Aotea/Great Barrier Island, New Zealand International Dark Sky Sanctuary

An application to:
The International Dark-Sky Association

March 2017

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19 December 2016

Board of Directors
International Dark-Sky Association
3223 North First Ave.
Tucson, AZ 85719
USA

9 Castle Drive
Auckland 1023
Epsom
New Zealand

Dear IDA Board Members

As an IDA member in good standing, it is with great pleasure that I nominate New Zealand's Great Barrier Island for International Dark Sky Sanctuary status.

On my numerous visits to Great Barrier Island to undertake its night sky brightness study, I have been consistently impressed by the sheer beauty, clear seeing and the pristine nature of its night skies. I have previously made a number of visits to Aoraki McKenzie National Park (New Zealand's only IDA certified International Dark Sky Place) and am privileged to have a holiday home located in another IDA certified International Dark Sky Reserve, the Brecon Beacons National Park in Wales. I believe that the night skies of Great Barrier Island are at least as good as the night skies in these two very special places.

The ingrained conservation philosophy of Great Barrier Island, the fact that it has extremely low population density and has no reticulated electricity (minimising any localised man-made lighting) as well as its considerable distance from Auckland city, make the island a unique dark sky location within the Auckland Region (a region which contains a third New Zealand's population).

Great Barrier Island's night skies are an ideal fit for IDA International Dark Sky Sanctuary certification given: a) they meet IDA eligibility criteria; and b) the island's unique natural state and conservation philosophy. Recognition by IDA would help preserve and protect Great Barrier Island's night skies for future generations. It would also encourage appreciation by professional and amateur astronomers, astrophotographers, science educators and domestic and international tourists interested in astronomy, nature and Maori cultural tourism. The commitment of the island's Local Board as well as the enthusiasm of its residents to protect and preserve their pristine dark skies deserve appropriate support.

Given the facts, I hope that you look favourably upon Great Barrier Island's nomination.

Yours sincerely

Nalayini Davies

Member – Royal Astronomical Society of New Zealand (RASNZ)
Member – Auckland Astronomical Society (AAS)
Chairperson – Astronz (established by AAS to promote NZ astronomy and science education)

16 March 2017

Great Barrier Local Board
Auckland Council

International Dark Sky Association Board
c/- John Barentine
International Dark Sky Association

Dear IDA Board Members

As Chair of the Great Barrier Local Board, I am nominating Great Barrier Island, Auckland, New Zealand, as a Dark Sky Sanctuary.

Great Barrier Island is a unique place where the dark sky is protected due to our isolation, the small resident population and the Island being off the grid. Our starry nights and nocturnal environment are exceptional and we want to protect these for the future. We are therefore committed to the IDA Dark Sky principles and requirements for Sanctuary status.

It is difficult to prepare visitors for the experience of Great Barrier Island at night. Although there are 939 residents, there is virtually no outdoor lighting and even indoor lighting is discrete. Because we are off the grid, there is no street lighting, no advertising lighting, and no airport or port lighting. Night lighting on commercial or social premises is for safety and security purposes and is intermittent, with few individual lights a potential issue on the whole island. The Milky Way spans the sky and the depth and brilliance of universe can be appreciated with the naked eye as well as through telescopes.

However, it is protection of the quality of our night sky that has driven this application. With the advances in technology, we need to ensure inappropriate lighting generated by off the grid power sources does not spoil our night sky. We have worked with Auckland Council planners to ensure regulation is in place to prevent future pollution, specifying light brightness, light direction and light curfews. This will come into force in the next few years and in the interim, the Local Board will work with business/land owners to encourage and ensure compliance where it is necessary.

Nearly 60% of the island is in public ownership under the stewardship of the Department of Conservation and Auckland Council and the ethos of environmental protection and enhancement is well embedded in the community. The support for this application has been strong and widespread. Local residents, including children, do not need the level of education about dark sky protection that visitors need - off the grid power is precious and sparingly used. However, for visitors it is a different matter. The Local Board is committed to telling the story of our night sky protection through public information, and developing ideas such as a compliance star rating system for businesses, and a night sky star rating system at public viewing sites across the Island. We will also encourage visitors to come to experience the night sky where there is no light pollution – astro tourism fits well with our focus on eco-tourism.

The preparation of this application has been an education in itself. It has made us realise how dark our sky is and how well it is currently protected – something as residents, we expect and take for granted. It has made us realise how important it is to care for and future proof this asset. Nearly 1.5 million Aucklanders are on our doorstep, 100km across the sea, yet there is almost no light spill. Our Sanctuary status would provide an impetus for them to not only visit and help build our economy, but also to visit to learn more about the stars and planets, and the importance of dark sky protection.

The International Dark Sky Association is providing the world with a great service in ensuring there are pockets of Sanctuaries, Parks, Reserves, Communities and Developments of Distinction where light pollution does not impact on the sky and where the dark sky is protected for present and future generations. Sanctuaries are remote and dark, and Great Barrier Island's administrative authority, the Local Board, is committed to ensuring we remain within Sanctuary status requirements. I would like to thank John Barentine for his help in preparing our application and I look forward to working with you in the future to showcase your work and ours in minimising light pollution and protecting the night sky.

Thanks and regards

Izzy Fordham
Chair, Great Barrier Local Board

Executive Summary

The Great Barrier Local Board, a governing community committee of Auckland Council, is applying to the International Dark-Sky Association for the status of International Dark Sky Sanctuary for Aotea/Great Barrier Island.

Great Barrier Island's night skies are exceptionally clear and dark. Extensive readings show there is no effect from light pollution from Auckland – and no light pollution from human activity on the island. With sky quality measurements averaging mpsas of 21.79, Great Barrier Island is comfortably above the 21.5 mpsas required for Sanctuary status. This average is on a par with New Zealand's only other certified area, Aoraki McKenzie, which at 21.72 is sufficient for Gold standard certification.

From the dark sky of Great Barrier Island you can enjoy the full splendour of the southern hemisphere night sky.

A thick Milky Way traverses the evening sky. Several thousand stars are visible to the naked eye plus numerous binocular and telescopic deep sky objects such as star clusters. In the southern sky the Large Magellanic Cloud and Small Magellanic Cloud, our nearest galaxies, are easily visible to the naked eye. Crux, the Southern Cross, and the rich fields of the Southern Milky Way are visible all year round. It is a special sky viewed from a special place.

The Great Barrier Local Board represents a unique community – one that has always lived off the-grid. There is no electric cable to the Island and as electric power is precious, outdoor lighting is minimal - few sites on the island have been identified as having any outdoor lighting. As a result of this, and the island's location 100km off the coast of Auckland, the skies are not spoilt by light pollution. The 939 residents on the island appreciate what they have and are fortunate in having regulation in place, or pending, to protect their extraordinary night sky in line within IDA guidelines.

Although Great Barrier Island has a permanent population, 56% of the island is in public ownership, largely as part of New Zealand's Conservation estate. All public road, and most coastal beaches, are bound by a reserve, allowing parking across the island for public night sky viewing. Privately owned land, much of which has difficult access, will not be impacted as exceptional viewing points are readily available on public land.

Regular unsupervised visits by the public to view our night sky are not only possible but will be actively encouraged. Although the island is distant from Auckland, it is well serviced by daytime flights and ferries. Employment options for residents on the island are limited and astro-tourism, along with night sky education, provides opportunities for sustainable development and growth. Astro-tourism also fits well with the environmental preservation and enhancement ethos of the island.

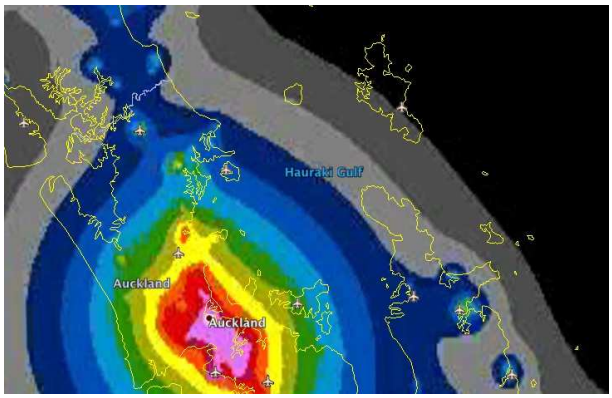
Great Barrier is a perfect place for an International Night Sky Sanctuary. Remote, yet accessible. Inhabited yet dark. Dark and protected. We hope our application is successful so the beauty of our skies is recognised and protected for all in the future.

Application

1. Aotea/Great Barrier Island – Our place in the Hauraki Gulf, Auckland

Great Barrier Island is situated in the Hauraki Gulf, 100 kilometres northeast of Auckland. The nearest landmass is the Coromandel Peninsula 9.4km away, a sparsely populated, mountainous area with a small farming community. The nearest city is Auckland with a population of nearly 1.6 million. As satellite modelling shows, Auckland is the only potential source of light pollution for Great Barrier Island.

The island is 288 square kilometres, nearly 45km long, and is 2km to 12km in width East to West. It is the sixth largest island in New Zealand.



Great Barrier Island has a diverse and beautiful landscape, from beaches to sheltered bays, steep forest- covered hills to mangrove estuaries and diverse wetlands. The island has no externally- provided electricity supply, no local banking facilities, no supermarkets, footpaths, streetlights or public transport. Residents are proudly independent and innovative.

1.1 Our night sky

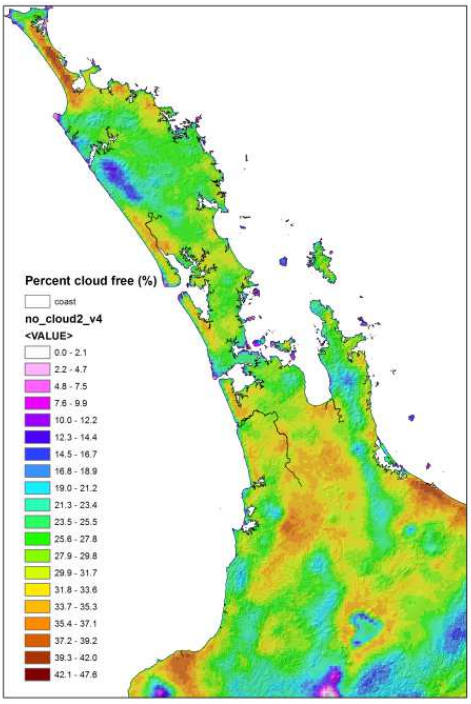
Although computer modelling suggests the South West of Great Barrier Island should be impacted by light pollution from Auckland City, extensive testing proves otherwise. Being an island, Great Barrier Island has the advantage of a natural barrier – the sea.

The nearest landmass is Coromandel Peninsula. Light from the North Eastern portion, facing Great Barrier Island, does not impact on Great Barrier Island, as computer modelling shows. The public road around part of the Coromandel Peninsula is unsealed, with no street lighting. The resident population of the Northern tip of Coromandel past Colville, is 168. Lighting is distant and limited to normal household use.

Auckland City does produce a minimal light dome on the Western horizon. However, stars and planets are visible on the horizon and readings of 21.9 on the Western side of the island show the impact is virtually nil.

Great Barrier Island residents live with a spectacular night sky. The Milky Way spans the skies and the Magellanic Clouds, unseen in the Northern Hemisphere, are visible. The air is clear and

transparent and although there is no data for night-time clear skies, day-time records suggest this will be close to 30%. The night sky is a sight residents already share with visitors, but the special nature of our island sky deserves to be shared with the world.



1.2 History

Great Barrier Island (Aotea) has a rich history dating back to the initial settlement of New Zealand by the East Polynesian ancestors of today's Maori population.

Great Barrier Island is the ancestral land of Ngāti Rehua Ngātiwai ki Aotea (Ngati Rehua being the sub-tribe of the wider Ngatiwai tribe.) Ngati Rehua people living on the island today trace their association back over many centuries. Evidence of this long history can be found in the island's many archaeological sites, generally found in coastal locations. They include pa (earthwork fortifications) with extensive defence and habitation features, terraced agricultural and settlement sites, groups of storage pit depressions, middens (food waste deposits), and stone-working sites. Some of the middens date to the earliest period of occupation, and provide information on past food sources and the environment.

Captain James Cook named the island Great Barrier in 1769 for the shelter and protection it provides to the Hauraki Gulf. From the 1840s, the island's natural resources attracted European settlement, A number of boom and bust industries exploited the island's forests, minerals (copper, silver, gold) and migrating whales.

Descendants of the early settler families still live on Great Barrier Island. Roads are named after the Blackwells, Medlands and Sandersons, and some families have been continuously on the island for more than 150 years. Old homesteads can still be seen with Ollies Cottage, built in the 1860s, still standing at Puriri Bay and homesteads at Harataonga, Tryphena, and Port Fitzroy reminding visitors of colonial times. Tryphena School was built in 1884 and is now used as a community service building.

1.3 Maori astronomy

Māori, the indigenous people of New Zealand, had an extensive knowledge of the night sky. The movements of constellations, the heliacal rising of stars, the arrival of comets, the phases of the moon and many other astronomical phenomena were noted and examined. This detailed astronomical knowledge resulted in Māori having a precise understanding of the seasons and helped Maori ancestors navigate across the vast expanse of the Pacific Ocean.

The night sky is deeply woven into Maori culture. Stories of a mythical nature were often used to make sense of the sky and to help memorise and pass on astronomical knowledge.

Astronomy was used in everyday Maori life, particularly for gathering and planting food, and calculating the seasons. The stars that rise just before the Sun comes up vary in time by four minutes a day and could therefore be used to calculate the changing seasons. So if it's winter, Takurua (Sirius, the Dog Star) comes up just before the Sun; Rehua (Antares - the brightest star in the constellation Scorpius) comes up just before the Sun in summer. Rākaunui (the full Moon) was the time to plant crops because the Moon was thought to draw water nearer the surface.

The rise of the Matariki or Pleiades constellation in the celestial skies above Aotearoa New Zealand signalled not only a change in season - the arrival of the winter solstice and the countdown to spring and summer – but the start of the New Year. Māori tohunga / learned elders would go out in the early morning before first light to wait for the moment when the constellation rose before the dawn light. The twinkling of the stars helped them predict the weather for the coming season.

In traditional times, Matariki was a season to celebrate, and prepare the ground for the coming year. It was an important event on the lunar calendar that the Māori followed for planting, fishing and trapping game.

New Year celebrations provided the opportunity for communities to come together, acknowledge the year gone by and look towards the year ahead. This involved the sharing of kai (food), kōrero (stories), rituals and entertainment.

Matariki celebrations were held from pre-European settlement through to the 1940s when they dwindled in popularity. In recent times, celebrations were revived and have now become a special time of the year to celebrate the unique place we live in and to show respect for the land we live on and the sky we live beneath. Matariki festivals have been held on Great Barrier for the last eight years (http://maoriastronomy.org.nz).

1.4 Physical geography

Great Barrier Island (Aotea) consists of 23 islands and rock stacks. The terrain varies from sea level flats and wetlands to the exposed rocky outcrops. The island acts as its name suggests: as a barrier for Auckland and the inner islands of the Hauraki Gulf from the stormy weather originating from the east and north east.

Great Barrier Island originally formed a continuation of the Coromandel Ranges. It has the same rugged landscape and strong north-south axial range. In the centre of the island are spectacular pinnacles and

bluffs peaking at the highest point, Hirakimata (Mt Hobson) at 621m. These ranges run straight down to the sea on the western side which is characterised by a number of indented harbours and bays. Port Fitzroy is the most sheltered harbour, showing its origin as a drowned river system.

The eastern side is gentler and features coastal flats and long white sandy beaches with extensive dune systems forming wetlands due to tidal creeks backing up behind them. Some of these are now drained for pasture. Predominantly volcanic in origin, ancient sedimentary rocks underlie the entire island. Fossil evidence shows the sedimentary sandstone and mudstone are about 150 million years old with the conglomerate granite coming from West Antarctica (or Eastern Australia) prior to separation of New Zealand from Gondwanaland.

As the Australian and Pacific tectonic plates continue to move, the eastern of the two chains formed in Northland extends from Whangaroa through Whangarei and Great Barrier Island to the Coromandel Peninsula. Hot springs are found at Kaitoke and at other points on the island.

Slopes of more than 10 degrees and frequently more than 26 degrees occur over 84% of the island. The rolling, undulating and near-flat land farms and wetlands make up the remaining 16%. Although extensively cleared in the past for farming and settlement, the predominant aspect today is of regenerating 'scrub' of kanuka and manuka forest.

1.5 Flora and fauna

Great Barrier Island has been fortunate – the introduced pests that have done so much damage to the flora and fauna of mainland New Zealand have never been present on the island. Although ship rats, cats and dogs are present, there have never been possums, deer, wallabies, ferrets, stoats, weasels, hedgehogs and Norway rats. Much effort is put into controlling pests on the island, and ensuring others do not arrive.

Many plants that have survived on Great Barrier are absent (or occur only in low numbers) on the Auckland mainland. The unmodified coastal dune systems make the island one of the most significant sites for plant conservation in Auckland. There are three threatened plants found only on Great Barrier: an endemic känuka, the Great Barrier Island daisy and a hebe.

Bird life and other fauna on Great Barrier are also rich and varied. There are 13 species of lizard – many more than other parts of New Zealand – and an impressive variety of birds, many of which are threatened species. The chevron skink is one of New Zealand's largest and rarest lizards, and is found only on Great Barrier and Little Barrier islands. Birds found on Great Barrier include black petrel, New Zealand dotterel, variable oystercatcher, North Island käkä and banded rail. The island is home to about three quarters of New Zealand's brown teal (päteke) and is vital for the conservation of this nationally threatened species. Seabirds such as little blue penguins, many petrel species, gannets and albatross are also seen off the coast. All of these are protected species.

Marine mammals such as whales and dolphins are often seen off the Great Barrier coast. These include the common and bottlenose dolphins, orca, Brydes whales (that breed and feed in the Hauraki Gulf), and migrating whales such as humpback, minke and sei whales. Other protected species such as the leopard seal, New Zealand fur seal and large sea turtle, may also be seen along the coastline.

1.6 Land ownership and community

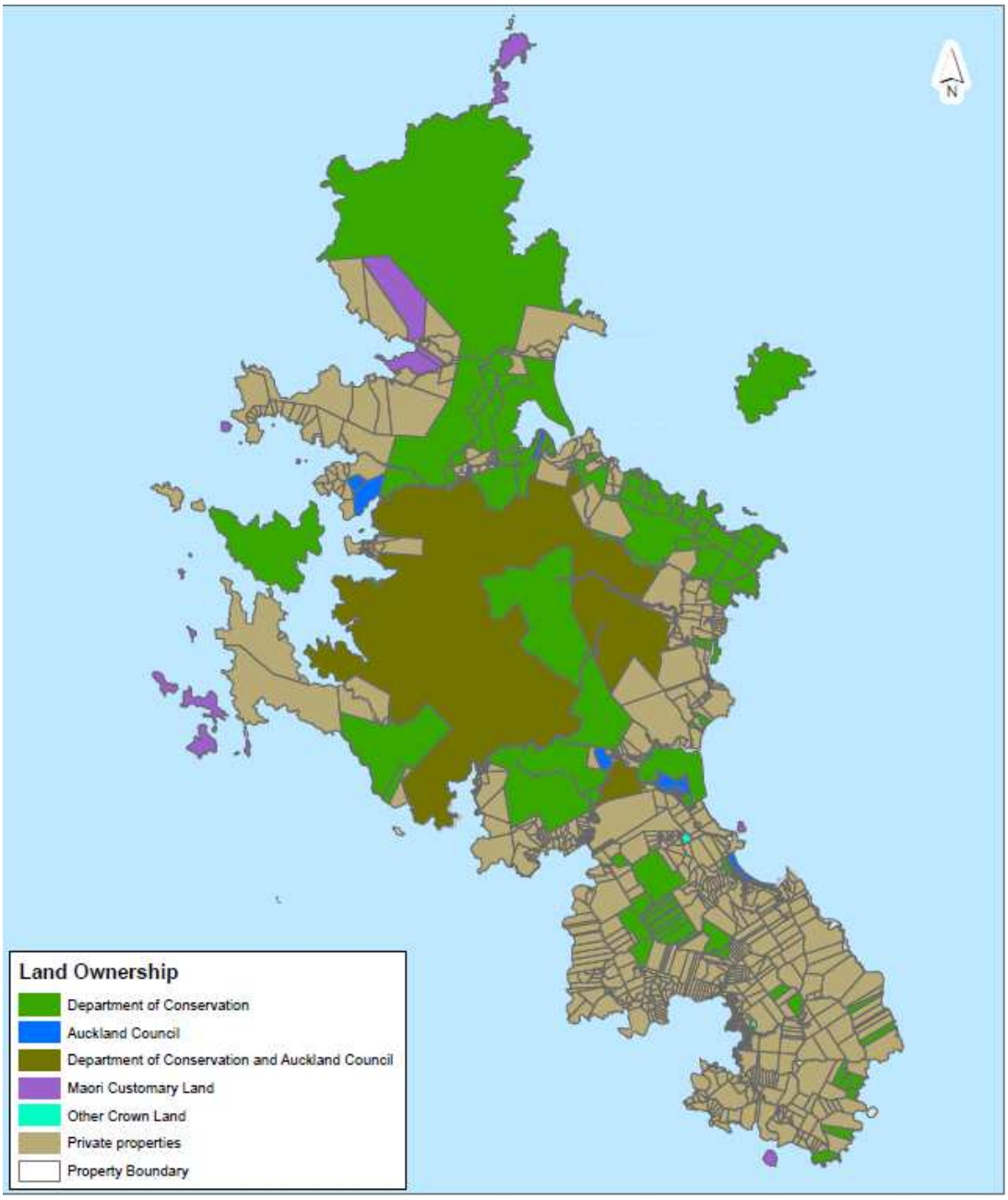
This application is for the whole of Great Barrier Island to be recognised as a Dark Sky Sanctuary, with regular night-time access and visitation by the public, with or without supervision, is possible across the island.

