data for the radio base stations was collected from the publicly accessible RFNSA developed and managed by the Australian Mobile Telecommunications Association. All sites were included in the analysis with no distinction made based on structure type (for example, free-standing pole or roof-top) or power level (microcell versus macrocells).
2. Access to data for community facilities including pre-schools, schools (primary and secondary), and medical facilities, was derived from a GIS data package (Street-Pro[24]).
3. For each of the base stations or community facilities, exclusion zones of a range of pre-defined radii were applied.
4. At each radius the number of affected base station sites or community facilities was calculated and the affected area enclosed by each circle was also assessed.

The GSMA specified distances of 100 m, 300 m, 500 m and 1000 m are based on policies proposed at various times in various locations. Specifically, the analysis examines the impacts if the planning exclusion zone distances around community facilities were applied on both the ability to locate radio base stations and existing radio base stations. The results are presented in tables showing the percentage of radio base stations sites that would be affected and the percentage of urban area where base stations could not be located (refer to Appendices 2, 4 and 6). These results have been further broken down by the frequency of the radio base station (850, 900, 1800 or 2100 MHz).

If applied consistently a planning-based exclusion zone policy would also restrict the development of future community facilities (such as schools) within the defined distances from existing radio base stations. Therefore, tabulated percentage data and maps have also been produced to clearly demonstrate the limitations on development of future community facilities should such policies be applied (Appendices 3, 5 and 7).

Finally, emergency service facilities have been included in the GIS system. This includes police, fire, ambulance and other first response emergency service facilities. These places almost invariably contain radio systems for contact with vehicles and personnel attending to emergencies. These radio systems will often have transmitters with equivalent or in some cases greater power than mobile network radio base stations. If an exclusion zone was to be applied around community facilities such as schools, it may also impact upon a range of other sources of RF including transmitters associated with emergency services. This is also assessed in Chapter 4, on page 20.

24 http://www.pbinsight.com.au/products/data/street-data/

4

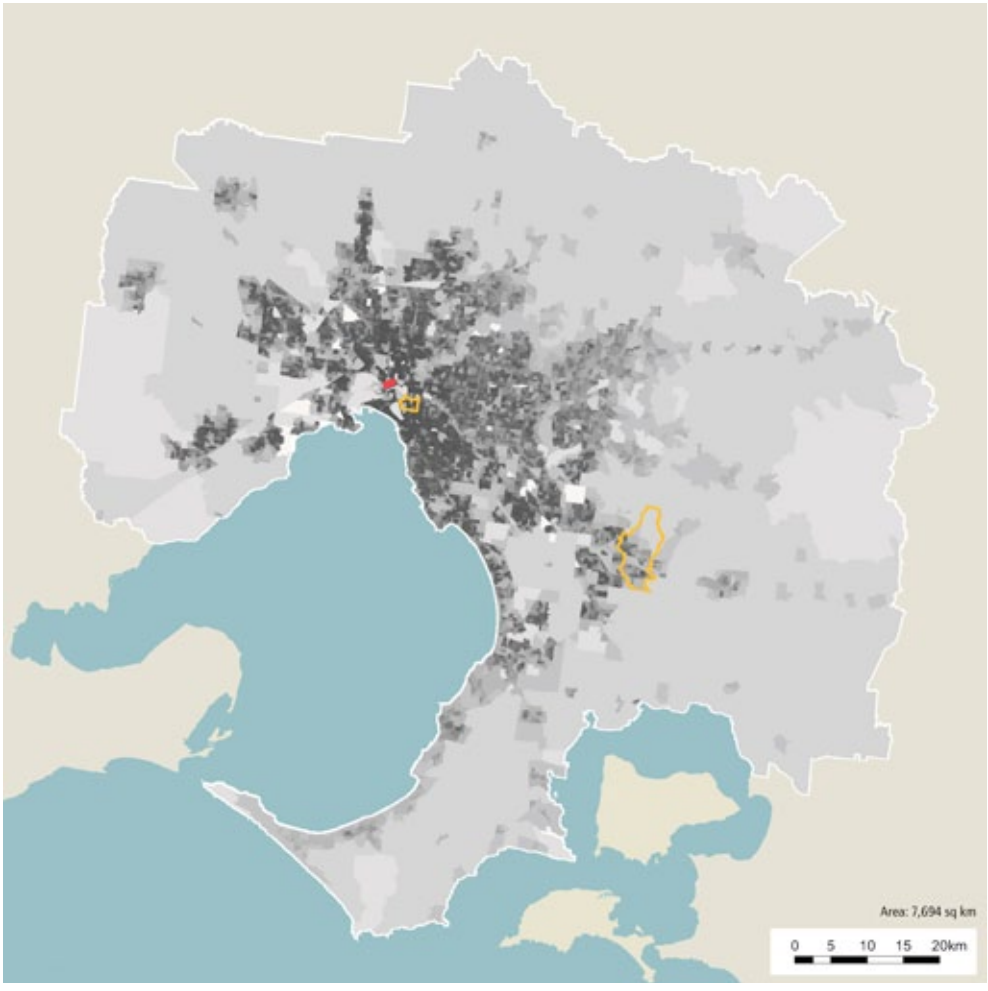
Analysis and results

Overview of the results

The map of the Melbourne metropolitan area in Figure 7 shows the spread of population. As will become evident from the results, analysis of GIS data shows a strong correlation between population densities and the presence of both mobile network radio base stations and community facilities.

Calculations have been done for each of the exclusion zone distances and applied with respect to base stations and community facilities. By way of illustration, we summarise the results and illustrate the impact of such policies with reference to the 500 m case, see Figure 8. Similar observations of lesser or greater impacts will apply to smaller or larger exclusion zones. The complete results are presented in Appendices 2 to 7 to this report.

Figure 7: Map showing Melbourne population density.