Fifty six percent of the Island is under the stewardship of the Department of Conservation or Auckland Council (DOC) and is publicly accessible, publicly owned land. This land is accessible at night time with two DOC huts sleeping up to 28 spaced out on a three-day walk through the Conservation Park and 6 camp grounds spread throughout the Island (Attachment 7). In addition, the 56km of sealed roads and 49.6km of unsealed roads are bounded by a "road reserve", which is also public land. The Island's beaches are also freely accessible by right as beaches, and often the surrounding land, are part of a defined coastal reserve.

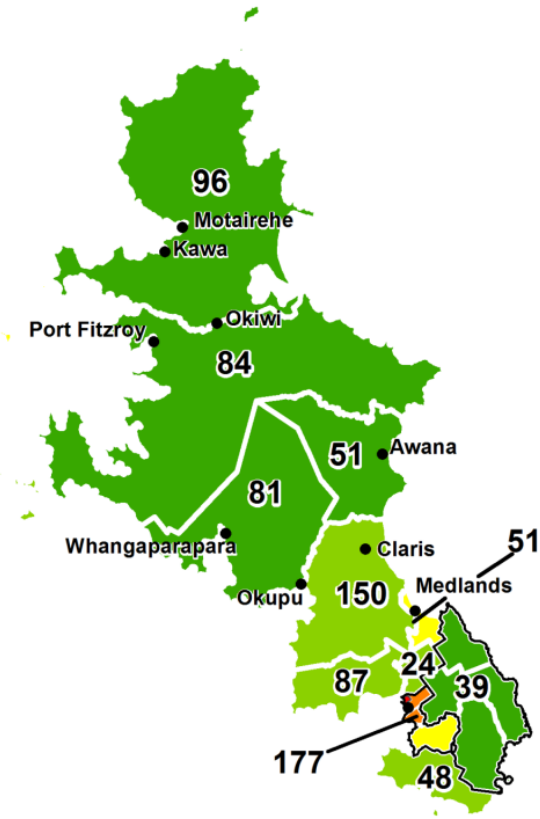
Although 44% of the island is in private ownership and therefore not freely accessible to the public, the amount of land, and spread of land, in public ownership means there is easy access to public land for viewing of the night sky right across the island. This is where Great Barrier Island is very different from many other places: private land is limited to just under 1500 private titles and is interspersed with public land reserves, as well as the majority of the Island being held in public ownership. Maps showing the extent of public land at both Medlands and Tryphena, the most densely developed areas on the Island, are attached as Attachment 5. These areas also cater for the bulk of the visitors to the Island who will benefit from the multiple viewing sites.

Land ownership	**Area in square kilometres**	**Percentage of total land mass**
Auckland Council	2.35	56%
Department of Conservation	100.83	
DOC and Auckland Council	58.55	
Other Crown Land (Schools etc)	0.13	
Maori Customary Land	5.99	2%
Private properties	121.00	42%

**Figures based on title area and may exclude road and coastal reserves*


N
Land Ownership
Department of Conservation
Auckland Council
Department of Conservation and Auckland Council
Maori Customary Land
Other Crown Land
Private properties
Property Boundary

The population of 939 (2013 Census) is well spread over the island. Private land is predominantly in the south of the island. There are only 501 occupied private dwellings on the island and 44% of all households are people living on their own.



Almost half (47.2%) of all dwellings on Great Barrier were unoccupied at the 2013 Census, reflecting their use as holiday homes. While settlements on Great Barrier Island are scattered there is a strong sense of community spirit.

Under the Auckland Council District Plan, future development is restricted to settlement areas in Tryphena, Medlands, Okupu, Claris, Awana, Port Fitzroy and Motairehe. Businesses operate from Tryphena, Claris, Okiwi and Port Fitzroy and are predominantly in the service sector. Most businesses, including grocery stores, only operate during the day and have no outdoor lighting at night.

The island is accessible by vehicular ferry or by plane. A ferry with a capacity for 20 cars and 196 passengers operates five days a week in summer and three days a week in winter. Two main airlines service Great Barrier Island with 20 and 9 seater planes running three scheduled flights a day in winter, and six or more flights a day in the height of summer.

During winter, visitor numbers drop from 12,000 per month to just 2,500 per month. Due to the reduced economic activity this brings, many businesses close or reduce their hours. Even community facilities such as the two social clubs open only 3 or 4 days a week. The residents are used to darkness and do not want their dark skies spoilt and for visitors, it is part of the Island's charm. Increased tourism provides an opportunity to educate visitors as to the value of lighting regulation to protect what we have and to show that lifestyle needs not be compromised in the process.

The spread-out, low density population on Great Barrier Island means there is no light pollution from households or business, and, as demonstrated by dark sky measurement, the human impact on night sky viewing is nil.

1.6.1 Extending the Sanctuary Status to the entire Island

Great Barrier Island is an exceptional place, and our application for Dark Sky Sanctuary Status for the entire Island may fall outside the normal framework of the IDA's definitions. Critically the proposed sanctuary would include both public conservation and reserve land (56% of the Island) and private land (44% of the Island). Thus not all the area of the Island can be legally restricted for scientific, natural, education cultural, heritage and/or public enjoyment purposes.

However, private land, which usually consists of large unoccupied blocks, is surrounded by and interlaced with public reserves and public land. Multiple sites on public land have drive-on access, flat land and toilet facilities making them ideal for astronomy enthusiasts or for public enjoyment of the night sky. Thus, the distinction between public and private land has no real effect on access to suitable sites for the public to

view the night sky. Further the quality of light readings between the designated public areas and the areas in the middle of private settlements was identical—there is no appreciable difference in the quality of night sky observations between the two areas.

The lighting use on smaller private titles in the settlement areas easily falls within the technical standards required for Dark Sky recognition. There is no grid power on the Island; no street lights; no after-hours advertising; no permanent parking lot lighting; minimal commercial lighting and no appreciable external commercial lighting; a de facto curfew applies as no public venues operate outdoor lighting to any appreciable affect after 10:00pm on any but a few days each year.

The Department of Conservation estate requires no further protection. The estate is undeveloped with no outdoor lighting. Similarly, the Auckland Council reserve areas, which include roads, coastal reserves, and recreational reserves, have no lighting.

The dark sky quality of the Island will be protected in fact by bringing the private land within the ambit of the sanctuary. We see this fact as a vital reason for extended sanctuary status to the entire Island.

Public access is assured across the entire Island with the exception of the northern conservation estate which is limited through the density of the forest cover. The local board is proposing a policy of designated night sky places across the Island, where appropriate facilities and signage can be provided. However, with immediate effect, public night-time access is readily available at numerous sites: Port Fitzroy wharf and reserve; road reserve parking bays at various sites along Aotea Rd from Port Fitzroy in the north to Okiwi; Okiwi Reserve; Okiwi Airfield parking lot; DOC beach front reserve, Mabey's Rd Whangaparoua; Motairehe beach front reserve; Kawa beach front reserve; Orama settlement/ OPC Centre, Karaka Bay; Whangaparoua DOC beach front camp-ground and reserve; Harataonga DOC reserve and camp-site; Awana beach reserve; Aotea road reserve parking spaces south of the naval station; Great Barrier Sports and Social Club, Claris; Whangaparapara wharf reserve; Claris airfield parking area; Claris Arts & Heritage Village; Medlands Beach reserve; DOC camp-ground Medlands; parking spaces Medlands Rd between Medlands and Tryphena; Tryphena beach-front reserves at Pah Beach, Gooseberry Flat, and Mulberry Grove; beach reserve at Schooner Bay; Shoal Bay Wharf at Tryphena. These sites were included in the data samples for the technical readings. They include a range of sites both in the more forested areas and the settlement sites.

Several of the above sites are in close proximity to public conveniences, toilets and parking, and could be reclassified to special observation sites with minimal reorganisation.

Evidence of the careful use of lighting, and lack of lighting, can be seen in the photographs in Attachment 6. As one photographer said, taking photographs evidencing the use of outdoor lighting was like trying to take photos of nothing.

1.7 Life off the grid

There is no electric cable from the North Island to Great Barrier Island – nor is there any plan for one to be installed. (*see appendix letter from lines company, Vector Ltd*). Great Barrier Island is 100% off the grid. Residents live permanently with Dark Skies – it is a natural part of their lives.

Being off the grid has practical and financial implications. LPG gas is the main source of energy used by households with 95% of households using it for heating, cooking, or hot water. Lighting and electrical appliances are largely powered by the sun through solar power systems. Generators are used for back up. A sophisticated solar power system costs up to NZ$35,000 (US$25,500) but as the median household income on Great Barrier Island is $31,100 per annum (2013 Census), considerably lower than Auckland as a whole at $76,500, installing such a system is not possible for many households. This means many households have basic power systems and electricity generation is carefully monitored and carefully used.

The cost of fuel to run generators is also a factor in night- time energy use. Fuel has to be shipped to the island as dangerous goods, adding a considerable premium to petrol and diesel prices. Petrol costs are significantly higher than on the mainland (NZ$2.63 per litre /$7.31 per gallon, compared with about $1.90 per litre in Auckland) and diesel $1.66 per litre /$4.62 per gallon (about $1.25 per litre in Auckland) and running a generator for any length of time becomes an expensive exercise. Social activity tends to start early and end early. This does not mean residents are missing out – they just know how to manage and conserve their power consumption. As a result, business and domestic light pollution is nil.

Being off the grid also impacts lighting in public areas. There are no streetlights and public facilities such as schools, sports areas, arrival points and medical centres do not have night lighting, except for exceptional circumstances such as meetings, emergency medical evacuations or early evening sport.

Ferries and airlines only operate in the daytime so the airports and wharves do not have night- time lighting.

Great Barrier Island celebrates its use of alternative energy with the annual “Off the Grid” four- day festival, showcasing power systems on various properties and knowledge sharing with locals and visiting experts. (See http://offthegridgbi.co.nz/)

The off- the- grid lifestyle provides protection for our spectacularly dark skies, both through practical and economic constraints - and by choice.

2. Night Sky Brightness Study

2.1 Introduction

The Night Sky Brightness (NSB) of the Great Barrier Island (GBI) was surveyed on two clear moonless (new moon) nights - 1 September 2016 and 31 October 2016 - using Unihedron Sky Quality Meters (SQM).

The surveys were scientifically conducted led by a suitably experienced Auckland astronomer who is also a Member of IDA. Comprehensive details on the survey approach; coverage and site selection; equipment; observational conditions; methodology, for data collection, cleansing and analysis; detailed discussion and interpretation of the findings and the comparison between the two surveys are provided in Attachment 1. The survey findings were compared to the data for Great Barrier Island of the June 2016 New World Atlas of Artificial Night Sky Brightness (World Atlas) light pollution predictions from the globalised modelling of world satellite data and is also detailed in Attachment 1.

All three studies - the World Atlas (June 2016), Initial Survey (1 September 2016) and In-Depth Survey (31 October 2016) – independently confirm that with an average of 21.7 mpsas (95% confidence average of 21.63 mpsas and a range of 21.54 mpsas to 21.86 mpsas) GBI enjoys pristine night skies and would meet IDA's night sky brightness requirements for all their Dark Sky Places categories.

2.2 Initial Survey

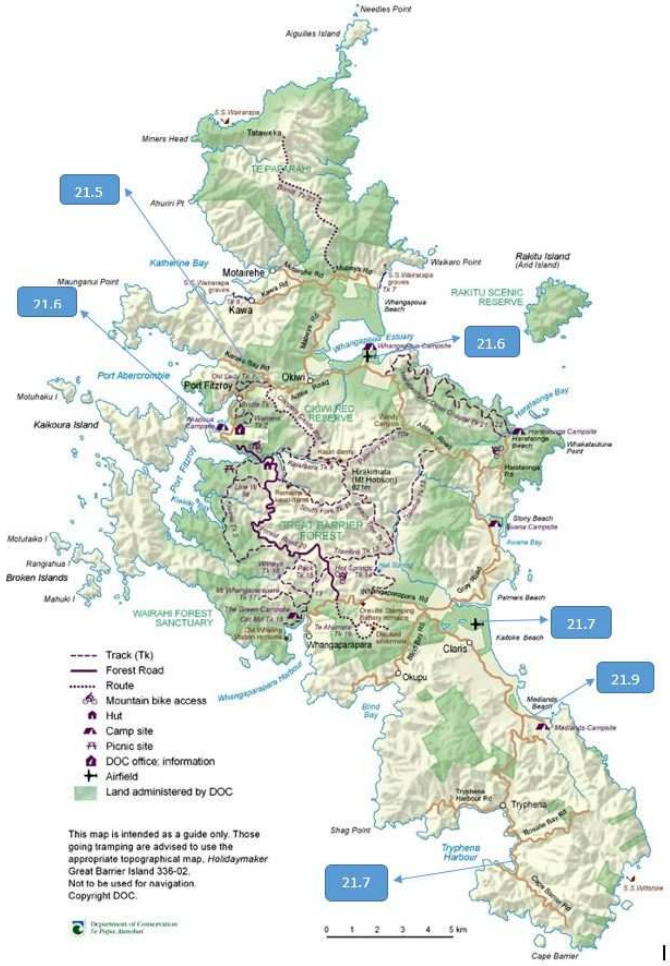
An initial survey was conducted to assess for the very first time, the sky quality of Great Barrier Island. The North, South, East and West sides of the island were covered. The observational results from the initial survey are summarised in Table 1 below

Table 1: Summary of Data from the Initial GBI Survey

Site #	Site Name	Time	Lattitude	Longitude	Number of Accepted Observations	Mean Measurement (Mpsas)
1	Girlie's Grave	7.36	-36°10'35"	175°21'25"	16	21.60
2	Aotea Road	7.59	-36°09'45"	175°21'55"	29	21.50
3	Okiwi Airfield	8.26	-36°08'58"	175°25'03"	31	21.60
4	Claris Airfield	9.32	-36.2414	175.4719	39	21.70
5	#228 Shoal Road	11.22	-36.3154	175.493	6	21.70
6	Medlands Beach Lodge	11.59	-36.2649	175.4896	39	21.90

The findings in map form in Figure 1 below shows the locations covered in the different directions.

Figure 1: Results of the Initial Survey of GBI



To remain conservative, none of the observations were adjusted for the impact of the Milky Way and thereby made darker.

This was the first ever NSB measurements of the GBI skies which the residents have always known to be very dark. The most enlightening finding was that the NSB of all locations observed on GBI met IDA's requirement for Dark Sky Sanctuary of >21.5 mpsas although they varied a little from location to location. These sky quality finding were discussed with GBI Local Board as they were of the standard that would qualify GBI to apply for International Dark-Sky Association's Sanctuary status and given their keen interest to pursue this path, an in-depth survey was carried out as a more comprehensive survey of the NSB was required for inclusion in the submission to the IDA by GBI.

2.3 In-depth Survey

The in-depth survey covered all the major entry points into the island (all three wharves and both airfields), culturally significant points (both Maori maraes and a church), social meeting points (sports club and all three schools), recreation spots (campsites), other significant spots (e.g. Navy base) and significant points, clearings and intersections on each of the radial roads. The diverse range of geographical and settlement features represented on the island - harbours, peninsulas, beaches, estuaries, valleys, ridgelines, bays, rural bush clad forest areas, settlement areas, private residential properties and neighbourhoods, schools, camp-grounds and commercial areas (to the extent that such areas exist on the island), were also extensively covered. Although the survey was comprehensive in its coverage, by necessity it was limited to

public road reserve and publicly accessible land and one representative private residence in the area which is most densely populated and on the South-Western side of the island closest to mainland Auckland. In short, the entire island was covered from all practical perspectives.

Site selection for observing focused on dark sky locations (e.g. Navy base), locations potentially affected by light propagation from mainland Auckland (i.e. the South-Western parts of the island) and easily accessible locations (e.g. schools and clubs). Observations were taken from flat sites in open areas with a clear and wide view of the night sky. Although the mountainous nature of the island made clear horizon views in all directions rarely possible, in most cases at least one horizon perspective was possible and only a small number of sampled sites did not provide a clear view of any horizon.

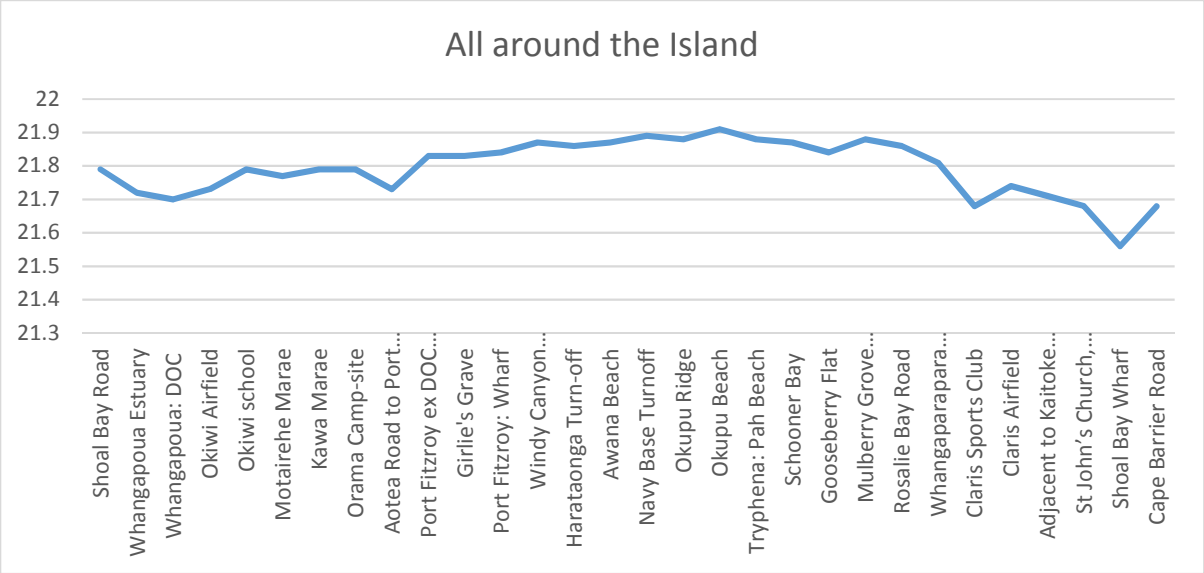
The observational results from this in-depth survey consists of 718 data points - 29 locations averaging about 10 observations each within a range of 5 – 17 readings and Shoal Bay observations from the stationary SQM accounting for the remaining 418. They show that at 95% level of confidence, the lower end of the average measurement is 21.63 mpsas and ranges from 21.54 mpsas to 21.86 mpsas and are summarised in Table 2 below.

Table 2: Summary of Data from the In-Depth GBI Survey

Site #	Site Name	Start Time	Latitude	Longitude	No. of Accepted Observations	Mean Measurement (mpsas)	Standard Deviation (SD) in mpsas	Measurement less 2 SD (mpsas)	Measurement plus 2 SD (mpsas)	Less 0.1 mpsas Instrument Error (mpsas)	Plus 0.1 mpsas Instrument Error (mpsas)
1	Tryphena, 228 Shoal Bay Road	21:39:14	-36.3154	175.4926	418	21.79	0.10	21.59	21.99	21.49	22.09
2	Whangapoua Estuary	21:35:47	-36.1477	175.4191	5	21.72	0.01	21.70	21.74	21.60	21.84
3	Whangapoua: DOC	21:41:07	-36.1457	175.4219	5	21.70	0.02	21.66	21.74	21.56	21.84
4	Okiwi Airfield	21:49:06	-36.1493	175.4173	8	21.73	0.00	21.73	21.73	21.63	21.83
5	Okiwi school	21:56:26	-36.1550	175.3949	6	21.79	0.01	21.77	21.81	21.67	21.91
6	Motairehe Marae	22:15:06	-36.1175	175.3775	6	21.77	0.02	21.73	21.81	21.63	21.91
7	Kawa Marae	22:27:46	-36.1292	175.3678	13	21.79	0.01	21.77	21.81	21.67	21.91
8	Orama Camp-site	23:01:06	-36.1500	175.3550	15	21.79	0.01	21.77	21.81	21.67	21.91
9	Aotea Road to Port Fitzroy	23:15:06	-36.1584	175.3742	8	21.73	0.09	21.55	21.91	21.45	22.01
10	Port Fitzroy ex DOC yard	23:27:26	-36.1721	175.3646	11	21.83	0.00	21.83	21.83	21.73	21.93
11	Girlie's Grave	23:34:06	-36.1762	175.3570	7	21.83	0.02	21.79	21.87	21.69	21.97
12	Port Fitzroy: Wharf	23:41:06	-36.1650	175.3613	9	21.84	0.01	21.82	21.86	21.72	21.96
13	Windy Canyon Entrance	00:03:29	-36.1702	175.4372	15	21.87	0.01	21.85	21.89	21.75	21.99
14	Harataonga Turn-off	00:16:30	-36.1848	175.4699	10	21.86	0.04	21.78	21.94	21.68	22.04
15	Awana Beach	00:25:30	-36.2107	175.4788	14	21.87	0.01	21.85	21.89	21.75	21.99
16	Navy Base Turnoff	00:33:10	-36.2194	175.4732	12	21.89	0.06	21.77	22.01	21.67	22.11
17	Okupu Ridge	00:48:02	-36.2505	175.4400	11	21.88	0.02	21.84	21.92	21.74	22.02
18	Okupu Beach	00:55:11	-36.2589	175.4366	9	21.91	0.04	21.83	21.99	21.73	22.09
19	Tryphena: Pah Beach	01:22:15	-36.3019	175.4883	10	21.88	0.07	21.74	22.02	21.64	22.12
20	Schooner Bay	01:34:36	-36.3054	175.4536	12	21.87	0.01	21.85	21.89	21.75	21.99
21	Gooseberry Flat	01:54:48	-36.3050	175.4901	11	21.84	0.09	21.66	22.02	21.56	22.12
22	Mulberry Grove School	02:01:08	-36.3115	175.4942	10	21.88	0.01	21.86	21.90	21.76	22.00
23	Rosalie Bay Road	02:10:09	-36.3088	175.5149	15	21.86	0.05	21.76	21.96	21.66	22.06
24	Whangaparapara Wharf	02:58:38	-36.2445	175.3972	11	21.81	0.04	21.73	21.89	21.63	21.99
25	Claris Sports Club	03:16:38	-36.2331	175.4459	13	21.68	0.03	21.62	21.74	21.52	21.84
26	Claris Airfield	03:24:38	-36.2428	175.4678	10	21.74	0.04	21.66	21.82	21.56	21.92
27	Adjacent to Kaitoke School	03:30:58	-36.2553	175.4796	6	21.71	0.01	21.69	21.73	21.59	21.83
28	St John's Church, Medlands	03:36:58	-36.2679	175.4919	10	21.68	0.03	21.62	21.74	21.52	21.84
29	Shoal Bay Wharf	03:57:58	-36.3201	175.4854	11	21.56	0.01	21.54	21.58	21.44	21.68
30	Cape Barrier Road	04:09:18	-36.3289	175.5018	17	21.68	0.04	21.60	21.76	21.50	21.86
	Overall for Great Barrier Island				**718**	**21.79**	**0.08**	**21.63**	**21.95**	**21.53**	**22.05**

All locations recorded over IDA's Dark Sky Places threshold of 21.5 mpsas as depicted in Chart 1 below.

Chart 1: The NSB of the 30 locations observed during the In-Depth GBI Survey



Given the observed standard deviations of up to 0.1 mpsas, SQM precision error of +/-0.1 mpsas and the impact of the Milky Way of 0.1-0.3 mpsas, the 0.35 mpsas difference (maximum of 0.35 mpsas i.e. 21.91 mpsas minimum 21.56 mpsas) between the locations is insufficient to conclude that some locations are notably darker than others. Given the total absence of man-made lighting on the island and the absence of all but the faintest of light domes very near the horizon from Auckland city at a couple of locations, the small variations between locations rather than uniform measurements given apparently identical observing conditions, is due to atmospheric changes during the night combined with the changing position of the Milky Way. Although this was too subtle to visually notice, live view monitoring showed a trend of darker readings being recorded around the middle part of the night and comparison with the data from the stationary NSB recordings at Shoal Bay confirms that the peak readings from about midnight to 2.30am.

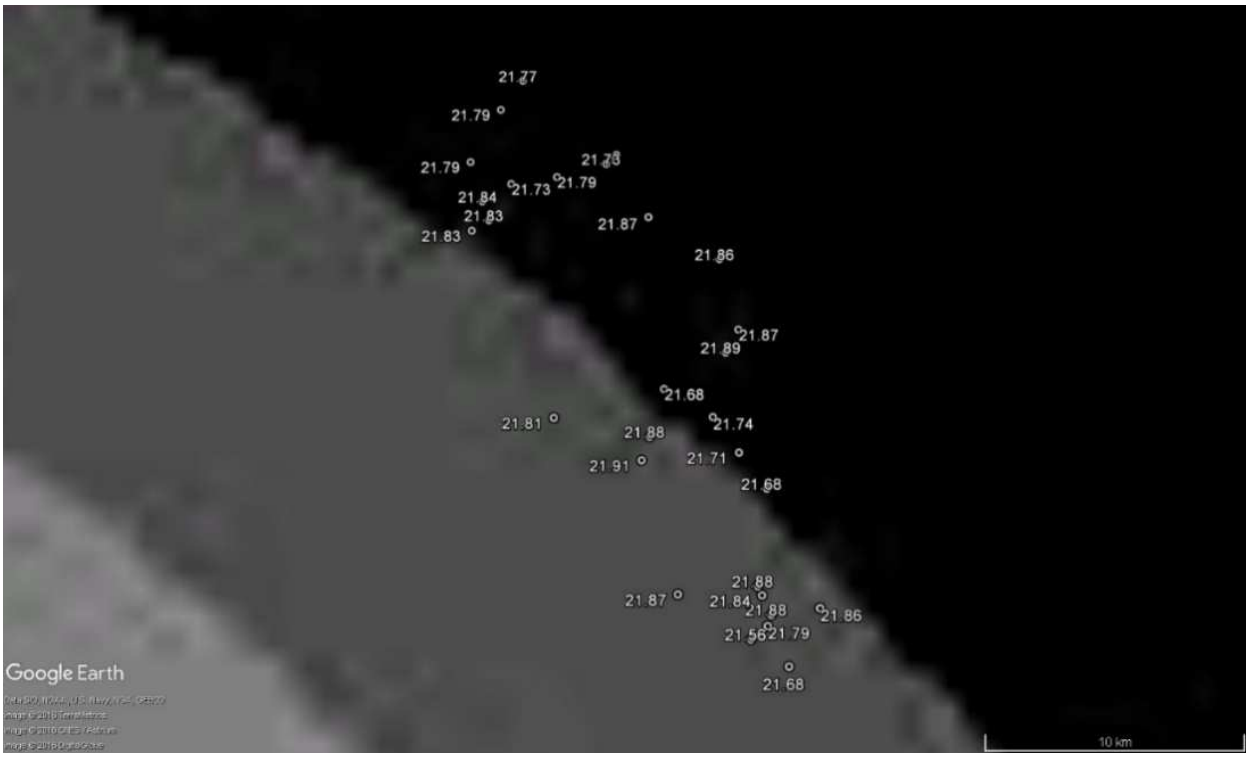
The map in Figure 2 below displays the results and confirms that the survey has covered all parts of the island that can be reached by any motorised vehicle.

Figure 2: Map of the NSB of GBI from the In-Depth Survey

2.4 Comparing Observed Data with the World Atlas Predictions

Although intuitively and from the World Atlas (dark grey and black zones shown for GBI) one would expect the North-Eastern side of the island to record higher readings than the South-Western side, no clear delineation is apparent in the findings - see Figure 3 below where the survey results are transposed on the World Atlas (with GBI area enlarged).

Figure 3: NSB for various Great Barrier Island sites presented on the World Atlas map

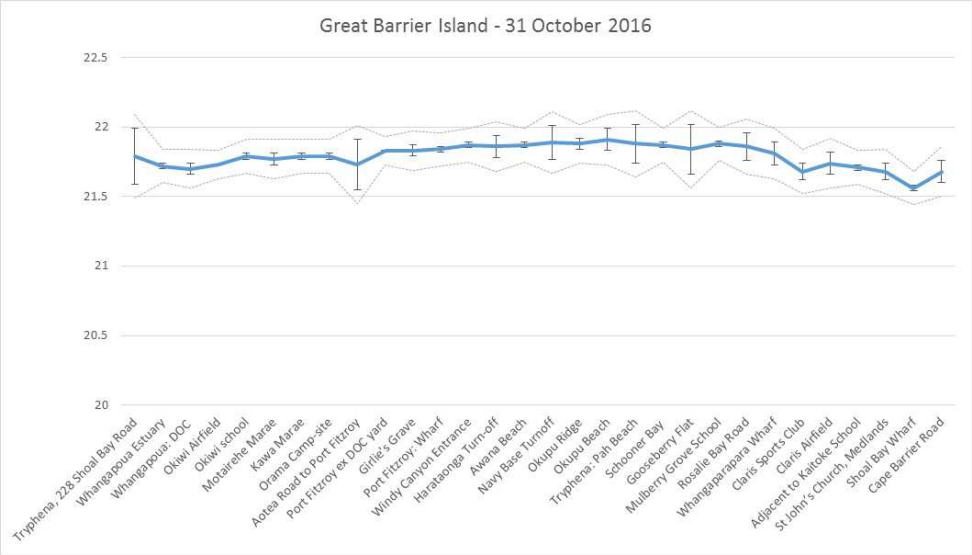


The difference between the black and dark grey areas of the island in the model (21.96 – 21.97 mpsas for dark grey and >21.97 mpsas for black) of 0.1 mpsas is negligible. The difference of 0.18 mpsas between the survey mean measurement of 21.79 mpsas and the World Atlas's >21.97 mpsas falls within the +/- 0.1 mpsas error margins for each of the measurements and for the SQMs (i.e. total error margins of +/- 0.2 mpsas) and thereby confirms the findings that the NSB of the entire island is very similar.

2.5 Conclusions

The findings for Great Barrier Island night sky brightness measures are comprehensively summarised in Chart 2 below with the standard deviation for each location shown as error bars and the dotted lines above and below depicting the adjustment for the +/-0.1 mpsas SQM precision error. To keep the measures conservative, no adjustments have been made to any possible contribution to NSB from the Milky Way as it would have made the measurements even darker.

Chart 2: The error bar inclusive NSB of the 30 locations observed during the In-Depth GBI Survey



The following can be concluded in relation to GBI's night sky brightness:

1. With a 95% confidence average of 21.63 mpsas and a range of 21.54 mpsas to 21.86 mpsas, the entire island comfortably meets the IDA's qualifying criteria of >21.5 mpsas for night sky brightness.
2. With an average of 21.79 mpsas, GBI is on a par with New Zealand's only other IDA certified area, Tekapo Aoraki McKenzie with a NSB of 21.72 mpsas that gives it a Gold standard.
3. GBI generally conforms with the predictions of the World Atlas with only a small explainable difference of 0.18 mpsas between the survey mean measurement of 21.79 mpsas and World Atlas prediction of >21.97 mpsas.
4. NSB is uniform around the island as shown from the survey results and also the World Atlas where the difference between grey and dark areas shown for the island is a negligible 0.1 mpsas (21.96 – 21.97 mpsas for dark grey and >21.97 mpsas for black).

2.6 Ongoing Monitoring

Going forward, follow-up sky quality surveys will be undertaken at regular intervals – at least once a year. Arrangements are already in place to undertake more frequent surveys in the initial period so that the impact of the weather patterns of the different seasons and the changing position of the Milky Way can be better assessed. To have consistent comparative data to track the evolution of sky quality, it is proposed to deploy the same methodology, equipment and the observing team of astronomers as that for the in-depth survey and to cover the same sites with flexibility to add additional locations. The results will be compared to the baseline data from the late 2016 studies and reported on. Updated findings on the night sky brightness will be will be reported to IDA on an annual basis by the Local Board.

The data from the in-depth survey will also be calibrated against a Dark Sky NZ night sky star rating system developed by the NSB Study and each location surveyed will be issued its unique night sky star rating. The Local Board intends to utilise this to erect signs on up to 25 public viewing sites across the island to promote the enjoyment and protection of the island's dark skies. The ratings will be updated as future sky quality surveys are undertaken and as such is expected to provide additional motivation to the islanders associated with each of the locations to preserve and improve their rating.

3. Key Commitment Statements and Letters of Support

These are attached here and have been received from the following:

1. Phil Goff, Mayor of Auckland

2. Honourable Nikki Kaye, Member of Parliament for Auckland Central (Great Barrier Island falls within this constituency) and a currently serving Government Minister with a portfolio of Ministries

3. Mike Lee, Councillor for Waitemata and Gulf Ward (which encompasses the Great Barrier Island) and Chris Darby, Councillor for North Shore Ward; both members of Auckland Council's Planning Committee, the policy making body for lighting

4. Tony Twyford, Operations Manager for the Department of Conservation (DOC), Aotea Great Barrier Island; which administers approximately 60% of the land on Great Barrier Island

5. Steve Butler, Leader of the Dark Skies Group (and John Drummond, President) of the Royal Astronomical Society of New Zealand and Member of the Board of Management of the Aoraki McKenzie International Dark Sky Reserve

6. Bill Thomas, President of the Auckland Astronomical Society

7. Nalayini Davies, Chairperson of Astronz, wholly owned subsidiary of Auckland Astronomical Society with a mission to promote astronomy in New Zealand

8. Honourable Margaret Austin, former Government Minister and Chair of the Aoraki McKenzie Starlight Reserve Working Party which successfully applied to achieve New Zealand's only IDA accredited International Dark Sky Place, Aoraki McKenzie International Dark Sky Reserve

Office of the Mayor of Auckland

17 March 2016

Izzy Fordham
Chairperson
Great Barrier Local Board
By email: izzy.fordham@aucklandcouncil.govt.nz

Dear Izzy

Aotea/Great Barrier Island, New Zealand, Dark Sky Accreditation

I have been advised the Great Barrier community and Local Board are working together on a project to achieve Dark Sky Sanctuary Accreditation for Aotea Great Barrier Island. I wish to offer my support to this proposal.

I am advised that preliminary sky brightness measurements by the Auckland Astronomical Society (AAS) on Aotea Great Barrier Island are the best in the Auckland region, and that it has an excellent chance of being awarded Dark Sky Sanctuary status, matching the higher Gold standard currently enjoyed by Tekapo. This is a great outcome.

Aotea Great Barrier Island is in a unique position in the Auckland region to be a sanctuary. It is important to protect its dark sky, as the island has no reticulated electricity, a very small permanent population of 940 people, and around 70% of its land area is held by the Department of Conservation and Auckland Council in public reserve.

A successful dark sky accreditation and sanctuary status would provide impetus for Aotea Great Barrier Island to advance a number of complementary initiatives, including showcasing alternative energy use exemplified in the very successful "off the grid" events being held on the island over the last two years.

The local board plan has identified increasing visitor numbers as an essential component of the island's economic future and this initiative would contribute to that with potential new visitors, including astrophotographers, scientists and students.

I support this venture as something worthwhile for Aotea Great Barrier Island and the wider Auckland region.

Kind regards

Phil Goff
MAYOR OF AUCKLAND

OFFICE OF THE MAYOR OF AUCKLAND
Auckland Council, 135 Albert Street, Auckland 1010, New Zealand
Private Bag 92300, Victoria Street West, Auckland 1142, New Zealand
T: +64 9 301 0101

HON NIKKI KAYE MP FOR AUCKLAND CENTRAL

PO Box 47 658, PONSONBY 1144

2 March 2017

Izzy Fordham, Chairperson
Great Barrier Island Local Board
Auckland Council,
Private Bag 92300,
Auckland 1142

Dear Chair,

I am writing to support the application by the Great Barrier Island Local Board for Great Barrier Island to become a Dark Sky Sanctuary.

Great Barrier Island falls under my constituency in my role as a Member of Parliament for New Zealand. It gives me great pleasure to advocate once again for the establishment of an environmental conservation area for the island.

In September 2013, I put forward a proposal to establish the Aotea Conservation Park on Great Barrier Island. The park was opened in 2015 and it is now the largest conservation park in Auckland, New Zealand's largest city.

Last year the Glenfern Sanctuary, an 83ha coastal property, was secured by a group of funding partners including the local board, local council and the government via a heritage fund. I was a strong advocate for this and now the sanctuary is both a significant gateway to the island for tourism and education; and an important haven for native animals to prosper.

Great Barrier Island is a leader as one of the most environmentally conscious places in the world. Achieving sanctuary status will mean the island can highlight and help protect another important aspect of our environment as well as bring educational opportunities to the island.

I am of the belief that our environment and our national heritage – our soils and oceans and the imagery that surrounds our biodiversity and wilderness – hold the key to our nation's future prosperity. Most Kiwis have a conservation gene and a natural desire to do the best we can to protect and enhance our environment.

I strongly support the certification of Great Barrier Island as a Dark Sky Sanctuary.

Yours sincerely,

Nicola Kaye

Hon Nikki Kaye
MP for Auckland Central

48C College Hill, Freemans Bay | P: 09 378 2088 | E: mp.aucklandcentral@parliament.govt.nz
www.twitter.com/nikkikayeMP www.facebook.com/NikkiKaye | www.nikkikaye.co.nz
Funded by the Parliamentary Service and authorised by Nikki Kaye MP, 48C College Hill, Freemans Bay, Auckland

Councillors' Office

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Izzy Fordham
Chairperson
Great Barrier Local Board
By email: Izzy.Fordham@aucklandcouncil.govt.nz

15 March 2017

Dear Izzy,

Support for International Dark-Sky Association Dark Sky Accreditation of Aotea Great Barrier Island

It came to our attention via Local Board input at the recent Planning Committee meeting that the Great Barrier Island Local Board together with the community is currently in the process of applying to the International Dark Sky Association (IDA) for Dark Sky Sanctuary Accreditation. We are writing this letter to express our unequivocal support for this application.

IDA Sanctuary Accreditation is an international recognition awarded by the IDA for an area of public or private land possessing an exceptional or distinguished quality of starry nights. We are firmly of the belief that Aotea Great Barrier Island (Aotea) fits this description.