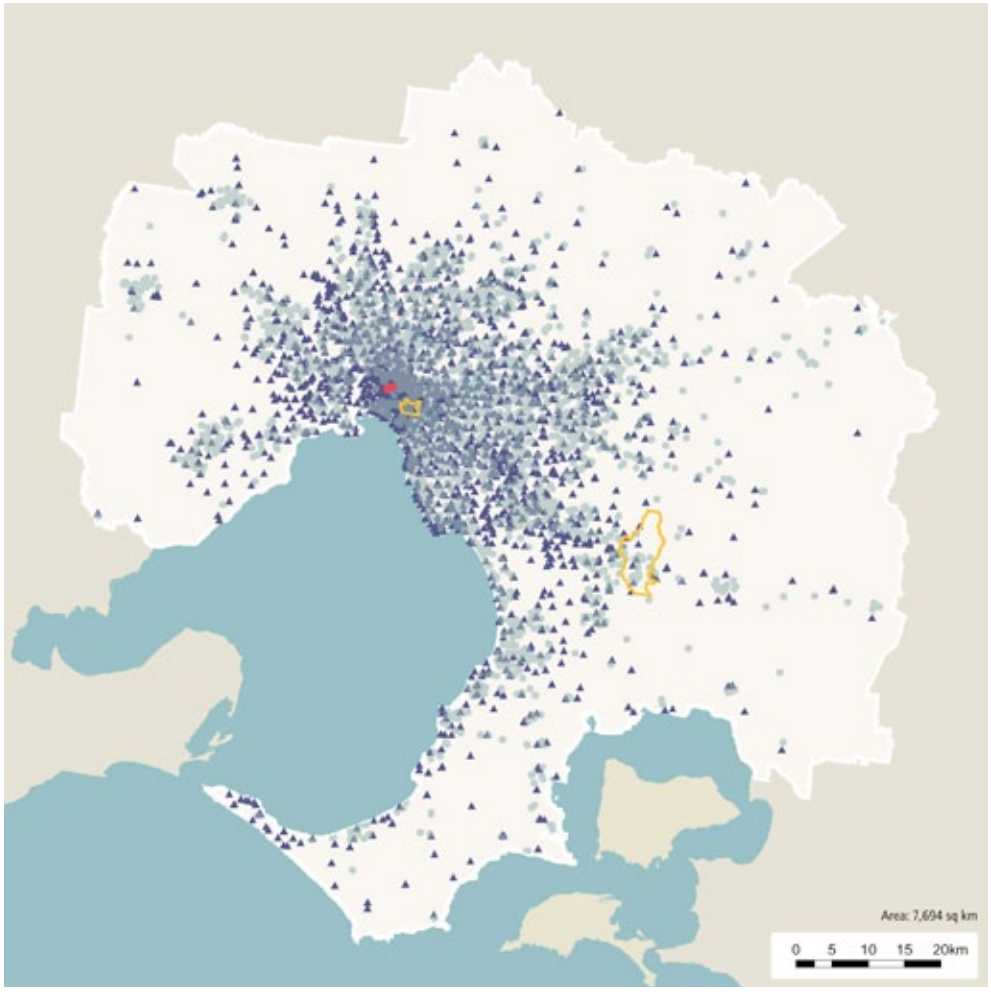


Impact on the Melbourne metropolitan area

The map in Figure 8 illustrates the impact on existing radio base stations of a 500 m exclusion zone[25] if applied around community facilities. Such an exclusion zone would cover 14.5% of the geographic area of Melbourne. However, because there is a clear relationship between population, community facilities and the positions of radio base station, we found that 54.1% of all existing radio base stations in that area (3,102 sites) would be impacted by such an exclusion zone. If the policy was applied retrospectively these would need to be relocated.

If applied by policy makers, the logical implication (for policy consistency) of an exclusion zone is that new community facilities could not then be built within the area affected by the same distanced based exclusion zone surrounding radio base stations, see Figure 9. However, obvious inconsistencies would also be exposed. For example, with the application of a 500 m exclusion zone in metropolitan Melbourne, nearly half (47.8%) of all existing community facilities (pre-schools, primary / secondary schools and medical facilities) would already be located within that exclusion zone. According to Appendix 2, more than 13% of Melbourne's metropolitan area would be excluded from being a future site for a community facility due to its inclusion within an exclusion zone.

Figure 8: Map showing potential impact of a hypothetical 500 m planning exclusion zone policy if applied around community facilities in Melbourne.



Case study areas

Melbourne CBD

Community facility centred exclusion zone + % land covered

Radio base station (RBS)

Triangles mark base station locations and blue/green shaded areas are overlapping 500 m exclusion zones around community facilities.

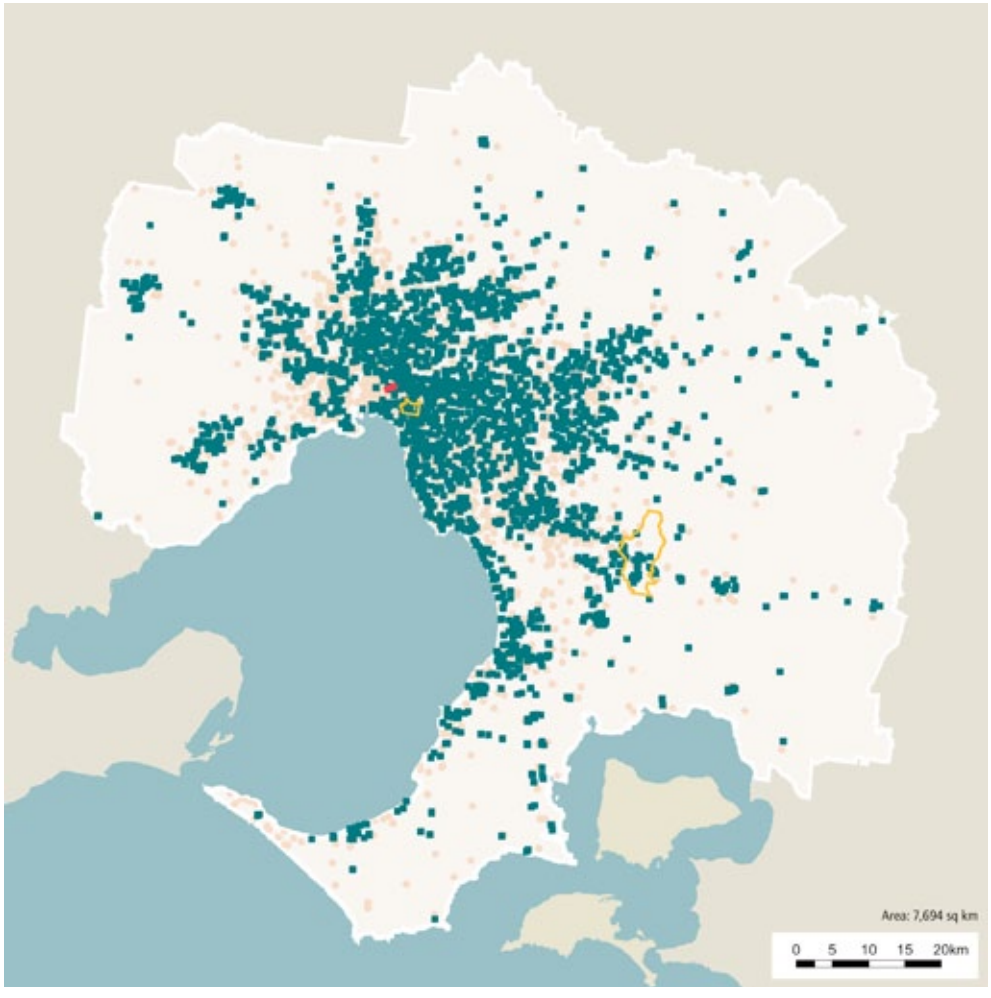
25 Similar to that applied by the NSW Education Department.

Figure 9 illustrates the Melbourne metropolitan area with all community facilities indicated and a 500 m exclusion zone around each base station to show the impact on existing community facilities and the constraints on development of future community facilities.

Impact in South Yarra

An exclusion zone of 500 m around all community facilities in South Yarra would cover 87.5% of the total geographic area of that suburb (Figure 10). As per the table in Appendix 3, more than 92% of existing radio base stations in South Yarra would fall within a 500 m exclusion zone area. If applied retrospectively, mobile telecommunications services in these areas would be extremely limited, particularly during peak periods, and provision of future service to these places would be virtually impossible.

Figure 9: Map showing potential impact of a hypothetical 500 m planning exclusion zone policy if applied around base stations in Melbourne.



Case study areas

Melbourne CBD

Radio base station centred exclusion zone + % land covered

Community facility

Green squares mark community facilities and brown shaded areas are overlapping 500 m exclusion zones around base stations.

The policy would also have the effect of restricting the ability to establish base stations on the elevated building rooftops along major arterial roads such as Punt Road, Toorak Road, Chapel Street and Commercial Rd. Rooftop sites, where available and technically suitable, generally have a lower visual profile than freestanding radio base station equipment. So another consequence of the possible exclusion zones could be the construction of new masts. As can be seen in Figure 10 only some residential areas in the eastern portions of the suburb would potentially be available for the establishment of radio base stations under such an exclusion zone policy. The scenic value of the non-excluded area would make it unlikely that a radio base station could be built.

With its relatively high population density the impact of exclusion zones on siting and development of community facilities is particularly stark in South Yarra. As can be seen in Figure 11 all (100%) of the existing community facilities are within 500 m of one or more existing radio base stations. Even if the exclusion zones are reduced to 300 m, 100% of all existing community facilities would remain affected (refer to Appendix 4).

Figure 10: Map showing potential impact of a hypothetical 500 m planning exclusion zone policy if applied around community facilities in South Yarra.

Community facility
Pre-school
Primary/secondary school
Medical facility
Radio base station

Triangles mark base station locations and blue/green shaded areas are overlapping 500 m exclusion zones around community facilities (marked by individual symbols).

Impact in Berwick

There are seven pre-schools, 14 primary/secondary schools and two hospitals in the Berwick postcode area. There are also 16 radio base stations providing network service. Both the number of community facilities and radio base stations are likely to increase significantly as Berwick continues to expand. The impact on the ability to consolidate existing or establish new base station sites if such a policy was applied in Berwick is currently significant and only likely to increase as the area develops.

If a 500 m zone was applied around community facilities then more than one-quarter (27.1%) of the Berwick area could not be used for base stations. As the map in Figure 12 shows, this area is likely to increase because regions in the northern portions of Berwick area are under-developed.

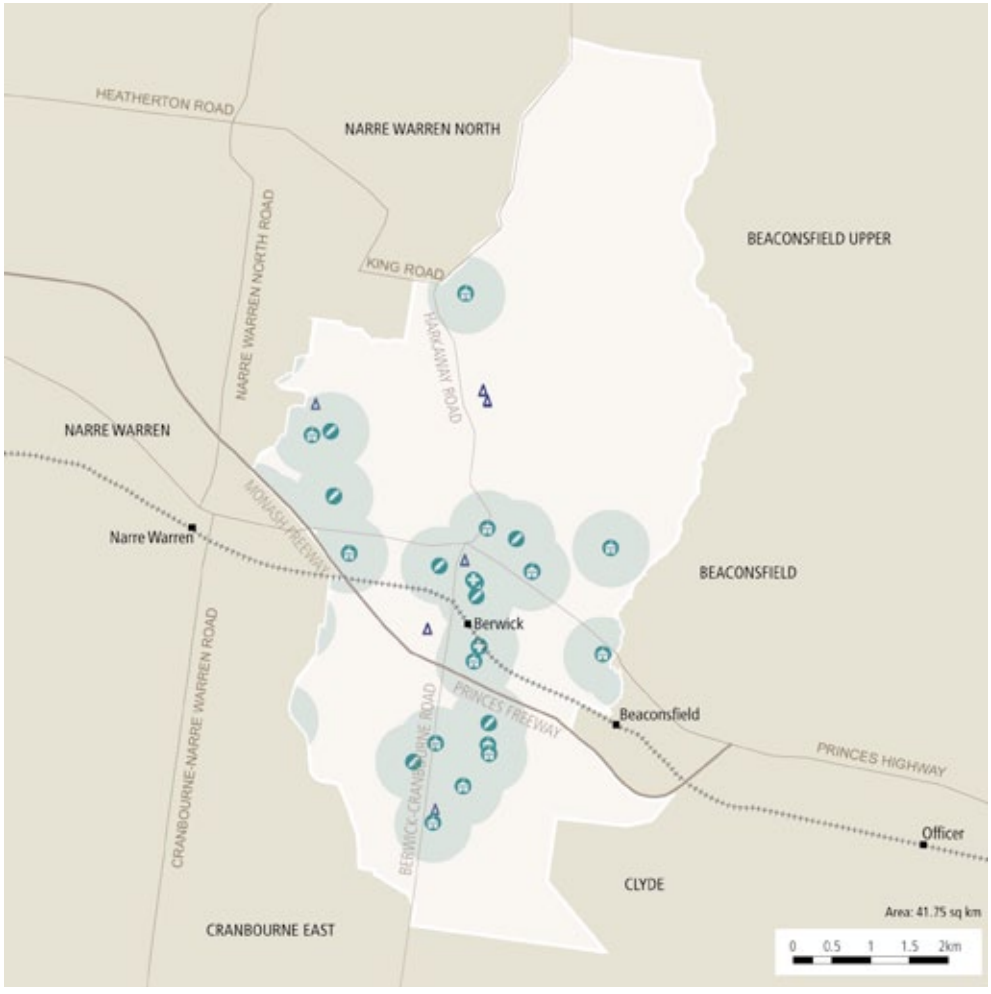
Figure 11: Map showing potential impact of a hypothetical 500 m planning exclusion zone policy if applied around radio base stations in South Yarra.