Aotea is uniquely placed within the Auckland region to be a Dark Sky Sanctuary. Aotea enjoys a remoteness that enables access to a suite of outstanding natural features, of which an unpolluted night sky is one. This nightscape is facilitated by the following factors:

- The island does not have reticulated electricity, street lights or lit advertising.
- The majority of the land area comprising Aotea (approx. 70%) is held by both the Department of Conservation and Auckland Council as public reserves, so is not at the whim of private development.
- Preliminary sky brightness measurements on Aotea made by the Auckland Astronomical Society indicate a requisite level of darkness and demonstrate the suitability of Aotea for IDA Accreditation.

A successful IDA Accreditation will make Aotea the only Dark Sky Sanctuary in New Zealand, and the third in the world. This will be a wonderful attraction for visitors to Aotea to enjoy, which will encourage the economic prospects of Aotea. Furthermore, an IDA Accreditation would be a strong string to the bow of Aotea's strong culture of conservation and sustainable development.

We understand that the IDA is seeking confirmation of measures to be taken to relieve any uncertainty around the perpetuity of this outstanding nightscape. The factors drawn on above lend themselves to the retention of Aotea's night sky as it currently is. We also wish to convey that the existing planning framework applicable to the Auckland region is consistent with providing ongoing protection of the nightscape conditions required to meet IDA Accreditation requirements.

For the reasons articulated in this letter, we are entirely supportive of the Great Barrier Local Board's application for IDA Dark Sky Sanctuary Accreditation.

Best,

Chris Darby
Chair | Planning Committee

Mike Lee
Ward Councillor | Waitemata and Gulf

Department of Conservation
Te Papa Atawhai

28th September, 2016

The Chairperson,
Great Barrier Local Board,
P.O. Box 61
Claris,
Great Barrier Island 0961

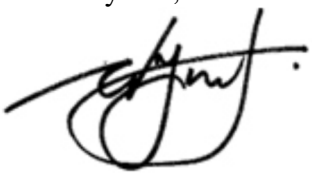
Dear Chairperson,

Re: **Support for International Dark-Sky Association Accreditation for Dark-Sky Sanctuary Status on Aotea Great Barrier Island**

The Department of Conservation (DOC) on Great Barrier Island has no hesitation in supporting the International Dark Sky Association Accreditation for Dark-Sky Sanctuary Status on Aotea Great Barrier Island.
It is a positive initiative for this community and can only highlight the significance of Aotea Great Barrier Island as a Dark-Sky area.
I understand that there is no other area in the Auckland region that has any Dark-Sky status.
Due to the Aotea Great Barrier Island's unique position the night skies are pristine and do not have to compete with major outdoor lighting systems.
It is important that the night sky environment is protected and Aotea Great Barrier Island fits the criteria as there is no mains power and therefore no street lighting or electrical signage.
DOC administers approximately 60% of Aotea Great Barrier Island and as this area is primarily forest and parkland, including the Aotea Conservation Park, it will significantly help the endeavor of a Dark-Sky Sanctuary as the land is accessible to the public and there is no lighting to interfere with viewing.
The initiative fits well into the Department's stretch goals and vision which states that 90% of New Zealanders' lives are enriched through connection to our nature and that 50% of international holiday visitors come to New Zealand to connect with our natural places.
DOC also wants the environment to be accessible to people. Education is seen as the obvious way for people to learn about their environment and this sanctuary would provide another educational vehicle for the public to connect with their environment.
I wish the Great Barrier Local Board every success in its endeavor to secure Dark-Sky Association Accreditation for Dark-Sky Sanctuary status.

If you require any further information or support from DOC for this proposal, please don't hesitate to let me know.

Kind regards,
Toni Twyford,



Operations Manager,
Department of Conservation
Aotea Great Barrier Island

Royal Astronomical Society of New Zealand

(INCORPORATED)

Signatory to New Zealand Urban Design Protocol
Supporter of the International Dark-Sky Association

PO BOX 3181
WELLINGTON
NEW ZEALAND

Email : urbanstars@rasnz.org.nz

21 March 2017

The International Dark-Sky Association
3223 North First Ave.
Tucson, AZ 85719

Support for Great Barrier Island Dark Sky Sanctuary - New Zealand

Dear dark sky colleagues

I am writing to express the support of the Royal Astronomical Society of New Zealand (RASNZ) and the RASNZ Dark Skies Group for the application from the Great Barrier Island community for recognition of Great Barrier Island as a Dark Sky Sanctuary.

Great Barrier Island is well qualified to become a Dark Sky Sanctuary with low resident population, over half the island protected as conservation land, no grid supplied electricity and an established reputation as a natural recreation haven. Dark night skies are a feature of the island as shown by the SQM readings in the application.

Support for an accredited Great Barrier Island Dark Sky Sanctuary is assured from the nearby Auckland astronomical community, the RASNZ and New Zealand's Aoraki Mackenzie International Dark Sky Reserve.

Yours sincerely,

Steve Butler
Leader – Dark Skies Group, Royal Astronomical Society of New Zealand
Member - International Dark-Sky Association

John Drummond
President – Royal Astronomical Society of New Zealand

AUCKLAND
ASTRONOMICAL
SOCIETY

21 March 2017

The Chairperson
Great Barrier Local Board
P.O.Box 61
Claris
Great Barrier Island 0961

Dear Chairperson

The Auckland Astronomical Society is very pleased to support Great Barrier Island's application for accreditation as an International Dark-Sky Sanctuary which will help the island to preserve its high quality night skies for the future.

We are privileged to have such a pristine night sky location within the Auckland region with relatively easy access to our members whose interests range from stargazing to astrophotography to research interests.

We were very pleased sponsoring, along with our subsidiary Astronz, the successful "*Is there life out there?*" event on the island last September when our team was able to support the schools and public outreach evenings that accompanied the event.

We are aware that there is a 90+ strong Astronomy Enthusiasts Group on the island now and some of its members are also members of our Society. We will be happy to share the resources of the Society as appropriate (for example, livestreaming of suitable events and assistance with public outreach) to continue to support astronomical and dark sky pursuits and events on the island.

Kind Regards

Bill Thomas

President

17 March 2017

Izzy Fordam
Chairperson
Great Barrier Local Board
P. O. Box 61
Claris
Great Barrier Island 0961

Dear Izzy

Astronz is wholly owned by Auckland Astronomical Society and is run by volunteers with a mission to promote astronomy in New Zealand. We make astronomy more accessible to New Zealanders by providing quality astronomical equipment and resources. Astronz is unique in reinvesting everything it makes from its activities back into astronomy and science education in New Zealand.

In September 2016, Astronz together with Auckland Astronomical Society, sponsored the "*Is there life out there?*" event on Great Barrier Island. The associated public outreach supported by the sponsors was exceptionally well attended by the public and we were pleased to see so many school children amongst the audiences.

With the increasing profile of the pristine night skies viewable from Great Barrier Island, it is likely you will attract the interest and visits from the astronomical communities of Auckland and wider New Zealand - exactly the people we seek to serve. Consequently, it is with great pleasure that Astronz gives its strong support to your island's application for accreditation as an International Dark-Sky Sanctuary.

Kind Regards

N. Davies

Nalayini Davies

Chairperson

Hon Margaret Austin
CNZM, CRSNZ, FNZIM
D.Sc (Honoris Causa)
11A St Clio Street
Christchurch 8041
March 2017

To whom it may concern

It gives me great pleasure to write in support of the application of the Great Barrier Local Board for recognition as a Dark Sky Sanctuary for the Aotea Great Barrier Island.

The Local Board has recognized how important it is to establish the provisions necessary to protect the night sky for all as demonstrated in their planning and policy guidelines. They are committed to creating and maintaining an extremely low outdoor lighting regime to ensure that the Island's Dark Sky environment is such that it will meet the IDA's requirements for now and into the future.

Great Barrier Island is an important conservation location in New Zealand and treasured by both its inhabitants and its visitors. That they understand the importance of Dark Skies for animal and plant welfare and especially nocturnal animals and also now the increasing evidence of the importance of darkness for human health is apparent from their work.

I wish them well in their endeavours in seeking this important milestone. I do so from experience in long standing involvement in the Achievement of Gold Status for the Aoraki Mackenzie Dark Sky Reserve which was granted with great fanfare in 2012. The impact of the recognition has led to a huge number of people from both the domestic and international communities visiting the Mackenzie to learn about the stars and enjoy a wonderful experience in a very controlled lighting environment. The Support of the Mackenzie District Council in maintaining and monitoring the 1981 lighting ordinance has been hugely beneficial in ensuring the visitors have a unique experience of the stars and the environment.

I wish the group well in their endeavours.

4. Lighting Inventory and Lightscape Management Plan

4.1 Overview

A broad review of the existing regulations relevant to Great Barrier Island's application for Dark Sky Sanctuary status was undertaken and it was established that around 60% of the area of the island is completely protected as it is either DOC estate or Council Reserve land as summarised in section 5.2 below detailed in Appendix 2.

Although the island operates from an extremely dark baseline due to its off-the-grid nature, a comprehensive lighting inventory was undertaken and the complete inventory is recorded in Attachment 4 and is discussed in section 5.3 below. Only 5 potentially significant sites were identified through this exercise and they are also discussed in section 5.3 below while detailed information on them and the plan to manage them is provided in Attachment 3.

Only a handful of marginal lighting issues were observed during the two sky quality surveys and the lighting inventory exercise. Of the potentially significant 5 sites identified, 3 have already committed to working within the guidelines set by the Local Board (see Letter of Support from two of them) and one is part of Department of Conservation's working site. The Department is also committed to dark skies (see Letter of Support) and the remaining site is a local club which rarely uses outdoor lighting after 10:00pm. As we believe there are approximately 500 built-on sites on the Island, 49% of which are only occupied on a seasonal basis, compliance with IDA standards is conservatively estimated to be 90% or higher.

Although no practical problems currently exist, the Local Board is committed to working towards achieving total compliance with IDA standards by extending voluntary curfews within a year and encouraging owners to upgrade and review lighting fixtures. Further, as detailed in section 5.4 below and in Attachment 5, it has adopted both IDA and internal guidelines and recommendations so that a binding policy will be in place as the currently operational Hauraki Gulf District Plan is absorbed into the Auckland Unitary Plan over the coming 3 years.

Although there are no plans in place to provide traditional network mains power supply to the island as it is seen to be cost prohibitive (see Letter from Vector), improved solar panel and new battery technology is viewed as a potential long-term risk to preserving the island's dark skies. Achieving International Dark-Sky Sanctuary status would provide the motivation and impetus for the Auckland Council to incorporate lighting policies in line with IDA guidelines, and give weight to the Local Board's request that IDA guidelines and international best practice be incorporated into the Unitary Plan as it applies to the Island.

The Local Board has established a formal structure for on-going review and monitoring through an Advisory Group convened by the Board's Chairperson.

In summary, the Great Barrier Island already meets the IDA requirement of >90% and is committed to achieving total compliance by putting in place a binding policy incorporating IDA standards or higher and a programme of ongoing monitoring both through the lighting compliance rating system and by checking for compliance.

4.2 Regulation for Dark Sky protection

4.2.1 Plans, Rules and Compliance

New Zealand has one of the most environmentally proactive planning regimes in the world. The Resource Management Act (RMA) provides the framework for environmental management of New Zealand through District and Regional Plans developed by local Councils. Dark Sky protection for Great Barrier Island falls under the planning regime of Auckland Council, the country's largest local government body. Councils are required to take into account several layers of national policy guidelines, environmental protection rules, amenity values rules, coastal protection rules, and map overlays protecting outstanding natural landscapes.

4.2.2 Current Situation-Hauraki Gulf District Plan

Great Barrier Island is currently under the Hauraki Gulf District Plan (Operative 2013). The relevant clause in this plan is:

"*The use of artificial lighting producing an illuminance up to but not exceeding 150 lux, measured at any point on the site containing the light source, in a horizontal or vertical plane at ground level or at the exterior of any building within or adjacent to the site on which the lighting is placed, is a permitted activity."*

Several sections of higher level planning documents refer to goals and policies for protecting the quality of the night sky. However, the above statement is the applicable rule. Lighting outside that standard is a discretionary activity and the Council can impose a wide range of restrictions.

Our assessment is that this clause does not completely meet the minimum standards of the IDA. However, the practical effect of this is virtually nil. There is virtually no outdoor lighting on the Island. This is demonstrated in the lighting inventory. While the rule does not yet adequately cover the dark sky requirements, the actual lighting, both indoor and outdoor, is well within the IDA guidelines for preserving the dark sky environment. Existing national policy statements and planning guidelines provide sufficient high-level legal support to enable the Council to readily incorporate dark sky protection as a critical factor at district plan level.

4.2.3 Transitional Phase.

The Hauraki Gulf Plan will be absorbed into the wider Auckland Unitary Plan in the next few years. The development of the lighting component for the Great Barrier Precinct within this plan is a priority for the Great Barrier Local Board and the strategic planners within Auckland Council. Until these sections are fully incorporated, the transition strategy is to encourage all landowners and residents of Great Barrier to adopt best practices. With the establishment of the Dark Sky Sanctuary on the Island, the Board will formally recommend that any landowner applying for a resource consent for a development on the Island will be given documentation regarding the Island's sanctuary status, the transitional guidelines, and recommended fixtures. The Local Board will actively promote the need to ensure the Island's dark sky qualities are preserved.

4.2.4 Unitary Plan

The Unitary Plan for the rest of Auckland is already operative and has more specific guidelines and rules for protecting the night sky and relevant amenity values within the wider city. With the endorsement of the Dark Sky Sanctuary Status for Great Barrier Island, Auckland Council will in principle adopt the minimum standards outlined in the IDA documentation for inclusion in the Unitary Plan section for the island. The Council will also review international and New Zealand best practice and applicable New Zealand law in preparing the necessary legal sections of the plan.

4.2.5 Governance and Compliance

Compliance is the responsibility of Auckland Council under both the existing Hauraki Gulf Plan and the Unitary Plan. The Council has a robust process of dealing with planning and compliance. Encouragement and education will be the main means of gaining acceptance in the transition phase, but the Council has a full range of legal resources from abatement orders to actions before the Environment Court to ensure compliance. The Board has indicated its commitment to the principles of preserving our dark skies in the Unitary Plan.

4.2.6 Great Barrier Island Local Board Formal Governance and Monitoring

The Great Barrier Island Local Board met on 21 March 2017 to finalise its application and give formal expression to its intentions of creating a Dark Sky Sanctuary on the Island. The meeting considered reports from the Dark Sky team, Auckland Council's planning team (Planning Advice for Aotea Great Barrier Island Dark Sky Application Application), national planning guidelines and policy statements, the Outstanding Natural Landscape Overlay documentation, transitional guidelines draft documentation (Draft Guidelines for Outdoor Lighting) and (IDA Outdoor Lighting Basics). The Board formally endorsed the application and the lighting standards and fixture suggestions outlined in the IDA Guidelines for Dark Sky Sanctuary Status, the IDA Outdoor Lighting Basics information hand-out, and the transitional guidelines discussion document. It has committed to a public education programme, and has formally established a monitoring and advisory group for the Dark Sky Sanctuary. The detailed documents are provided as attachment 6.

4.2.7 In Summary

In summary of the current regulatory situation: around 60% of the area of the island is completely protected as it is either DOC estate or Council Reserve land. The road reserve is protected as it is under the Council's jurisdiction and there are no plans for installing any road lighting whatsoever. With transition to the Unitary Plan, Aotea Great Barrier's compliance will at a minimum achieve and normally exceed IDA guidelines.

4.3 Lighting Inventory

Great Barrier Island approaches the light planning issue from an extremely dark baseline. During the In-depth Night Sky Brightness Survey, after 11:00pm on 31 October, 2016 only 4 sites were showing lights that were noticeable from a dark sky perspective. Subsequently, it was resolved that 2 of these were

temporary mast-head lights from visiting yachts. Additional assessments were done by undertaking a full lighting inventory and assessments show that 5 sites had a lighting impact which warranted discussions with property owners. These sites are:

a) The Currach Irish Bar, Tryphena;
b) Tipi & Bob's, Tryphena;
c) Great Barrier Social Club, Tryphena;
d) Great Barrier Sports and Social Club, Claris;
e) Department of Conservation Storage Yard, Okiwi.

Since this survey, the Great Barrier astronomy enthusiasts group has had informal discussions with all but one of the owners of the above properties (as DOC is already committed a separate discussion was not necessary). Full details on the current situation and management proposals to make the properties compliant are detailed in Attachment 3, Lighting Inventory Significant Sites. The Lighting Inventory of currently non-compliant sites has been assessed as limited to 5. It has not been possible to take consistent light readings from these properties as usually outdoor lights are turned-off after around 11:00pm each night. In other words, there is a voluntary curfew operating with these sites due to the desire to conserve power in the off-the-grid environment

Although there is provision for emergency lighting at each of the wharves on the Island at Port Fitzroy, Whangaparapara and Tryphena, these require generators to be brought to the wharves for the occasion, and none has been used over the last 10 years. The airfields are not lit, and apart from the DOC yard there is no lighting on other publicly owned buildings throughout the Island.

We have prepared a separate lighting management/monitoring inventory (Attachment 4) for a wider purpose. The Lighting Inventory consists of sites where the level of public/private use and fixture types warrant proactive monitoring, although none of these sites had outdoor lighting at the times readings were being taken.

Lighting on the Island is limited by de facto curfews imposed by the need to generate independent power. At this stage, outdoor lighting is not really an issue.

Large blocks of private land have limited development potential or rights. The settlement areas consist of smaller titles, but no practical problems exist in any of these areas as off-the-grid power is precious and expensive. As we believe there are approximately 500 built-on sites on the Island, 49% of which are only occupied on a seasonal basis, compliance with IDA standards is conservatively estimated to be 90% or higher.

Lighting inventories have been prepared (Attachment 4) and Attachment 3 lists those properties where active discussions were required. Site specific management plans are also detailed in Appendix 3. Sites identified in Attachment 4 will be proactively covered as part of a medium-term monitoring and management strategy. There is now a comprehensive inventory of sites which have been identified as those that would benefit from monitoring to achieve the goals of 100% compliance by the time the regulatory document, the Unitary Plan, is formally adopted, an estimated timeframe of 3 years.

4.4 Lightscape Management Plan

Basically, the Island has almost no systemic or regular outdoor lighting. The basis of the Lightscape Management Plan is less on correcting problems, but more on ensuring problems don't get started. On this basis, the Island is comfortable with setting a high standard for 'dark sky goals'. Broadly, the Local Board has set a pre-curfew target for lighting assessments at property boundaries of <0.05 lux for reserve and public land outside the settlement areas, <0.1lux for private land areas outside the settlement areas, and <1.5 lux within the settlement areas of Tryphena, Claris, Okupu, Okiwi, Port Fitzroy, Motairehe, and Kawa. Across the entire Island the Local Board has set a colour temperature range of 2400K to 3000K, with adequate shielding and shading, and a reasonable commitment to a curfew plan. The Board's guidelines for inclusion in the Unitary Plan include the special purpose lighting fixture standard requiring shading and shielding for any light >500 initial lumens, in addition to the general lux and colour temperature standards set above. These have now been formally documented and passed as a Local Board Resolution (see Attachment 5)

4.4.1 Goals of the Lighting Management Plan

Given the extremely low baseline, the over-riding goal is to maintain the current situation for future generations. The targets stated above actually represent the current situation. Night-time curfews are a fact of life on the Island. Power is not wasted on outdoor lighting. The over-riding goals are to maintain the existing low-light standard across the Island, encourage residents to upgrade fixtures over time, and actively manage light control measures in the future. We propose the following steps:

a) Existing Light Sources

The Board and Advisory Group have already begun discussions with owners of the 5 non-compliant sites. These are analysed in more detail in Attachment 3. To date 3 owners have indicated a willingness to make appropriate alterations to their outdoor lighting subject to safety and legal restraints. One site is the Department of Conservation's work site, and no problem is anticipated in making appropriate changes, and the other is a club rarely uses outdoor lighting after about 10:00pm.

b) Adoption of IDA specifications and best practice measures in the proposed Unitary Plan Revision

Lighting requirements and restrictions are best dealt with under the District and Unitary Plans. The Great Barrier Local Board is currently working with the city's planning department to ensure that appropriate planning rules are included in the new planning Unitary Plan documentation. As the city is at the preparation stage of developing the Unitary Plan provisions for Great Barrier Island now is the perfect time to establish the IDA protocols as an integral part of the planning regime for the Island.

c) Private lighting and Retrofitting lighting

No other significant private lighting pollution was observed either during the lighting inventory on any of the sky quality data collection dates. Most private power on the Island is generated through the use of solar systems with large storage batteries. A very small number of people use wind generation systems as a complementary system. Back-up generators are used, but the cost of such systems ensures they are only used when absolutely necessary. Thus no-one wastes power and a de facto lighting curfew applies from around 10:00 give or take an hour. Consequently, the Board believes an educational and promotional

approach is all that will be required to increase awareness of the IDA goals and requirements. Over the coming years the Board will adopt the following strategies:

i. School and public information booklets.