Community facility
Pre-school
Primary/secondary school
Medical facility
Radio base station

Triangles mark base station locations and blue/green shaded areas are overlapping 500 m exclusion zones around community facilities (marked by individual symbols).

Examining the corollary as shown in Figure 13, there are already 39.1% of all community facilities within 500 m of a radio base station (refer to Appendix 6). As radio base stations are further developed to cater for growth in mobile broadband, the number of places that could be sites for community facilities will become very limited.

Figure 12 Map showing potential impact of a hypothetical 500 m planning exclusion zone policy if applied around community facilities in Berwick.



Community facility
Pre-school
Primary/secondary school
Medical facility
Radio base station

Triangles mark base station locations and blue/green shaded areas are overlapping 500 m exclusion zones around community facilities (marked by individual symbols).

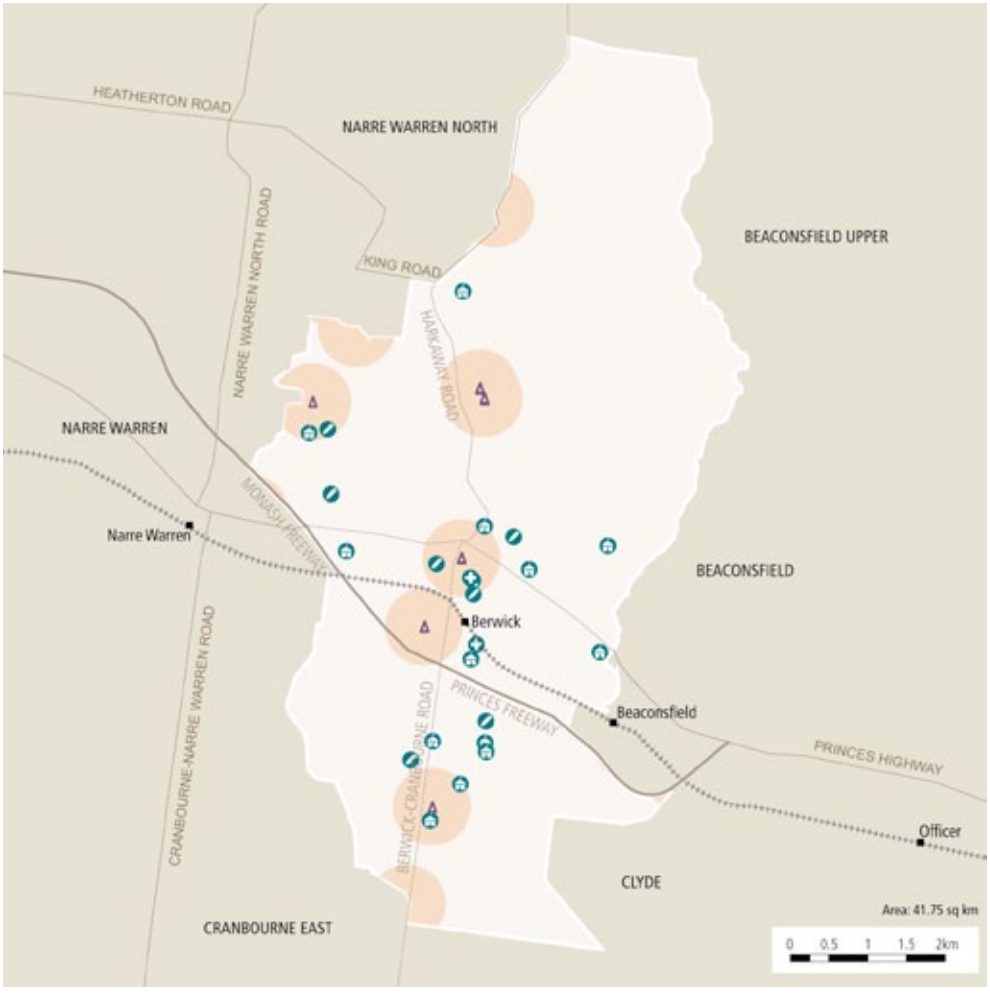
Impact on emergency services

In the Commentary section on planning exclusion zone policies (Chapter 2) we noted that there are many other sources of RF and in public areas typical exposures are often comparable.

Police, fire, ambulance and other first response emergency service stations in Melbourne almost invariably contain radio systems for contact with vehicles and personnel attending to emergencies. These radio systems will often have transmitters with equivalent or in some cases greater power levels than mobile network radio base stations. If an exclusion zone was to be applied around community facilities such as schools, then it may also impact upon a range of other RF sources including transmitters associated with emergency services.

The map of the Melbourne metropolitan area in Figure 14 shows the impact on the location of emergency services, if a 500 m exclusion zone is applied around community facilities. A very large proportion of the emergency service locations would be potentially impacted by such an exclusion zone policy if applied uniformly.

Figure 13: Map showing potential impact of a hypothetical 500 m planning exclusion zone policy if applied around radio base stations in South Yarra.



Community facility
Pre-school
Primary/secondary school
Medical facility
Radio base station

Triangles mark base station locations and blue/green shaded areas are overlapping 500 m exclusion zones around community facilities (marked by individual symbols).