Ii Dark Sky book.

iii. Inclusion in the annual Off the Grid expo.

iv. Inclusion of DSS material in DOC publicity and information packs.

v. Barrier Bulletin articles.

vi. Auckland Council and the Department of Conservation will be asked to formally establish the minimum IDA guidelines as a requirement on all public land. This will establish coverage of the regulations for 56% of the surveyed titles. In addition, this will establish the regime for all road reserves and coastal reserve areas.

vii Information leaflet to existing landowners and to landowners who apply for resource consents for building and lighting projects. Under the Unitary Plan for the Island, the Board will propose that outdoor lighting requires a specific consent and be classified as a discretionary activity. Under the current plan, all landowners will be notified of the Island's sanctuary status and encouraged to meet or exceed the minimum requirements set out in the IDA guidelines. Updated sample sheets of approved lighting will be made available through the Council's planning consent process.

viii. Site warranties and special purpose areas

For the transition period before the adoption of the revised Unitary Plan, the Local Board will propose that owners of sites which fall outside the IDA parameters or which have special use requirements (eg. Recreation, security, safety, etc.) be asked to obtain planning advice and warranties which will include curfews and agreed limitations on the nature of the lighting fixtures and their use.

d) Risk Identification

The Island faces few current risks to its dark sky status. Private outdoor lighting is barely noticeable and the little that does occur is widely scattered through the Island and not concentrated. Public lighting is non-existent, and will be controlled through Council and DOC policies. However, the Board will adopt a precautionary approach to risk management. It sees the following issues as warranting particular focus: possible intensification of development in settlement areas; private buildings on the larger sites outside the settlement areas, and technological change.

i. Intensification of settlements

Only 5 or 6 building consents are issued in a normal year, and most of these are for holiday homes in the settlement areas and currently have no effect on the light generated from the areas on normal evenings after about 11:00.

Until the Unitary Plan is operative for the Island, landowners will be advised that the Island is a Dark Sky Sanctuary and encouraged to adopt the minimum standards as laid out in the IDA guidelines and the

board's guidelines. The Council's planners will be asked to adopt a precautionary approach in advising landowners of lighting that is acceptable on the Island. Under the Unitary Plan, outdoor lighting will be proposed as a discretionary activity (the highest threshold for allowing activities where the Council can impose a wide range of restrictions on a consent), and the IDA guidelines, or other best-practice as determined by NZ's environment planning regime, will be adopted.

ii. Private development outside settlements

Most private titles outside of settlement areas consist of very large blocks of land with minimal development rights. Subdivision is very difficult on large blocks outside the settlements. As above, owners will be encouraged to adopt the IDA standards, and a discretionary regime will be included in the revised Unitary Plan.

iii. Technological Changes

This is the only potential source of concern for this project over the long-term and is one of the major reasons for the application for Dark Sky Sanctuary Status. Solar panel technology and new battery technology are improving all the time and may completely change the economics of small-scale power production and use. Restrictions on outdoor light use will be included in the Unitary Plan and the high standard of "discretionary activity" applied to all significant outdoor lighting. Until the adoption of the Unitary Plan the Council's planners are asked to adopt a precautionary approach following the regional best practice guidelines for protection of amenity values, night sky and landscape values, and protection from light spill and its effect on adjacent and adjoining properties. Landowners will be encouraged to help preserve the Island's unique character.

e. Colour temperature

This issue will require careful management. Technological changes in lighting and lighting fixtures mean that landowners will need advice and that the issue of colour temperature will need to be highlighted in Council brochures and information sheets. The Island's reliance on solar generated power makes us enthusiastic early-adopters of power saving technology. Information will stress the advantages of restricting lights to the 2400K to 3000K range which aligns with the commercially available "soft or warm white" lights.

Achieving International Dark-Sky Sanctuary status would provide the motivation and impetus for the Auckland Council to incorporate lighting policies in line with IDA guidelines, and give weight to the Local Board's request that IDA guidelines and international best practice be incorporated into the Unitary Plan as it applies to the Island.

5. Protecting and Enhancing our Environment

With nearly 60% of Great Barrier Island in Department of Conservation (DOC) and Auckland Council ownership, the ethos of environmental protection and enhancement is well entrenched. Programmes for pest eradication to protect bird life and fauna are well established and well supported on private as well as public land.

Our Local Board plan outlines the community's vision for the future, with its emphasis on environmental protection and enhancement

1. ***The environment is at its best here***

   Our native wildlife and forests flourish, our streams run clean, and our coastal waters are full of life. We waste very little and our homes, businesses and cars run on renewable energy.

2. ***Infrastructure that fits with our environment***

   As our island attracts more people and visitors, we will ensure new buildings, communications, and our transport network don't compromise the special things that bring people here.

3. ***We have more residents and visitors but we won't lose our way of life***

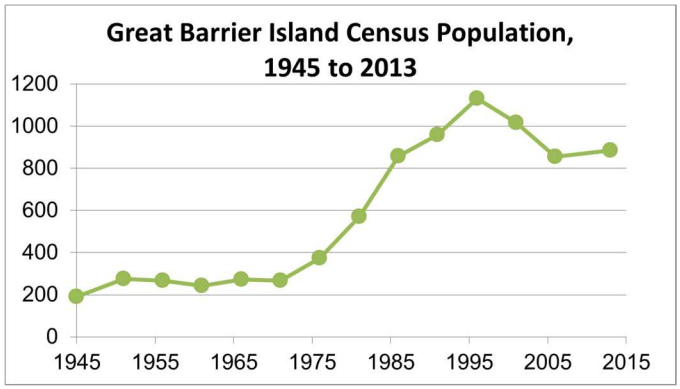
   We want to attract more people to our island to create more jobs and opportunities and make our lives better. At the same time we must protect the special things we have and promote these as the reason to come here.

An example of this environmental protection and enhancement is the programme to protect the breeding grounds of the black petrel. Although once endemic in New Zealand, this sea bird now only breeds on Great Barrier Island and the uninhabited, limited-access Little Barrier Island. The black petrel feeds by day but returns to it burrow nests at night to feed chicks – Great Barrier Island's Mount Hobson/Hirakimata provides 35 hectares of a dark, undisturbed environment, making it an ideal and successful breeding ground for between 900-1000 pairs of birds.

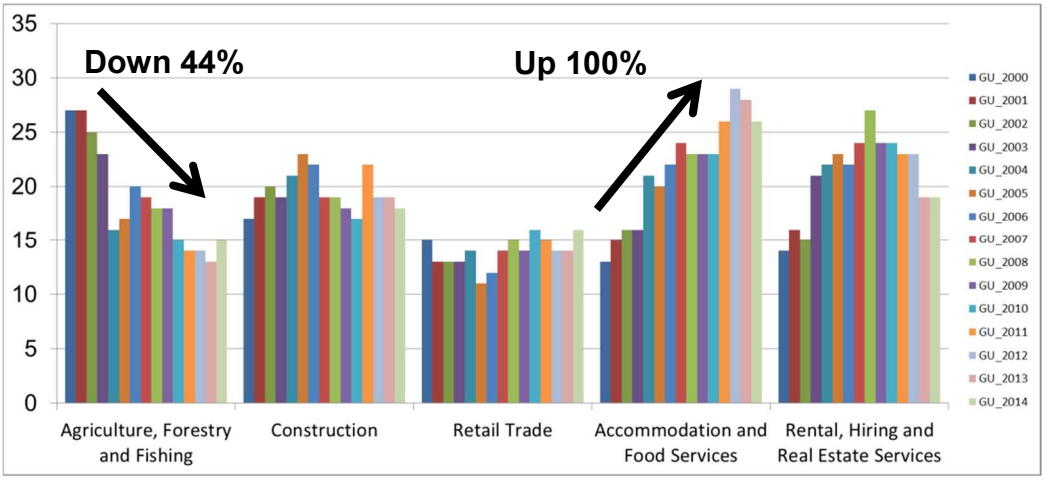
6. The Importance of Tourism

Eco Tourism is extremely important to Great Barrier Island. Dark Sky Sanctuary status would not only be a differentiator for the island but would also provide an enhanced visitor experience and opportunities for economic development.

Great Barrier Island has the highest percentage of households earning $20,000 or less in the Auckland region. Employment options are limited and only 43% of the working age population is in full time employment with another 20% in part time employment. Of the working age population, 31% are self-employed and do not employ anyone else. Business and individuals make most of their money during the summer months and Great Barrier Island would benefit from tourism that is sustained throughout the year.

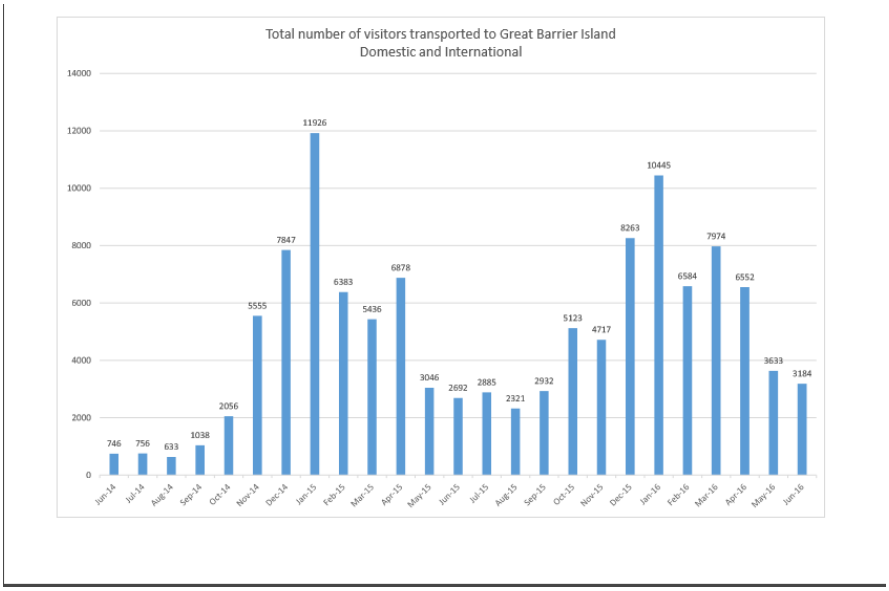


The three largest areas of employment are Accommodation and Hospitality Managers, Miscellaneous Labourers, Farmers and Farm Managers (NZ Census categories). As demand for workers in Agriculture, Forestry and Fishing has declined, the importance of employment in tourism-related industries has increased.



A recent study by Auckland Council's Auckland Tourism, Events, and Economic Development agency shows that efforts to increase tourism to Great Barrier Island by the Local Board and funding organisations are paying off (*see graph below*). Accommodation on the island is almost at capacity in January with 12,000 visitors, but there is obviously scope for a sustainable expansion of tourism on the island throughout the rest of the year.

Most accommodation on the island is self-catered holiday homes. However, there are a two or three accommodation providers who can cater for more than 30 people and a handful who can accommodate over 20. A boutique 5-star luxury lodge caters for 12. The not-for-profit Christian community of Orama Oasis in the North of the Island caters for groups of up to 150, including school groups. Management at Orama has invested in an 8" telescope and is interested in expanding its programme to include Dark Sky observation and education.



Nearly 3.9 million international visitors arrive in New Zealand each year – 72% of them through Auckland Airport. Tourism contributes more than $10 billion to the national economy, generating 5.6% of GDP. The average visitor spends 19 days in the country. Auckland City attracts 825,000 international visitors and 425,000 domestic visitors per year.

At present, Great Barrier Island attracts a mere 65,000 visitors a year - 41% of these from Auckland, with 54% from other parts of New Zealand. Only 4% are international visitors.

As the Annual Report for the Aoraki MacKenzie International Dark Sky Reserve shows, Dark Sky tourism can be a significant contributor to local economies:

The 2015 to 2016 year has seen increasing activity within the Aoraki Mackenzie International Dark Sky Reserve (AMIDSR). As tourism numbers climb throughout New Zealand, the benefits and impacts can be seen within the Reserve area.

and

Astro-tourism is now one of New Zealand's top tourist attractions. The Mackenzie has about 1.5 million tourists a year, and Earth & Sky are expecting up to 200,000 customers annually. Many accommodation places in the region mention AMIDSR on their websites, a testimony of the drawing power of the Reserve for their businesses.

and

Dark Sky Tourism is becoming increasingly popular in the Mackenzie Basin. Since July 2012 when the Aoraki Mackenzie International Dark Sky Reserve was announced, there has been a steady increase in bed nights

recorded in the Mackenzie district. This growth in visitor numbers is further revealed by a 43.6% increase between July 2015 and July 2016.

Great Barrier Island sky is spectacular and we are confident the island will attract astro-tourists. The 1.6 million people living in Auckland are a natural target but as the Aoraki Mackenzie International Dark Sky Reserve has found, international visitors who rarely see a true night sky find our skies impressive and irresistible. .

We are working with Auckland Tourism, Events and Economic Development (ATEED) to develop long term planning goals, and with the Auckland Astronomical Society to develop upskilling and outreach programmes. Dark Sky tourism has the added advantage for Great Barrier Island of not needing to be an activity confined to summer (when we already have a lot of visitors on the island). This means we would be able to develop tourism throughout the year. Sustainable growth of tourism is important to the island, but even a 20% increase in off-season numbers would make a huge difference to the island's economy and to the income of the local population. Dark Sky tourism is within the planning objectives and ethos of the island and would be a sustainable activity drawing on the strengths of the community.

7. Education and Outreach

The brilliant night sky on Great Barrier Island is very much part of island life. Matariki, the appearance of the Pleiades in late May, marks the beginning of the New Year for Maori and is celebrated annually by the community at special events. Schools decorate the local hall with artworks of stars and perform for very appreciative audiences.

In September 2016 a panel discussion on *Is there life out there*? was held on the island and included panellists Dr Faith Vilas, Senior Scientist at the USA Planetary Institute, and Bro Guy Consolmagno, Director of the Vatican Observatory. The Auckland Astronomical Society and Astronz also ran an outreach programme for schools and the general public. More than 450 people attended the various stargazing and educational sessions, and 15% of the population attended the panel discussion itself - demonstrating a keen enthusiasm for astronomy and a deep appreciation of the night sky.

As a result of this event, the Great Barrier Island Astronomy Enthusiasts group was formed and currently has more than 90 signed up individual and family members. Monthly sessions are being held to teach people how to use the 8" Dobsonian telescope donated to the group and to learn more about the night sky. The programme is supported by the Great Barrier Local Board, the Auckland Astronomical Society and its fully-owned subsidiary Astronz whose mission is to promote astronomy and science education in New Zealand.

A strong relationship has been built between members of the Great Barrier Island community and the Auckland Astronomical Society (AAS) and Astronz. The benefits are two-fold – residents can learn about the night sky from AAS members and AAS members can come to the island knowing it has amongst the darkest skies in New Zealand. The relationship can only grow in the future.

However, there is more to Dark Sky Sanctuary status than astro-tourism; it also gives us the opportunity to tell visitors, in particular, about the importance of light management and dark sky protection. Locals know well what protecting the night sky involves and the spectacular night sky we see as a result, but for visitors this is often a new experience.

The Local Board has undertaken to provide information on our protection programme through a number of methods: pamphlets on lighting regulation and the subsequent results; training the port of entry ambassadors at the i-site to tell visitors about our IDA status; including a section on Local Board sponsored "official" tourist/information website and including an in-depth section on regulation and protection in a publication of our application.

The Local Board will also promote dark sky awareness by issuing a lighting star rating to businesses for good lighting practices. It will also implement a Dark Sky NZ star rating system for the sites measured by the Night Sky Brightness Study and will erect signs on up to 25 public land viewing sites notifying visitors and residents of the star rating and the reading taken for this application. These sites will be from the North of the Island to the South, thus providing easy access from the main visitor and accommodation centres.

Destination Great Barrier Island, a charitable Trust charged with promoting tourism, fully supports this application. The group is planning up-skilling training for tourist operators, story tellers, and astronomers

so that visitors can appreciate Great Barrier Island's night sky and learn how protecting this extraordinary asset is something every community should aspire to.

8. Future Plans

The Local Board, land owners, and residents of Great Barrier Island are excited at the prospect of our Island becoming a Dark Sky Sanctuary. The driver for accreditation is not only to share what we already have but to protect our dark skies for the future.

We intend to do this by ensuring lighting can be kept within IDA guidelines through Council regulation and monitoring. We will undertake regular testing regime to measure night sky brightness and outdoor lighting compliance. We will also embark on a public education programme to ensure residents and visitors understand the importance of preserving our dark sky and what actions individuals and companies can take to do so.

We also intend to promote our International Dark Sky Sanctuary status to our nearest neighbours, Aucklanders, as well as to all New Zealanders and International visitors to the country. Starlit skies like ours are a precious sight and understanding what you are seeing and why you are able to see it is something that should be shared and appreciated as well as preserved.

Attachments

1. Night Sky Brightness Study
2. Regulation for Dark Sky Protection
3. Lighting Inventory Significant Sites
4. Lighting Inventory
5. Local Board Resolutions and supporting documents regarding Lighting Policy
6. Lighting Photographs
7. Department of Conservation Campgrounds and Huts; Council maps of public land at Tryphena and Medlands
8. Additional Letters of Support

Attachment 1 – Night Sky Brightness Study

Dark Sky NZ

Night Sky Brightness Study

Great Barrier Island

Submitted To:

Great Barrier Island Local Board

24 November 2016

Dark Sky NZ

Night Sky Brightness Study

Great Barrier Island

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Great Barrier Island

1. Background

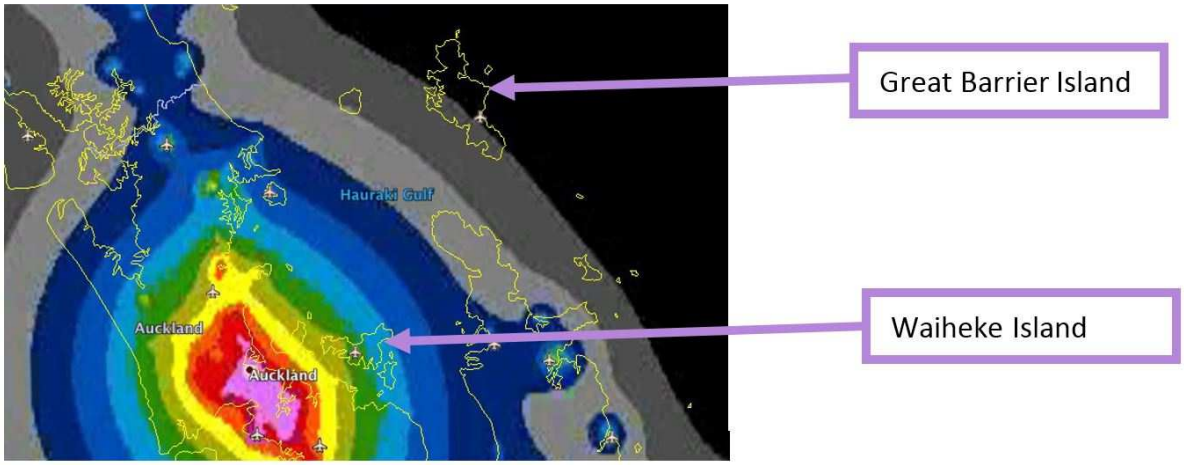
1.1 Auckland's Night Sky Brightness

Auckland is located in the North Island of New Zealand, it is the country's largest city with a third of the country's population and is its fastest-growing region. Auckland's Night Sky Brightness (NSB) has never been comprehensively surveyed with only satellite images to confirm high levels of light pollution.