In discussing impact on emergency services, it should also be noted that in Australia 64% of calls to emergency services came from mobile phones[26]. Therefore, reductions in mobile network quality may negatively affect the ability to make successful calls in emergency situations. A recent UK study[27] found that mobile phone reporting compared to landline reporting of emergencies resulted in significant reductions in the risk of death at the scene. This provides evidence of an association between the use of mobile phones to alert ambulance services in life-threatening situations and improved outcomes for patients.

Figure 14: Map showing potential impact on emergency service facilities of a hypothetical 500 m planning exclusion zone policy if applied around community facilities in the Melbourne metropolitan area.

26 Australian Communications and Media Authority (ACMA) Communications Report, 2010-2011 available at www.acma.gov.au.
27 Mobile Phone Use for Contacting Emergency Services in Life-threatening Circumstances, Wu et al., The Journal of Emergency Medicine, 52(3):291–298.e293, March 2012.

5

Conclusion

The metropolitan area of Melbourne, Australia, does not currently have planning-based exclusion zones restricting the siting of radio base stations near to community facilities. In this respect it provides a model to analyse the impact of hypothetical exclusion zone restrictions. While conducted in one urban area, the findings are generally applicable to other countries with similar mobile technologies, frequency allocations and patterns of population density. A limitation of this study is that all base stations types are treated equally. From an RF exposure point of view this is reasonable as the exposure from a microcell or a macrocell is similar due to the greater proximity to the former even though transmitter powers are lower. It is possible that a council could consider applying the policy to only certain classes of base station sites, however, the highest proportion of sites are macrocells and we expect the overall conclusions to remain valid.

The analysis shows the substantial impact of planning-based exclusion zones on the ability to site base stations (and other radio transmitters). It also shows that such a policy negatively impacts the ability to locate future community facilities by effectively excluding substantial areas from consideration as potential locations.

This study assessed the ability to locate base stations and did not directly assess the impact on the quality of mobile service (such as coverage area, dropped calls and congestion) of applying such policies. This could be a further extension of this study and would require the cooperation of mobile network operators to provide additional network configuration information. Nevertheless, it can be assumed that the loss of large numbers of base stations sites would certainly negatively impact mobile services. Reduced service for consumers will also be reflected in lost economic productivity, loss in social utility and potential impact on access to emergency services.

It is entirely understandable that the community and policy makers should question the possible impact of mobile telecommunications technology on the community. As this analysis shows distance based planning exclusion zones are often so restrictive as to be effectively pointless. The approval by a local council of almost any radio base station within the most of the heavily populated parts of a metropolitan area would require a variation to a council exclusion zone policy. Given the extensive impacts on base stations there would be more exceptions than applications of the policy.

Any proposal to adopt and implement such policies retrospectively would necessitate the relocation of many existing sites with consequent requirements for new planning applications in an effort to restore coverage and capacity. This would likely generate significant community concern related to impacts on availability of mobile services and siting base stations in other locations, perhaps closer to homes. It would also generate a significant additional work load for planning officials.

Overall, the many negative consequences mean that distance-based planning exclusion zones are not an effective response to community concerns about siting of base stations.

Positive policy responses include:

- Adopt science-based exposure limits following the recommendations of the WHO and the International Telecommunications Union (ITU)
- Adopt a technical framework so that RF exposures from radio base stations are assessed for compliance and make the results available
- Introduce nationally consistent planning policies for base stations, specifically recognising that nationally adopted RF exposure limits address all established health risks so that health concerns should not be considered by local planning policies
- Ensure the public availability of information about radio base stations in a format that is understandable by communities
- Task agencies with a high degree of public trust with producing material and actively disseminating this to the community
- In the case of disputes, there should be a transparent process with decision-making by an independent body.

Acknowledgements

- Dr Jack Rowley, Senior Director Research & Sustainability, GSMA for oversight of the project.
- The Australian Mobile Telecommunications Association (AMTA) for access to the Radio Frequency National Site Archive.

Appendix 1: Operation of mobile communication networks

Mobile communication services are delivered by a network of radio base station (RBS) sites. Each operator divides the geographic coverage areas into 'cells' and a radio base station provides service to each cell. When mobile users are on the move and travel from one cell to the next, their call connection is transferred between radio base stations by the mobile switching centre (or 'exchange'). If the coverage is not continuous the call will be dropped. A base station can only support a limited number of calls or data, so more radio base stations are needed where there are more users.

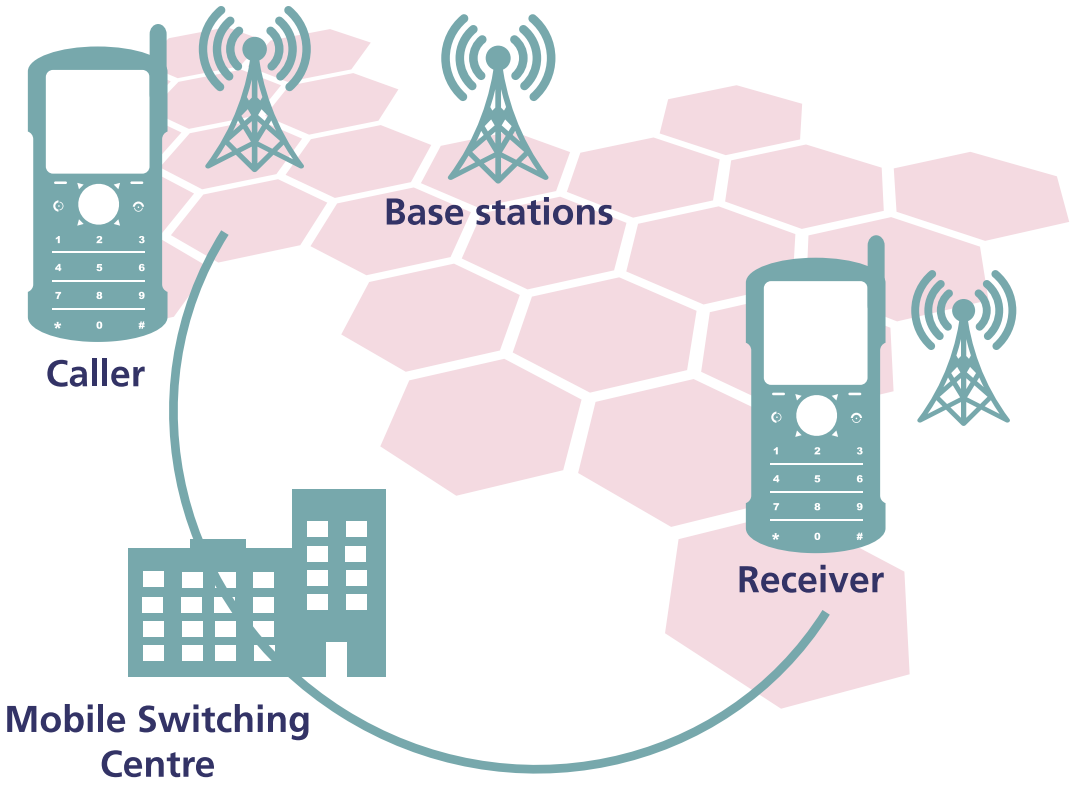
Each base station or antenna site consists of a mast or existing structure to support the antennas and associated transmission and network equipment. The radio signals are transmitted by the antennas and not by the supporting structures.
The number of frequencies available for use by mobile networks is small compared to the number of subscribers so the same frequencies have to be re-used. To avoid interference, base stations using the same frequency must transmit at low power and be separated by distance.