The June 2016 New World Atlas of Artificial Night Sky Brightness (World Atlas) is considered "a *ground breaking study*" by the International Dark-Sky Association (IDA) and is now an important 'best practice' international standard by which to assess global NSB.

World Atlas's light pollution predictions map of Auckland (Figure 1 below) extracted from the globalised modelling of world satellite data, shows the levels and impact of light pollution from Auckland CBD on its surrounding region.

Figure 1: Light Pollution Predictions Map of Auckland (Source: World Atlas)



The two major inhabited islands in the Hauraki Gulf area within the Auckland region are Great Barrier Island and Waiheke Island (identified in Figure 1) and account for 2 of the 21 Local Boards operating within the Auckland region. These islands have (i) less polluted (and possibly endangered) dark skies, (ii) clearly defined boundaries, (iii) separate Local Boards (iv) stated commitments to conservation, and (v) own community cultures.

The colour coding of this World Atlas map relevant to Great Barrier Island and Waiheke Island is as follows:

- Black: >21.97 mpsas
- Dark Grey: 21.96 to 21.97 mpsas
- Grey: 21.94 to 21.96 mpsas
- Light Blue: 21.68 to 21.82 mpsas
- Dark Green: 21.45 to 21.68 mpsas
- Yellowy Green: 21.09 to 21.45 mpsas

Note: Higher measures indicate darker skies (discussed in section 1.2 below)

There are good reasons to support World Atlas's prediction of darker skies for the Great Barrier Island (GBI) and they are as follows:

- at 83 km (vs. 31 km for Waiheke), GBI was further away from the central city
- GBI does not have any adjacent mainland coastal eastern residential suburbs like Waiheke

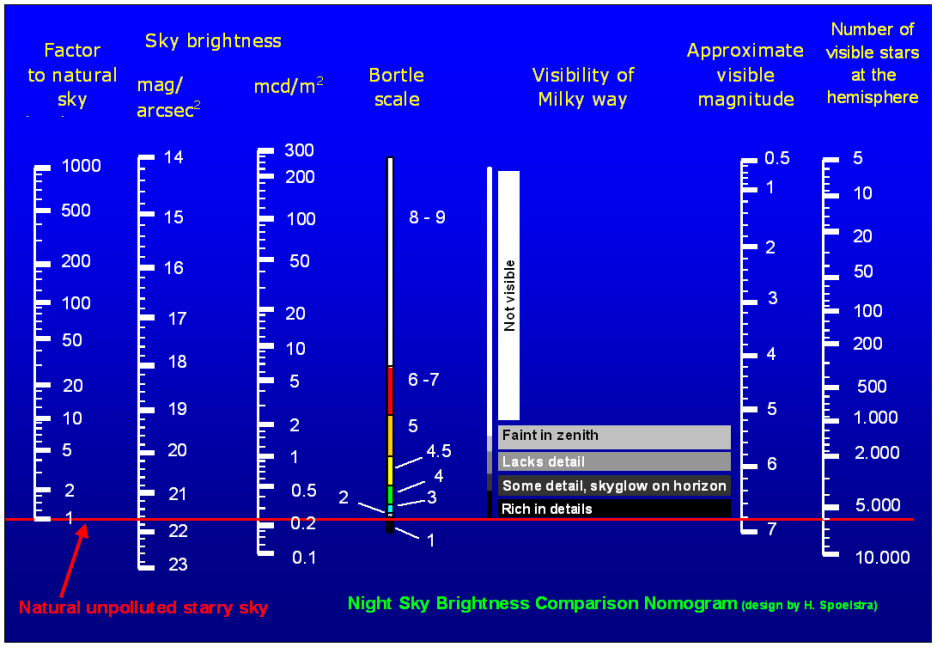
- at under 1,000 residents in a 285-square km area, GBI had a significantly lower population density (Waiheke has about 9,000 residents in 92 square km)
- GBI has much less local light pollution from street lighting, public lighting, signage, recreational lighting, commercial lighting etc. mainly because it has no mains power (Waiheke has significantly reduced levels of compared to the mainland Auckland but outdoor lighting is still present)

The authors of the World Atlas acknowledge that this map is dependent on generic assumptions and hence the actual sky brightness could vary from the map as the assumptions (e.g. atmospheric transparency of observing site, screening effect of mountains) vary for each location. It accepts the requirement for *in situ* site-specific measurements to ascertain "actual" NSB rather than "theoretical" NSB based on modelling. It is this "actual" NSB of Great Barrier Island that this project has sought to determine.

1.2 Quantifying Night Sky Brightness

Night Sky Brightness (NSB) can be quantified/assessed in various ways as depicted by the nomogram below (Figure 2) with the red line indicating the measures for the 'natural unpolluted starry sky'.

Figure 2: Night Sky Brightness Nomogram (Source: H. Spoilstra from DarkskiesAwarenessWeb)



Visual assessments, i.e. the last 4 columns of Figure 3 above, are popular methods used at various times by observational astronomers and involves nature's device, the human eye. Scientific measurements of NSB (which calls for independent and repeatable results which is not possible with the human eye as it varies from person to person and with ageing), shown in the second and third columns of Figure 2 are the norm.

This project will use magnitude per square arc second (mpsas) to quantify NSB. A measure of say 18 mpsas quantifies sky brightness as though a star of magnitude 18 was spread across each square arc second of sky and 20 mpsas would mean darker skies with fainter brightness magnitudes. Such counter intuitive measurements are in keeping with the 2,000-year old Hipparchus scale, a well-known and the accepted practice within the astronomic community where the brightest star one could see is of the first magnitude and the less bright stars increase in magnitudes along the scale with the faintest naked eye stars labelled sixth magnitude.

Magnitude difference of 5 would therefore suggest a 100 times brighter sky as shown in the first column of Figure 2 depicting just how much brighter the sky gets as it moves up these scales.

Comparing the different scales in Figure 2 shows that once NSB drops below 19.5 mpsas, the Milky Way can no longer be seen.

1.3 Project Specific Information on Great Barrier Island

Great Barrier Island covers an area of 285 square kilometres, is nearly 45 kilometres long (North to South), and is from 2km to 12km in width (East to West).

GBI has no mains power as there is no electric cable to the island. As solar and generator produced electric power is precious, electricity is very carefully used by island residents and by the public and commercial facilities on the island. 56% of the Island is in public ownership, largely as part of New Zealand's Conservation estate.

The island has no brightly lit areas in the form of commercial/light-industrial areas and/or townships. Highway/street/advertising lighting is non-existent and land use consists of regional park / conservation / agricultural / low population density settlement areas. Ferry and flight services are not conducted after sunset hours and the facilities are not lit in anyway after the services cease each day.

1.4 Survey Approach

Sky Quality Meters (SQMs) are custom designed to measure visual magnitudes per square arcsecond (mpsas) with an infrared blocking filter to restrict measurements to visual bandpass.

SQM photometers have been tested extensively against other scientific systems, photopic and scotopic responses, with standard astronomical filters etc. and found to be reliable and precise (+/- 0.1 mpsas). It is the accepted de facto industry standard – IDA recommends it with *"SQM is the most widely used device for taking scientific-quality measurements of sky brightness"*. Testing over a range of -15°C to 35°C confirm that "*the temperature compensation of SQMs to be adequate under expected outdoor operating conditions"*. To achieve varied Fields of View (FoV) coverage, larger observational data and for multiple observations to corroborate the findings, three different versions of SQMs viz. SQM (~42° HWHM), SQM-L (~10° HWHM) and SQM-LU-DL (continual autonomous datalogging with ~10° HWHM permitting customised flexible observations) were deployed by the project.

2. Initial Survey of Great Barrier Island

2.1 The Observing Team

This survey was undertaken on 1 September 2016 by Nalayini Davies with the assistance of (i) Gareth Davies (taking back-up GPS measurements with an iPhone to supplement the physical locations/addresses noted) and (ii) island residents Richard and Gendie Somerville-Ryan in selecting specific observing locations and with transport.

2.2 Coverage and Site Selection

As it was the initial survey on a night with passing clouds deploying a (time consuming) manual methodology (even the SQM – LU – DL auto-logger was manually operated when moved from site to site), the approach was to select observing sites to provide a sample of North, West, South and East sides of the island.

2.3 Equipment

An SQM unit, an SQM-L unit and an SQM-DL-LU unit were used in this survey. The SQM-LU-DL was left pointing at the zenith and recording while readings were taken with the other two handheld units. All three units were calibrated for measurement range and checked beforehand against each other for reading accuracy. The SQM-LU-DL was used with housing unit which was calibrated to show as requiring a 0.11 mpsas adjustment which is marginally more conservative than the 0.1 mpsas adjustment recommended by Unihedron, the makers of SQMs.

2.4 Observational Conditions

The night of 1 September 2016 saw a new Moon and the Moonset was 5.49 pm (i.e. a Moonless). As there were passing clouds, only the cloud-free windows were available for observations which shortened the coverage to just 6 locations. The Milky Way was overhead at the early part of the survey and went down as time progressed. All observations were undertaken after astronomical twilight (7.27 pm) and ended well before astronomical twilight the following day. The sky

cleared unbelievably well around midnight and that opportunity was used to make observations at the last site at Medlands Beach Lodge.

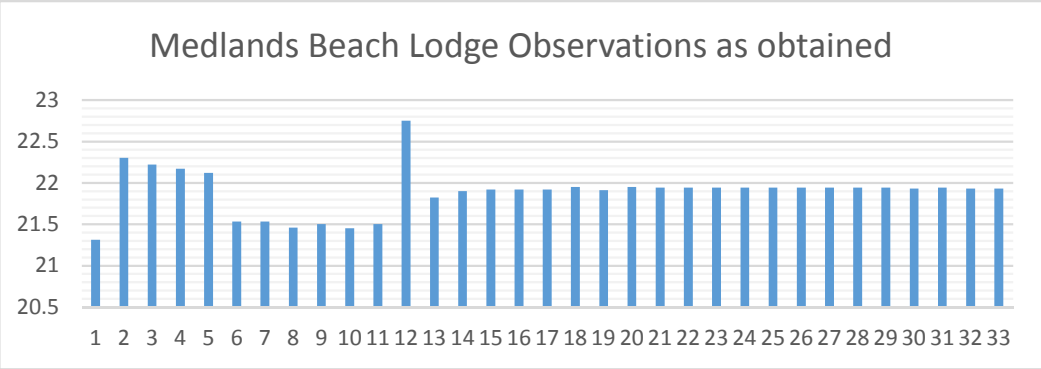
2.5 Methodology

The SQM and SQM-L units followed the IDA recommended and generally practised data capturing protocol of discarding the first (or more) reading(s) and taking 3 further readings ensuring that there are no outliers from any mistakes such as not pointing correctly, reading corrupted by lights from passing cars etc. The readings taken with the SQM -LU-DL were one minute apart.

2.6 Observations

The data was cleaned for any outliers which occurs during set up of the auto-logger as illustrated in Chart 1 below.

Chart 1: Illustration of Cleansing of Raw Data



Observations 1-13 in Chart 1 above were during the setup time when lights were on and Observation 12 appears to be an outlier possibly due to the lens of the SQM being covered during the observation. Observations 14-33 calibrated for the housing unit were accepted. Then, these observations were combined with the observations from the SQM and SQM-L and averaged for each location.

2.7 The Results

2.7.1 Observational Results

The summary of the observational data is presented in Table 1 below.

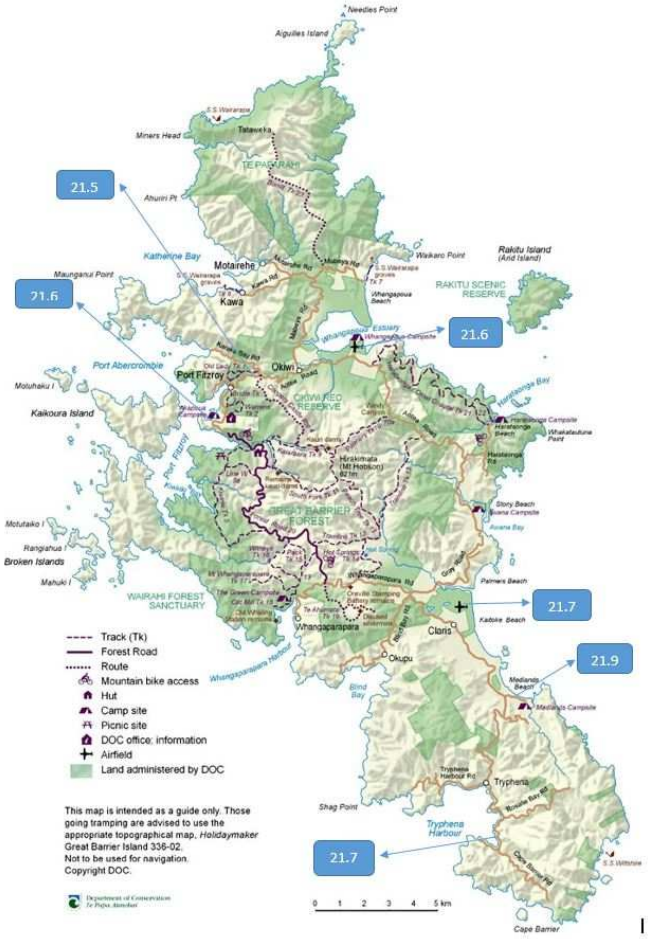
Table 1: Summary of Data from the Initial GBI Survey

Site #	Site Name	Time	Lattitude	Longitude	Number of Accepted Observations	Mean Measurement (Mpsas)
1	Girlie's Grave	7.36	-36°10'35"	175°21'25"	16	21.60
2	Aotea Road	7.59	-36°09'45"	175°21'55"	29	21.50
3	Okiwi Airfield	8.26	-36°08'58"	175°25'03"	31	21.60
4	Claris Airfield	9.32	-36.2414	175.4719	39	21.70
5	#228 Shoal Road	11.22	-36.3154	175.493	6	21.70
6	Medlands Beach Lodge	11.59	-36.2649	175.4896	39	21.90

2.7.2 Survey Results

Presenting the findings on a map of GBI in Figure 3 below shows that the island was sampled in all directions.

Figure 3: Results of the Initial Survey of GBI



2.8 Discussion of Survey Results

At 21.5 mpsas to 21.7 mpsas (except for the one reading of 21.9 mpsas at the very last location), these measurements are lower than those predicted by the World Atlas (>21.96 mpsas). The presence of the Milky Way overhead could have impacted these observations as the impact of the Milky Way can vary from 0.1 to 0.3 mpsas. But, to remain conservative, none of the observations were adjusted for the impact of the Milky Way and thereby made darker. With the clearing off of the clouds and with the Milky Way no longer overhead, the observations at the end of the night recorded the highest measurement of 21.9 mpsas. As this is 0.1 mpsas over what is generally considered the upper limit for a natural unpolluted night sky of 21.8 mpsas the observations and the process used of obtain them were shared with the founder-inventor of SQMs at Unihedron for quality assurance. He confirmed that readings "*seem to stabilize quite well after the 12th value, would trust those*". Further, the variation is still within the SQM precision error margin of +/-0.1 mpsas.

2.9 Interpretation of Survey Results

This was the first ever NSB measurements of the GBI skies which the residents have always known to be very dark. The most enlightening finding was that the NSB of all locations observed on GBI met IDA's requirement for Dark Sky Sanctuary of >21.5 mpsas although they varied a little from location to location.

2.10 Action Taken Post Survey

These findings were presented to GBI's Local Board with the information that International Dark Sky Places programme of the IDA is designed to safeguard pristine dark sky areas and that GBI will suit the Sanctuary category. Sanctuary category is defined as a place "*typically situated in a very remote location with few (if any) nearby threats to the quality of its dark night skies. The typical geographic isolation of Dark Sky Sanctuaries significantly limits opportunities for public outreach, so a sanctuary designation is specifically designed to increase awareness of these fragile sites and promote their long-term conservation*" and that the location satisfies IDA's NSB measurement hurdle requirement of > 21.5 mpsas for certification as an International Dark Sky Sanctuary.

This resulted in keen interest on the part of the Local Board to apply for accreditation as an International Dark Sky Sanctuary. It was agreed that a more comprehensive survey of the NSB would be required for inclusion in GBI's IDA submission. This survey was to cover all parts of the island especially those shown as grey in Figure 1 so that the potentially brighter South-Western area is well addressed. There was also a need to clearly confirm that the 'entire' island would meet IDA's Sanctuary category requirement.

3. In-depth Survey of Great Barrier Island

3.1 The Observation Team

This survey was undertaken on 31 October 2016 by Nalayini Davies (operating a custom designed, computer operated, auto-logging system for both NSB observations and for GPS readings constructed with the assistance of information technology consultant, Justin Le Grice) and was assisted by island resident, Richard Somerville-Ryan, in selecting specific observing locations and with transport.

3.2 Coverage and Site Selection

The survey was designed to cover all areas of the island that had vehicular access and to address a comprehensive range of perspectives. It covered all the major entry points into the island (all three wharves and both airfields), culturally significant points (both Maori maraes and a church), social meeting points (sports club and all three schools), recreation spots (campsites), other significant spots (e.g. Navy base) and significant points, clearings and intersections on each of the radial roads. The diverse range of geographical and settlement features represented on the island - harbours, peninsulas, beaches, estuaries, valleys, ridgelines, bays, rural bush clad forest areas, settlement areas, private residential properties and neighbourhoods, schools, camp-grounds and commercial areas (to the extent that such areas exist on the island), were also extensively covered. Although the survey was comprehensive in its coverage, by necessity it was limited to public road reserve and publicly accessible land and one representative private residence in the area which is most densely populated and on the South-Western side of the island closest to mainland Auckland. In short, the entire island was covered from all practical perspectives.

Site selection for observing focused on dark sky locations (e.g. Navy base), locations potentially affected by light propagation from mainland Auckland (i.e. the South-Western parts of the island) and easily accessible locations (e.g. schools and clubs). Observations were taken from flat sites in open areas with a clear and wide view of the night sky. Although the mountainous nature of the island made clear horizon views in all directions rarely possible, in most cases at least one horizon perspective was possible and only a small number of sampled sites did not provide a clear view of any horizon.

3.3 Equipment

Two SQM-DL-LU units placed in weather proof housing were used in this survey. One was left pointing at the zenith on the roof at #228 Shoal Road all night long while the other, hoisted up on a metal pole and connected to a GPS unit and a laptop computer, was used in a drive through around the island stopping at 29 carefully selected locations.

The SQM-LU-DL was placed in the weather proof unit and attached to the laptop computer during the drive through. The GPS unit was placed on the dashboard of the car and attached to the lap top during the drive through. Nalayini sat in the passenger seat with the laptop and monitored the observations live as they were being recorded making notes of locations and any location, sky and weather conditions related to the observations. Richard did the driving and checked on the outside location and sky conditions at each location.

Both SQM-LU-DL units were calibrated for measurement range and checked beforehand with other SQM units (SQM-L and SQM) for reading accuracy. The method and unit used for drive through was calibrated the previous night against a handheld SQM-L unit. As both units were used with housing units, they were calibrated by taking measurements with and without the housing units. These calibrations showed that they required adjustments of 0.11 mpsas and 0.13 mpsas respectively which were marginally more conservative than the 0.1 mpsas adjustment recommended by Unihedron.

3.4 Observing Conditions

It was a new moon and Moonset was 8.10 pm (i.e. a Moonless) night and the sky was clear of any clouds. The Milky Way was in the sky but it was not quite overhead when the observations were being taken and given the time of the year, it was the fainter northern Milky Way. Jupiter was bright but not close to the zenith. Only the observations undertaken after astronomical twilight (9.29 pm) were accepted. These great observing conditions lasted all night (astronomical twilight the following day was 4.40 am) except for a short duration of passing cloud over Claris Sports Club where the readings were rejected. Fortunately, it was possible to do the measurements at Claris Spots Club on the drive back from Whangaparapara Wharf.

Headlights of a few passing cars, some planes flying overhead and a few harbour navigation lights were observed but none of them were intrusive or affected the readings in anyway. The only visible light domes from Auckland city were extremely faint and very close to the horizon. In general, stars close to the horizon were clearly visible.

3.5 Methodology

The readings were automatically logged and automatically linked to the latitudes and longitudes of each of the locations minimising human error.

Auto-logging also permitted the opportunity to increase the sample size with readings taken 20 seconds apart for the drive through unit (as compared with 1 minute apart for the stationary unit) and this increased productivity facilitated the coverage of the whole island under identical observational conditions other than from the changes in the location of celestial objects in the night sky as the night progressed and any subtle changes in atmospheric conditions through the night.

It was possible to monitor the survey through live view of recordings by viewing them on the laptop computer for reasonableness and for trends.

Only the observations made when the vehicle was totally stationary (the latitude and longitude were identical for these observations and speed shown as zero) were accepted. In a few instances, the very first stationary reading was rejected if it was noticeably inconsistent with the readings that followed to allow for the time taken between the time the car came to a stop and when the lights were switched off. In the case of Mulberry Grove, the second reading was also rejected as it was a clear outlier likely impacted by the light from the opening of the car door. A second set of readings were available for Schooner Bay as the SQM-LU-DL Unit which had reached its capacity of 5,000 readings was reprogrammed at that point but was not included as superfluous and to avoid duplication.

3.6 Observations

The total observations consisted of many thousands of readings but the data collected while the car was moving indicated considerable distortion mainly due to light reflection off the trees and road surface rather than from the car headlights which was directional. Hence all ‘mobile’ data was discarded and only the data collected while the car was stationary with all lighting extinguished accepted.

3.7 The Results

3.7.1 Observational Results

The observational data accepted after sorting, cleaning and grouping and analysing consists of 718 data points - 29 locations averaging about 10 observations each within a range of 5 – 17 readings and Shoal Bay observations accounted for 418 with the remaining. These are summarised in Table 2 below.

Table 2: Summary of Data from the In-Depth GBI Survey

Site #	Site Name	Start Time	Latitude	Longitude	No. of Accepted Observations	Mean Measurement (mpsas)	Standard Deviation (SD) in mpsas	Measurement less 2 SD (mpsas)	Measurement plus 2 SD (mpsas)	Less 0.1 mpsas Instrument Error (mpsas)	Plus 0.1 mpsas Instrument Error (mpsas)
1	Tryphena, 228 Shoal Bay Road	21:39:14	-36.3154	175.4926	418	21.79	0.10	21.59	21.99	21.49	22.09
2	Whangapoua Estuary	21:35:47	-36.1477	175.4191	5	21.72	0.01	21.70	21.74	21.60	21.84
3	Whangapoua: DOC	21:41:07	-36.1457	175.4219	5	21.70	0.02	21.66	21.74	21.56	21.84
4	Okiwi Airfield	21:49:06	-36.1493	175.4173	8	21.73	0.00	21.73	21.73	21.63	21.83
5	Okiwi school	21:56:26	-36.1550	175.3949	6	21.79	0.01	21.77	21.81	21.67	21.91
6	Motairehe Marae	22:15:06	-36.1175	175.3775	6	21.77	0.02	21.73	21.81	21.63	21.91
7	Kawa Marae	22:27:46	-36.1292	175.3678	13	21.79	0.01	21.77	21.81	21.67	21.91
8	Orama Camp-site	23:01:06	-36.1500	175.3550	15	21.79	0.01	21.77	21.81	21.67	21.91
9	Aotea Road to Port Fitzroy	23:15:06	-36.1584	175.3742	8	21.73	0.09	21.55	21.91	21.45	22.01
10	Port Fitzroy ex DOC yard	23:27:26	-36.1721	175.3646	11	21.83	0.00	21.83	21.83	21.73	21.93
11	Girlie's Grave	23:34:06	-36.1762	175.3570	7	21.83	0.02	21.79	21.87	21.69	21.97
12	Port Fitzroy: Wharf	23:41:06	-36.1650	175.3613	9	21.84	0.01	21.82	21.86	21.72	21.96
13	Windy Canyon Entrance	00:03:29	-36.1702	175.4372	15	21.87	0.01	21.85	21.89	21.75	21.99
14	Harataonga Turn-off	00:16:30	-36.1848	175.4699	10	21.86	0.04	21.78	21.94	21.68	22.04
15	Awana Beach	00:25:30	-36.2107	175.4788	14	21.87	0.01	21.85	21.89	21.75	21.99
16	Navy Base Turnoff	00:33:10	-36.2194	175.4732	12	21.89	0.06	21.77	22.01	21.67	22.11
17	Okupu Ridge	00:48:02	-36.2505	175.4400	11	21.88	0.02	21.84	21.92	21.74	22.02
18	Okupu Beach	00:55:11	-36.2589	175.4366	9	21.91	0.04	21.83	21.99	21.73	22.09
19	Tryphena: Pah Beach	01:22:15	-36.3019	175.4883	10	21.88	0.07	21.74	22.02	21.64	22.12
20	Schooner Bay	01:34:36	-36.3054	175.4536	12	21.87	0.01	21.85	21.89	21.75	21.99
21	Gooseberry Flat	01:54:48	-36.3050	175.4901	11	21.84	0.09	21.66	22.02	21.56	22.12
22	Mulberry Grove School	02:01:08	-36.3115	175.4942	10	21.88	0.01	21.86	21.90	21.76	22.00
23	Rosalie Bay Road	02:10:09	-36.3088	175.5149	15	21.86	0.05	21.76	21.96	21.66	22.06
24	Whangaparapara Wharf	02:58:38	-36.2445	175.3972	11	21.81	0.04	21.73	21.89	21.63	21.99
25	Claris Sports Club	03:16:38	-36.2331	175.4459	13	21.68	0.03	21.62	21.74	21.52	21.84
26	Claris Airfield	03:24:38	-36.2428	175.4678	10	21.74	0.04	21.66	21.82	21.56	21.92
27	Adjacent to Kaitoke School	03:30:58	-36.2553	175.4796	6	21.71	0.01	21.69	21.73	21.59	21.83
28	St John's Church, Medlands	03:36:58	-36.2679	175.4919	10	21.68	0.03	21.62	21.74	21.52	21.84
29	Shoal Bay Wharf	03:57:58	-36.3201	175.4854	11	21.56	0.01	21.54	21.58	21.44	21.68
30	Cape Barrier Road	04:09:18	-36.3289	175.5018	17	21.68	0.04	21.60	21.76	21.50	21.86
	Overall for Great Barrier Island				**718**	**21.79**	**0.08**	**21.63**	**21.95**	**21.53**	**22.05**

3.7.2 Critique of Observational Results

3.7.2.1 Verification of Data

The automatically logged readings recorded averaged in a range from 21.56 mpsas to 21.91 mpsas. Although SQM readings above 21.8 mpsas are unusual as mentioned earlier, independent observations (made on the second stationary SQM–LU–DL) on the same night and made on three different devices (SQM, SQM–L and SQM–LU–DL) on 1 September (discussed in detail on section 2 above) verify these findings. Further, the measurements with 95% confidence level (measurement less 2 standard deviations column in Table 2) at 21.63 mpsas is still above the hurdle rate of 21.5 mpsas plus the SQM precision error margin of +/-0.1 mpsas.

Once again, further communications with the founder-inventor of SQMs provided assurance that the slightly >21.8 mpsas observations are acceptable for Great Barrier Island due to its unique situation of absence of localised man-made lighting. Other contributing factors include distance from Auckland city lights and some screening by the island's mountains. This was independently confirmed through communications with the lead author of the 'ground breaking' World Atlas, who confirmed that the model's prediction for the island was 21.97 mpsas and that the survey measurements "*testify a very dark sky*" and recommended measuring away from Milky Way and Zodiacal light for more consistent results (since the survey results fall short of World Atlas prediction of 21.97 mpsas). In earlier communications, he had directly confirmed "*This (i.e. World Atlas predicted) value depends STRONGLY on the real natural* brightness *at the moment of measurement*" and as such, the NSB data in Table 2 can be considered more acceptable than the potentially higher NSB measurements predicted by the World Atlas model.

The difference of 0.18 mpsas between the survey mean measurement of 21.79 mpsas vs. World Atlas prediction of >21.97 mpsas falls within the range that can be explained through differences in the full range of measurements recorded (i.e. not just the conservative end of deducting 2 standard deviations), atmospheric and sky conditions (e.g. the recommendation "*for more consistent results, measure far away from Milky Way and Zodiacal light*").

3.7.2.2 A Closer Look at Variations

The standard deviations for each of the locations are under 0.1 mpsas which is an acceptable level being within the SQM precision error margin of +/-0.1 mpsas.

As the 6 sites surveyed in the Initial GBI Survey (discussed in detail in section 2 above) were resurveyed by the In-depth GBI Survey, the results of the two surveys were compared (the In-Depth Survey results are shaded in grey) as given in Table 3 below.

Table 3: Comparison of the results of the GBI Initial and In-depth Surveys

Site #	Site Name	Time	Lattitude	Longitude	Number of Accepted Observations	Mean Measurement (Mpsas)	Difference	Inferred Cause of Discrepancy
1	Girlie's Grave	7.36	-36°10'35"	175°21'25"	16	21.60		
	Girlie's Grave	23:34:06	-36.1762	175.3570	7	21.83	0.23	Earlier time: higher Milky Way
2	Aotea Road	7.59	-36°09'45"	175°21'55"	29	21.50		
	Aotea Road to Port Fitzroy	23:15:06	-36.1584	175.3742	8	21.73	0.23	Earlier time: higher Milky Way
3	Okiwi Airfield	8.26	-36°08'58"	175°25'03"	31	21.60		
	Okiwi Airfield	21:49:06	-36.1493	175.4173	8	21.73	0.13	Not significant
4	Claris Airfield	9.32	-36.2414	175.4719	39	21.70		
	Claris Airfield	03:24:38	-36.2428	175.4678	10	21.74	0.04	Not significant
5	#228 Shoal Road	11.22	36.3154	175.493	6	21.70		
	#228 Shoal Road	21:39:14	-36.3154	175.4926	418	21.79	0.09	Not significant
6	Medlands Beach Lodge	11.59	-36.2649	175.4896	39	21.90		
	St John's Church, Medlands	03:36:58	-36.2679	175.4919	10	21.68	-0.22	Not comparable: different site

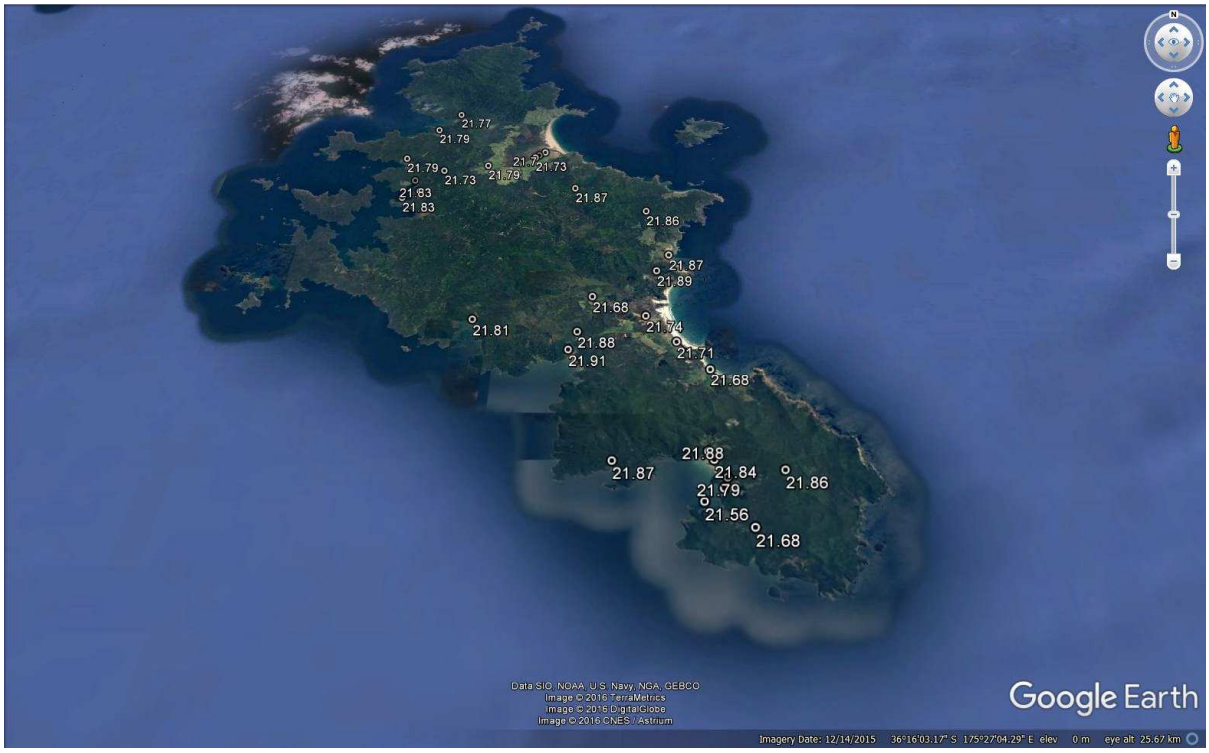
The comparisons above are based on observations made under similar conditions – same observation team, same equipment, same methodology except for the integration of the GPS, similar observing conditions – and hence are directly comparable.

The results between the surveys are consistent. The slightly poorer weather conditions and the greater possibility that the Milky Way impacted observing conditions leading to lower measurements for the Initial Survey making the small differences explainable as shown in the column titled 'Inferred Cause of Discrepancy' in Table 3.

3.7.3 Survey Results

The map in Figure 4 below displays the results and shows that the survey has covered all parts of the island that can be reached by any motorised vehicle.

Figure 4: Map of the NSB of GBI from the In-Depth Survey

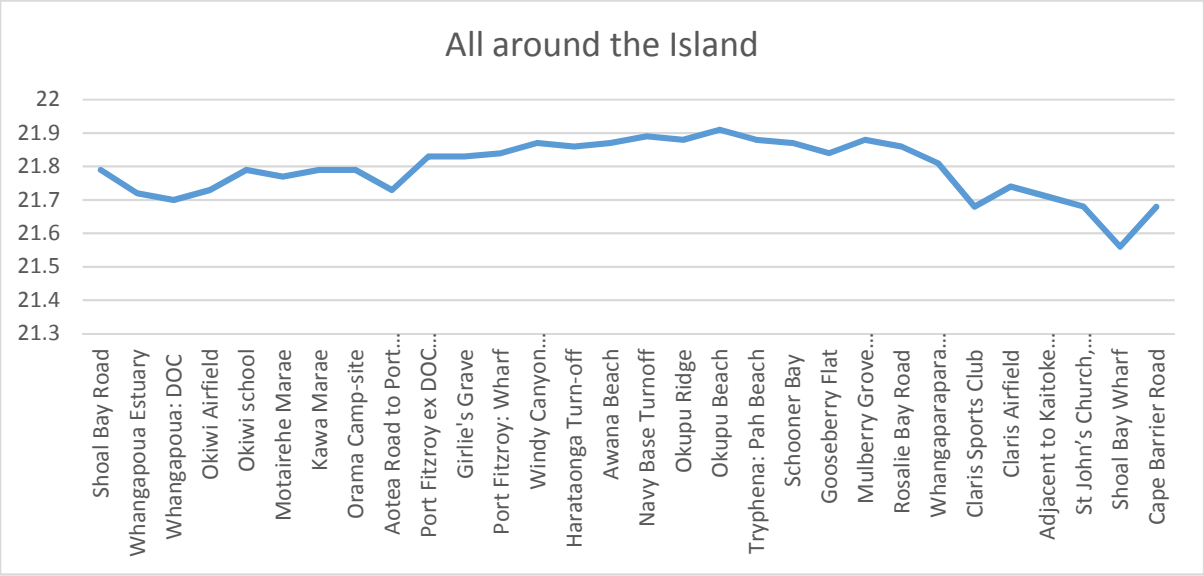


At 95% level of confidence, the lower end of the average measurement is 21.63 mpsas and ranges from 21.54 mpsas to 21.86 mpsas.

3.8 Discussion of Survey Results

Prima facie, the observations suggest that certain locations (e.g. Navy Base, Okupu Ridge, Okupu Beach and Pah Beach) are darker than others as illustrated by Chart 2 below.

Chart 2: The NSB of the 30 locations observed during the In-Depth GBI Survey



When observing, live view monitoring showed a trend of darker readings being recorded around the middle part of the night. To assess the veracity of this subjective observation, the observations were compared with those taken from the stationary unit at Shoal Bay road. This independently bears out the observed phenomenon and illustrated by the comparison of Charts 3 and 4 below - the measurements from both the stationary and 'mobile' units show peak readings from about midnight to 2.30am.

Chart 3: The Time Profile of the NSB of the Shoal Bay location observed during the In-Depth GBI Survey

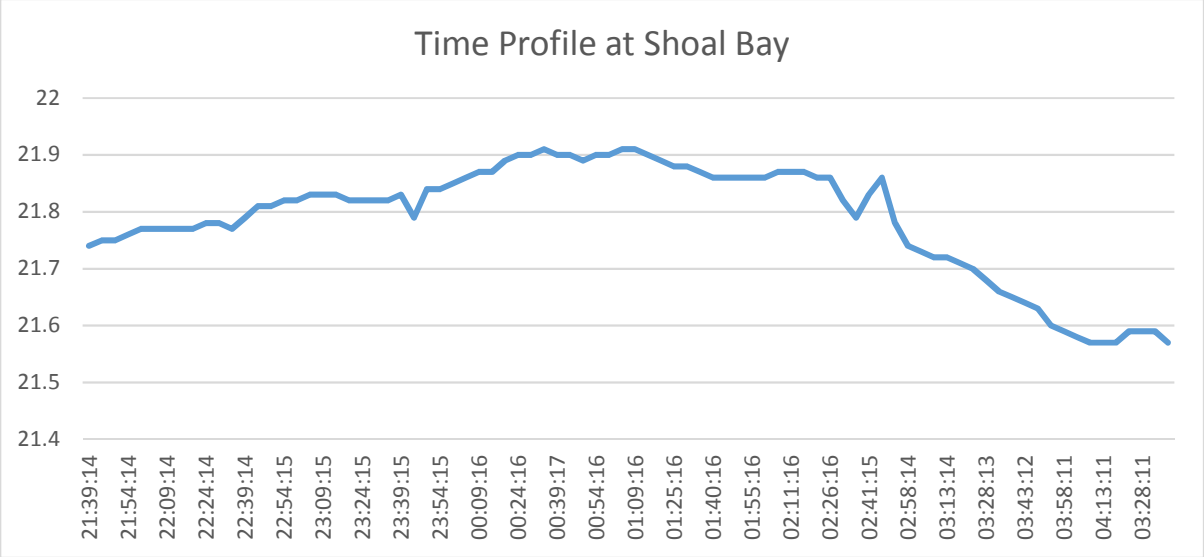
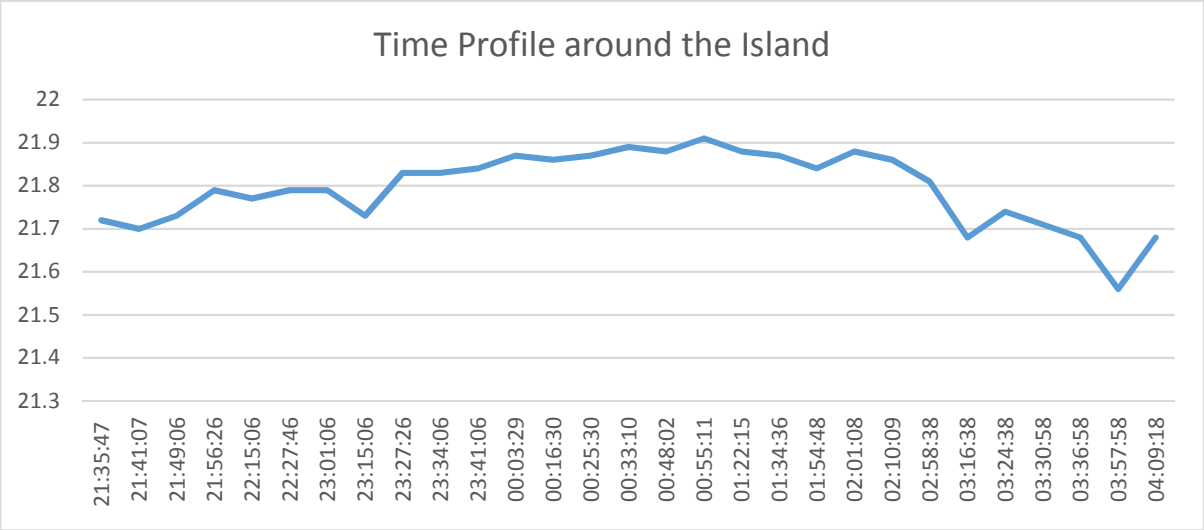