Radio base stations are usually found about 200 metres to 2 kilometres (km) apart in the built up areas of cities and towns and are 2 to 30 km apart in rural and remote areas, but the spacing and size of each cell depends on the local terrain, the frequency of operation and the capacity based on the number of calls or amount of data utilised in an area.

The antennas of a radio base station may be mounted on a new mast, on an existing mast or attached to a building or other suitable structure. The choice of whether to use a new mast or existing building will include factors such as right to access, radio coverage needs and structural safety.

In areas where the use of mobile phone and wireless enabled devices is high, such as business districts, major retail areas and metropolitan areas, sometimes 'infill sites' are required. In addition, the increasing use of mobile devices within buildings has led to the use of in-building systems to provide coverage.

Figure 15: Schematic representation of a mobile communications network.



Appendix 2: Impact on siting of radio base station facilities in the Melbourne metropolitan area

The table shows the impact of differing size exclusion zones around community facilities on the ability to locate base stations in the Melbourne statistical division (SD).

Location	Melbourne
Area	7693.82 km^2
Population	4,077,036
Total of base stations	5,731

Community facilities	Total in Melb SD	All system types	Exclusion zone around community facility			
			100m	300m	500m	1000m
Pre-schools	933	effected all system types - count	86	625	1510	3577
		effected all system types - % of total	1.50%	10.91%	26.35%	62.41%
		area of comm facility exclusion zones - km^2	29.02	248.24	623.06	1582.21
		% of case study area where radio base stations could not be located	0.38%	3.23%	8.10%	20.56%
Primary/secondary schools	1,367	effected all system types - count	116	982	2251	4452
		effected all system types - % of total	2.02%	17.13%	39.28%	77.68%
		area of comm facility exclusion zones - km^2	42.21	342.13	811.68	1911.21
		% of case study area where radio base stations could not be located	0.55%	4.45%	10.55%	24.84%
Medical facilities	196	effected all system types - count	116	487	855	1996
		effected all system types - % of total	2.02%	8.50%	14.92%	34.83%
		area of comm facility exclusion zones - km^2	5.96	50.26	129.46	415.10
		% of case study area where radio base stations could not be located	0.08%	0.65%	1.68%	5.40%
All community facilites	2,496	effected all system types - count	310	1758	3102	4806
		effected all system types - % of total	5.41%	30.68%	54.13%	83.86%
		area of comm facility exclusion zones - km^2	74.57	537.68	1117.54	2125.45
		% of case study area where radio base stations could not be located	0.97%	6.99%	14.53%	27.63%

Appendix 3: Impact on developing community facilities in the Melbourne metropolitan area

The table shows the impact of differing size exclusion zones around base station sites associated with different communication systems on the ability to locate community facilities in the Melbourne statistical division (SD).

Location	Melbourne
Area	7693.82 km^2
Population	4,077,036
Total of base stations	5,731

Band	Total in Melb SD	All community facilities	Exclusion zone around community facility			
			100m	300m	500m	1000m
850 systems	1,307	effected community facility - count	58	372	881	1899
		effected community facility - % of total	2.32%	14.90%	35.30%	76.08%
		area of system type exclusion zones - km^2	35.92	283.70	705.99	1939.15
		% of case study area where community facilities could not be located	0.47%	3.69%	9.18%	25.20%
900 systems	2,236	effected community facility - count	77	426	916	1869
		effected community facility - % of total	3.08%	17.07%	36.70%	74.88%
		area of system type exclusion zones	46.09	331.18	769.84	1971.71
		% of case study area where community facilities could not be located	0.60%	4.30%	10.01%	25.63%
1800 systems	516	effected community facility - count	27	152	369	937
		effected community facility - % of total	1.08%	6.09%	14.78%	37.54%
		area of system type exclusion zones - km^2	12.62	93.80	228.08	688.49
		% of case study area where community facilities could not be located	0.16%	1.22%	2.96%	8.95%
2100 systems	1,672	effected community facility - count	66	439	961	2009
		effected community facility - % of total	2.64%	17.59%	38.50%	80.49%
		area of system type exclusion zones - km^2	40.28	315.37	781.54	1942.13
		% of case study area where community facilities could not be located	0.52%	4.10%	10.16%	25.24%
All systems	5,731	effected community facility - count	109	593	1194	2135
		effected community facility - % of total	4.37%	23.76%	47.84%	85.54%
		area of system type exclusion zones - km^2	64.46	451.33	1017.03	2333.91
		% of case study area where community facilities could not be located	0.84%	5.87%	13.22%	30.33%

Appendix 4: Impact on radio base station facilities in the South Yarra case study area

The table shows the impact of differing size exclusion zones around community facilities on the ability to locate base stations in the South Yarra (dense urban) study area.

Location	South Yarra
Area	3.58 km^2
Population	19,135
Total of base stations	39

Community facilities	Total in study area	All carriers	Exclusion zone around community facility			
			100m	300m	500m	1000m
Pre-schools	4	effected carrier facility - count	0	11	17	38
		effected carrier facility - % of total	0.00%	28.95%	44.74%	100.00%
		area of comm facility exclusion zones - km^2	0.12	0.91	1.91	3.58
		% of case study area where radio base stations could not be located	3.42%	25.35%	53.40%	100.00%
Primary/secondary schools	7	effected carrier facility - count	5	16	29	38
		effected carrier facility - % of total	13.16%	42.11%	76.32%	100.00%
		area of comm facility exclusion zones - km^2	0.19	1.44	2.86	3.58
		% of case study area where radio base stations could not be located	5.26%	40.09%	79.95%	100.00%
Medical facilities	0	effected carrier facility - count	0	1	6	27
		effected carrier facility - % of total	0.00%	2.63%	15.79%	71.05%
		area of comm facility exclusion zones - km^2	0.01	0.23	0.71	2.27
		% of case study area where radio base stations could not be located	0.40%	6.41%	19.93%	63.39%
All community facilites	11	effected carrier facility - count	5	18	35	38
		effected carrier facility - % of total	13.16%	47.37%	92.11%	100.00%
		area of comm facility exclusion zones - km^2	0.29	1.96	3.14	3.58
		% of case study area where radio base stations could not be located	8.17%	54.71%	87.54%	100.00%

Appendix 5: Impact on developing community facilities in the South Yarra case study area

The table shows the impact of differing size exclusion zones around base stations on the ability to locate community facilities in the South Yarra (dense urban) study area.

Location	South Yarra
Area	3.58 km^2
Population	19,135
Total of base stations	39

Band	Total in study area	All community facilities	Exclusion zone around community facility			
			100m	300m	500m	1000m
850 systems	8	effected community facility - count	1	6	11	11
		effected community facility - % of total	9.09%	54.55%	100.00%	100.00%
		area of system type exclusion zones - km^2	0.21	1.54	3.19	3.58
		% of case study area where community facilities could not be located	5.95%	43.01%	88.89%	100.00%
900 systems	20	effected community facility - count	2	11	11	11
		effected community facility - % of total	18.18%	100.00%	100.00%	100.00%
		area of system type exclusion zones - km^2	0.51	2.79	3.56	3.58
		% of case study area where community facilities could not be located	14.36%	77.79%	99.21%	100.00%
1800 systems	4	effected community facility - count	0	2	11	11
		effected community facility - % of total	0.00%	18.18%	100.00%	100.00%
		area of system type exclusion zones - km^2	0.09	0.89	2.46	3.57
		% of case study area where community facilities could not be located	2.43%	24.64%	68.70%	99.72%
2100 systems	7	effected community facility - count	1	9	10	11
		effected community facility - % of total	9.09%	81.82%	90.91%	100.00%
		area of system type exclusion zones - km^2	0.23	1.70	3.30	3.58
		% of case study area where community facilities could not be located	6.39%	47.39%	92.01%	100.00%
All systems	39	effected community facility - count	2	11	11	11
		effected community facility - % of total	18.18%	100.00%	100.00%	100.00%
		area of system type exclusion zones - km^2	0.61	2.83	3.56	3.58
		% of case study area where community facilities could not be located	17.15%	79.11%	99.22%	100.00%

Appendix 6: Impact on siting of radio base station facilities in the Berwick case study area

The table shows the impact of differing size exclusion zones around community facilities on the ability to locate base stations in the Berwick (sub-urban) study area.

Location	Berwick
Area	41.75 km^2
Population	50,015
Total of base stations	18

Community facilities	Total in study area	All carriers	Exclusion zone around community facility			
			100m	300m	500m	1000m
Pre-schools	7	effected carrier facility - count	0	0	3	10
		effected carrier facility - % of total	0.00%	0.00%	18.75%	62.50%
		area of comm facility exclusion zones - km^2	0.22	2.10	5.76	16.62
		% of case study area where radio base stations could not be located	0.53%	5.04%	13.81%	39.80%
Primary/secondary schools	14	effected carrier facility - count	0	1	4	10
		effected carrier facility - % of total	0.00%	6.25%	25.00%	62.50%
		area of comm facility exclusion zones - km^2	0.43	3.69	8.95	22.74
		% of case study area where radio base stations could not be located	1.02%	8.83%	21.45%	54.47%
Medical facilities	2	effected carrier facility - count	0	1	1	7
		effected carrier facility - % of total	0.00%	6.25%	6.25%	43.75%
		area of comm facility exclusion zones - km^2	0.06	0.57	1.56	4.81
		% of case study area where radio base stations could not be located	0.15%	1.35%	3.74%	11.52%
All community facilites	23	effected carrier facility - count	0	2	4	10
		effected carrier facility - % of total	0.00%	12.50%	25.00%	62.50%
		area of comm facility exclusion zones - km^2	0.69	5.26	11.30	23.73
		% of case study area where radio base stations could not be located	1.65%	12.60%	27.06%	56.84%

Appendix 7: Impact on developing new community facilities in the Berwick case study area

The table shows the impact of differing size exclusion zones around base stations on the ability to locate community facilities in the Berwick (sub-urban) study area.

Location	Berwick
Area	41.75 km^2
Population	50,015
Total of base stations	18

Band	Total in study area	All community facilities	Exclusion zone around community facility			
			100m	300m	500m	1000m
850 systems	5	effected community facility - count	0	2	7	14
		effected community facility - % of total	0.00%	8.70%	30.43%	60.87%
		area of system type exclusion zones - km^2	0.16	1.51	4.27	15.53
		% of case study area where community facilities could not be located	0.39%	3.61%	10.23%	37.20%
900 systems	6	effected community facility - count	0	1	5	9
		effected community facility - % of total	0.00%	4.35%	21.74%	39.13%
		area of system type exclusion zones - km^2	0.12	1.12	3.14	11.53
		% of case study area where community facilities could not be located	0.29%	2.68%	7.52%	27.62%
1800 systems	2	effected community facility - count	0	0	0	6
		effected community facility - % of total	0.00%	0.00%	0.00%	26.09%
		area of system type exclusion zones - km^2	0.06	0.57	1.57	6.38
		% of case study area where community facilities could not be located	0.15%	1.35%	3.76%	15.28%
2100 systems	5	effected community facility - count	0	0	2	8
		effected community facility - % of total	0.00%	0.00%	8.70%	34.78%
		area of system type exclusion zones - km^2	0.12	1.09	3.06	11.99
		% of case study area where community facilities could not be located	0.29%	2.60%	7.33%	28.73%
All systems	18	effected community facility - count	0	2	9	16
		effected community facility - % of total	0.00%	8.70%	39.13%	69.57%
		area of system type exclusion zones - km^2	0.19	1.76	4.99	17.94
		% of case study area where community facilities could not be located	0.46%	4.21%	11.96%	42.97%

Appendix 8: Notes

RFNSA Data Quality

The mobile network operators (often referred to as "carriers" in Australia) assume responsibility for the site and transmitter data loaded and maintained in the RFNSA database. Independent RF Assessors validate the data to ensure correctness.

Data collation

The data was collated for the state of Victoria using the AMTA Compliance and Reporting System (CARS) Report generation application to source data from the RFNSA database in a csv[30] format. The sites are listed with fields covering site numbers, address, structure type, latitude, longitude, systems present, carriers present and other relevant information.

Data processing

The processing required for mapping and analysis involved filtering for sites without relevant mobile systems (exclude for example: microwaves, Wi-Fi, smart grid WiMax, and so on). Proposed mobile network systems were not included. Sites were identified by the three carriers. The separate systems and bands were then filtered: that is GSM 900, GSM 1800, WCDMA 850, WCDMA900, WCDMA 2100 and LTE 1800 as noted in the table below.

An additional complication was the existence of two shared infrastructure models. The carrier site counts were summed to include the sites in each of the carriers count as they were present on those sites with that particular system.

Some minor data validation was required for missing coordinates that were interpolated using satellite imagery.

The sites were then overlaid over the Melbourne metropolitan statistical zone and sorted using GIS software.

Band	Carrier A	Carrier B	Carrier C	Shared (A & C)	Joint venture (B & C)
850	WCDMA	N/A	WCDMA	N/A	N/A
900	GSM	GSM/WCDMA	GSM/WCDMA	N/A	N/A
1800	GSM/LTE	GSM/LTE	GSM/LTE	N/A	N/A
2100	WCDMA	WCDMA	WCDMA	WCDMA	WCDMA

30 Comma separated value.

Appendix 9: Risk assessment, a Precautionary Approach and radio base stations

No health hazard has been established from exposure to radiofrequency fields up to the levels recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The Australian Radiation Protection Standard (RPS3) is consistent with ICNIRP. However, in response to public concern and the perceived level of scientific uncertainty, there are continuing calls for the application of the precautionary principle to radiofrequency exposures from radio base stations. A policy including a planning-based exclusion zone is sometimes applied by policy makers as a means of taking a 'precautionary approach.'

The fundamental concept of the "precautionary principle" was summed up in 1992 at the UN Conference on Environment and Development (UNCED) in Rio de Janeiro. Here, the precautionary principle (PP) was explicitly recognised and included in the Rio Declaration. It is listed as Principle 15 among the principle of general rights and obligations of national authorities.

> *"In order to protect the environment, the precautionary approach should be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."*

In 1992, the precautionary principle was incorporated into the Treaty of the European Union (known as the Maastricht Treaty), by name but without definition (Treaty on European Union 1992). Eight years later, in 2000, the European Commission issued a Communication on when and how the precautionary principle should be applied, intending this to build a common understanding (Commission of the European Communities 2000). According to Dolan and Rowley:[31]

> *'…the criteria emphasized the need for policies to be evidence based, proportional to the risks to be controlled, and mindful of the costs and benefits of measures. In the European Commission criteria, we do not see a conflict between the PP and scientific risk assessment. The PP provides a basis in risk management for political decisions about the appropriate actions that society determines are necessary once an uncertain but scientifically plausible risk is identified.'*

The application of the PP requires commitment to the idea that scientific proof of a causal link between human activities and its effect is not required but there must be some plausible evidence of a risk not mere speculation.

In Australia, a Precautionary Approach is applied though the operators' compliance with C564:2011 Mobile Phone Base Station Deployment[32]. This code requires operators to consult with the local community and to adopt a precautionary approach in planning, installing and operating mobile phone radiocommunications infrastructure.

31 Environmental Health Perspectives, volume 117, number 9, September 2009
32 http://www.commsalliance.com.au/Documents/all/codes/c564

In legal cases relating to radio base station siting in Australia, the courts have consistently decided that in the absence of credible evidence of risk, compliance with existing RF exposure guidelines is an appropriate precautionary approach[33]. In a court case involving Hornsby Council and an operator[34] the State of New South Wales Land and Environment Court ruled that a precautionary approach has already been adopted in the Australian standard:

> *'The Australian standard embraces a precautionary approach. The exposure limits set are relative to scientific evidence on the biological effects of exposure to RF EME fields. There are margins for safety in the basic restrictions and associated reference levels. The reference levels are based on worst case assumptions.'*

Legal rulings in Australia have not required the operators to apply planning or distance-based exclusion zones around community facilities as a "precautionary" measure. While the precautionary measures applied by operators in Australia focus on provision of information to communities, research has suggested that information about precautionary measures can have a counter-intuitive impact on the public's risk perception of mobile communication technology[35]. Individuals informed about precautionary measures perceive the risks as being greater than those who were not informed about the precautionary measures.

The approach of over-consulting can also be counterproductive. Wiedemann and Schütz[36] found that providing too much or poorly targeted information about precautionary measures raises public anxiety. Public anxiety is expressed in terms of lack of trust in the regulators and carriers, and increased opposition and complaint.

33 Optus v. CC Kensington and Norwood & Frost. 1998. No. ERD-97-344 Judgement No. OE480. Environmental Resources and Development Court of South Australia, 29 May 1998.
34 [2006] NSWLEC 133.
35 The Impacts of Precautionary Measures and the Disclosure of Scientific Uncertainty on EMF Risk Perception and Trust, Wiedemann et al., Journal of Risk Research, 9(4):361 - 372, June 2006.
36 The Precautionary Principle and Risk Perception: Experimental Studies in the EMF Area, Wiedemann et al., Environmental Health Perspectives, 113(4):402-405, April 2005.

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