Chart 4: The Time Profile of the NSB of the 29 other locations observed during the In-Depth GBI Survey

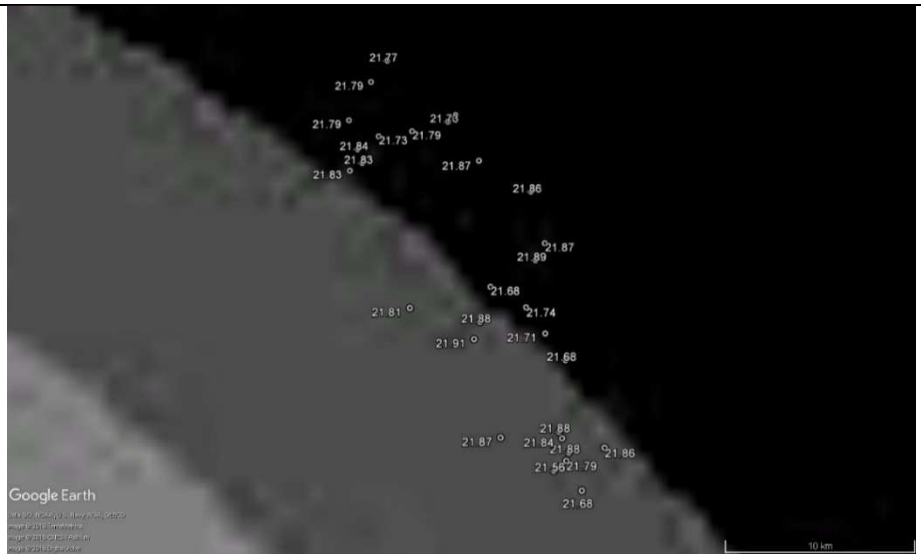


3.9 Interpretation of Survey Results

Given the total absence of man-made lighting on the island and the absence of all but the faintest of light domes very near the horizon from Auckland city at a couple of locations, the likely explanation for these small variations between locations (maximum of 0.35 mpsas i.e. 21.91 mpsas minimum 21.56 mpsas) rather than uniform measurements given apparently identical observing conditions, is that it is due to atmospheric changes during the night which was too subtle to notice, combined with the changing position of the Milky Way. Given the observed standard deviations of up to 0.1 mpsas, SQM precision error of +/-0.1 mpsas and the impact of the Milky Way of 0.1-0.3 mpsas, the 0.35 mpsas difference between the locations is insufficient to conclude that some locations are notably darker than others.

Further, although intuitively and from the World Atlas (dark grey and black zones shown for GBI) one would expect the North-Eastern side of the island to record higher readings than the South-Western side, no clear delineation is apparent in the findings - see Figure 5 below where the survey results are transposed on the World Atlas (with GBI area enlarged).

Figure 5: NSB for various Great Barrier Island sites presented on the World Atlas map



The difference between the black and dark grey areas of the island in the model (21.96 – 21.97 mpsas for dark grey and >21.97 mpsas for black) of 0.1 mpsas is negligible. The difference of 0.18 mpsas between the survey mean measurement of 21.79 mpsas and the World Atlas's >21.97 mpsas falls within the +/- 0.1 mpsas error margins for each of the measurements and for the SQMs (i.e. total error margins of +/- 0.2 mpsas) and thereby confirms the findings that the NSB of the entire island is very similar.

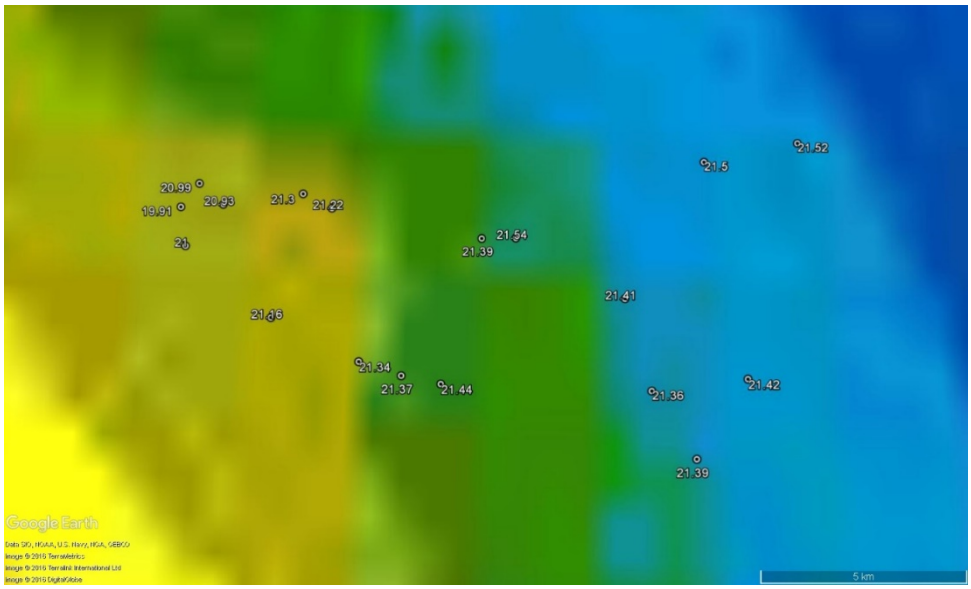
4. Comparison with Waiheke Night Sky Brightness

The Waiheke NSB Survey was carried out between the hours of astronomical twilight on Moonless low-cloud nights on 20 August (Western half) and 6 September (Eastern half) using the same methodology as GBI Initial Survey.

Waiheke NSB average of 21.3 mpsas (range of 19.91 – 21.54 mpsas) is on a par with bronze (20-20.99 mpsas) to silver (21 – 21.74 mpsas) standards for Dark-Sky Parks/Reserves of the International Dark Sky Association. The exception, reading for Matiatia recording 19.9 mpsas (just below <20 mpsas), was obtained at the far end of the lit-up Matiatia ferry terminal carpark which was included as a strategic site rather than as a dark sky site and would have slightly lowered the average for Waiheke.

The findings for Waiheke transposed on the World Map predictions (with Waiheke area enlarged) is given in Figure 6 below.

Figure 6: NSB for various Waiheke Island sites presented on the World Atlas map



The findings generally accord with the light propagation pattern (i.e. depending on respective distances from Auckland city) predicted by the World Map. However, these *in situ* measurements show the NSB of Waiheke to be brighter than the World Atlas predictions – see Table 4 below.

Table 4: Comparison of Waiheke's actual NSB with the World Atlas colour range predictions

Region	World Atlas Range	Observed Range
Light Blue	21.68 - 21.82	21.36 - 21.52
Dark Green	21.45 - 21.68	21.37 - 21.54
Yellowy Green	21.09 - 21.45	20.93 - 20.34

As both the Yellowy Green and Dark Green areas of the World Map i.e. those closer to Auckland city are more or less in line with the World Atlas predictions, the likely reason for the brighter than predicted NSB for the outer Light Blue area (it is in the same range as the Dark Green area) is locally generated light pollution. Waiheke lifestyle has changed dramatically over the past 20 years with more frequent ferry service and almost all amenities now available on the island. With this has come the 'urbanisation' of the island and with it the concern that it might become a satellite suburb of Auckland.

Although brighter NSB than the World Map predictions is not a major issue at present, given that the skies are still dark enough, the NSB of Waiheke should be regularly monitored on an ongoing basis because, left uncontrolled, the balance could tip resulting in a significant deterioration of Waiheke's night skies.

These findings:

- Confirm the generalised acceptability of the World Atlas predictions.
- Show the impact of rapidly increasing levels of localised light pollution from both public facilities and commercial/private sources.
- Show that the future impact from the increase in light propagation from the mainland Auckland is out of the control of the local community.

GBI should note the importance of:

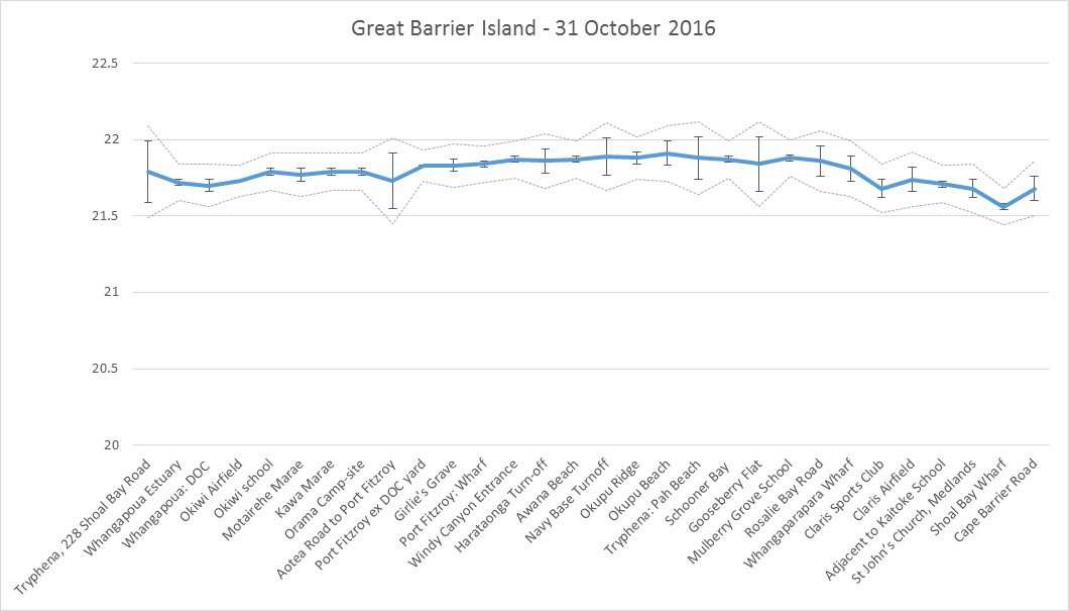
(i) Ensuring through appropriate Lighting Management Policies that there is no uncontrolled increase in localised light pollution over the coming years, and

(ii) Playing an advocacy role within the Auckland region in fighting light pollution through tighter and better-policed Lighting Management Policies.

5. Conclusions

The findings for Great Barrier Island night sky brightness measures are comprehensively summarised in Chart 5 below with the standard deviation for each location shown as error bars and the dotted lines above and below depicting the adjustment for the +/-0.1 mpsas SQM precision error. To keep the measures conservative, no adjustments have been made to any possible contribution to NSB from the Milky Way as it would have made the measurements darker.

Chart 5: The error bar inclusive NSB of the 30 locations observed during the In-Depth GBI Survey



The following can be concluded in relation to GBI's night sky brightness:

1. With a 95% confidence average of 21.63 mpsas and a range of 21.54 mpsas to 21.86 mpsas, the entire island comfortably meets the IDA's qualifying criteria of >21.5 mpsas for night sky brightness
2. With an average of 21.79 mpsas, GBI is on a par with New Zealand's only other IDA certified area, Tekapo Aoraki McKenzie with a NSB of 21.72 mpsas that gives it a Gold standard
3. GBI generally conforms with the predictions of the World Atlas with only a small explainable difference of 0.18 mpsas between the survey mean measurement of 21.79 mpsas and World Atlas prediction of >21.97 mpsas
4. NSB is uniform around the island as shown from the survey results and also the World Atlas where the difference between grey and dark areas shown for the island is a negligible 0.1 mpsas (21.96 – 21.97 mpsas for dark grey and >21.97 mpsas for black).

The night sky brightness of Great Barrier Island has now been confirmed by three independent means – the World Atlas (June 2016), Initial Survey (1 September 2016) and In-Depth Survey (31 October 2016). All three assessments show that GBI enjoys pristine night skies and would meet IDA's night sky brightness requirements for all their Dark Sky Places categories.

N. Davies

Nalayini Davies

Attachment 2 - Regulation for Dark Sky Protection

Population and Community Caveat:
Our Island is different, and it is crucial to keep in mind what makes it and its community distinctive.

a. A permanent population of 939;
b. No mains power--all power is generated locally—principally by solar domestic panels with generators as back-up;
c. No street lights or other public lighting. Advertising lighting is almost non-existent. There are no industrial sites with substantial outdoor lighting; commercial shop lighting is unobtrusive and shaded.
d. De facto automatic night curfew: no-one wants the cost of power generation if it's not necessary.

Consequently, in practical terms there is no significant light pollution at all originating on Great Barrier Island. The most common parting question at the end of an evening function on Great Barrier is: "*Do you have a torch?"*

Local Government
Great Barrier Island is incorporated under the Waitemata & Gulf Ward of Auckland Council. At a local level the island falls under the Great Barrier Local Board which is the community body responsible for making this application and will be responsible for guiding the implementation and monitoring process. Although the island is 100 kilometres north east of the metropolitan centre of the city it falls within the jurisdiction of the greater Auckland area.

New Zealand has a hierarchy of planning documents at a national, regional and district level. The Resource Management Act 1991 is the main piece of legislation that governs how we manage the environment. The hierarchy of documents moves from the general to the specific in regards to both content and locality.

Part 2 of the RMA sets out the core principle of sustainable management of natural and physical resources;

National Policy Statements (including the Coastal Policy Statement) set out objectives and identify policies to achieve those objectives from a national perspective;

Regional policy statements identify objectives, policies and methods in relation to particular regions;
Rules are found in both regional and district plans, which also identify objectives, policies and methods.

In 2010 the Auckland area underwent a major political reorganisation resulting in the unification of the entire region previously comprising eight separate councils under one new Auckland Council. As a result of this reorganisation the policy statements and district level plans for the entire region are in the process of revision and harmonisation. The operative district planning document for Great Barrier, the Auckland Council District Plan Hauraki Gulf Islands Section (Operative 2013) was excluded from this process, but once the comprehensive document for the city is finalised the process of bringing the island under the complete protocols of the Unitary Plan will begin. The Council is responsible for preparing, determining

and enforcing the plans which determine the regulatory structure of the island. Auckland Council is the Territorial Authority for planning, monitoring and enforcement purposes, and is the appropriate jurisdiction higher than community level for assuring that the dark skies are recognised as an important scientific, natural, cultural and scenic resource for the wider Auckland community and for Great Barrier in particular.

In relation to the Dark Sky Sanctuary proposal the following legislation, plans and policy documents are relevant:

The Resource Management Act (1991)
National Coastal Policy Statement (2010)
Regional Policy Statement (within the Auckland Unitary Plan - Operative in part):
Regional Policy Statement B8 – Coastal Environment
Regional Policy Statement B4 – Natural Heritage
Auckland Council District Plan - Hauraki Gulf Island Section (Operative 2013)
Auckland Unitary Plan (Operative In Part)

The Resource Management Act (1991)

New Zealand's environment and development is governed by the comprehensive powers of The Resource Management Act (1991). A copy of Sections 5, 6 & 7 of this act are attached in the Appendices. The purpose of the act is "*to promote the sustainable management of natural and physical resources."* which is further explained:

> (2) In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while—
>
> **(a)**sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
> **(b)**safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
> **(c)**avoiding, remedying, or mitigating any adverse effects of activities on the environment.

The act further lists areas of national importance, including:

> 6.(b) the protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development:
>
> 7 Other matters
>
> In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to—
> …
> (c) the maintenance and enhancement of amenity values:
> …

(f) maintenance and enhancement of the quality of the environment:
(g) any finite characteristics of natural and physical resources:

Activity Status

The Resource Management Act provides for a hierarchy of activity statuses within a plan (from lenient to more restrictive): Permitted activities, Controlled Activities, Restricted Discretionary Activities, Discretionary Activities, Non-Complying Activities, and Prohibited Activities. These distinctions are important as indicators of the level of Council scrutiny and regulatory control applied to any activity.

The act further lays out the hierarchy of planning statements and requirements, policies, principles and procedures which govern land development and use, buildings, the use of natural resources, and any activity which may affect amenity values attaching to any area. This hierarchy includes National Policy Statements, including the National Coastal Policy Statement, Regional Policy Statements, Regional Plans and District Plans. In practical terms the document which crystalises this structure for Great Barrier Island is the Auckland Council District Plan Hauraki Gulf Islands Section (Operative 2013). However, to establish the planning context a brief survey of the relevant sections of the high level planning guidelines is included below.

New Zealand National Coastal Policy Statement (2010)

Policy 13 Preservation of natural character

(1) To preserve the natural character of the coastal environment and to protect it from inappropriate subdivision, use, and development:
(a) avoid adverse effects of activities on natural character in areas of the coastal environment with outstanding natural character; and
(b) avoid significant adverse effects and avoid, remedy or mitigate other adverse effects of activities on natural character in all other areas of the coastal environment; including by:
(c) assessing the natural character of the coastal environment of the region or district, by mapping or otherwise identifying at least areas of high natural character; and
(d) ensuring that regional policy statements, and plans, identify areas where preserving natural character requires objectives, policies and rules, and include those provisions.

(2) Recognise that natural character is not the same as natural features and landscapes or amenity values and may include matters such as:
(a) natural elements, processes and patterns;
(b) biophysical, ecological, geological and geomorphological aspects;
(c) natural landforms such as headlands, peninsulas, cliffs, dunes, wetlands, reefs, freshwater springs and surf breaks;
(d) the natural movement of water and sediment;
(e) the natural darkness of the night sky;
(f) places or areas that are wild or scenic;
(g) a range of natural character from pristine to modified; and (h) experiential attributes, including the sounds and smell of the sea; and their context or setting

Regional Policy Statement (Auckland Unitary Plan Operative in Part)

The Auckland Unitary Plan became 'Operative in part' on 15 November 2016. The parts of the plan that are still subject to appeal in the High Court and the Environment Court and are therefore not operative are noted within this analysis. Although some of the provisions discussed below, including all the mapping of the Outstanding Natural Landscapes, are subject to appeal, the information here provides an indication of the direction that Auckland Council is taking in these matters. We also note that the regional coastal plan provisions are also not considered operative until the Minister of Conservation has formally approved them.

The new regional policy statement recognises a wide range of natural characteristics, features, and processes which are important elements of the environment. These are covered in chapters relating the Natural Heritage, Coastal Environment, Rural Environment, and Environmental Risk.

Unitary Plan Chapter B4 Natural Heritage

In the opening section on issues arising from protecting natural heritage features in the context of a rapidly developing city, the policy statement makes this statement: "Protecting outstanding natural features and landscapes and the natural character of the coastal environment, wetlands, lakes and rivers from inappropriate subdivision, use and development, and maintaining the contribution of landscape values to high amenity values, all need active stewardship if these qualities are to survive to meet the needs of future generations."

> B4.1. This issue has been extended to the following relevant objectives
> B4.2. Outstanding natural features and landscapes
> B4.2.1. Objectives
> (1) Outstanding natural features and landscapes are identified and protected from inappropriate subdivision, use and development.
> (2) The ancestral relationships of Mana Whenua and their culture and traditions with the landscapes and natural features of Auckland are recognised and provided for.

And the approach is further expressed in the following relevant policy statements (note that the italicised policies are subject to appeal and are therefore not considered operative at this time:

> B4.2.2. Policies
> Identify, evaluate and protect outstanding natural landscape
>
> (1) Identify and evaluate a place as an outstanding natural landscape considering the following factors:
>
> (a) natural science factors: geology, topography, hydrology, vegetation cover, ecology and natural processes;
> (b) expressiveness/legibility: including the degree to which the landscape reveals its formative processes;
> (c) aesthetic values and memorability: including landmarks and significant views;
> (d) perceptions of naturalness: related to human influences, the presence of buildings and structures or landform modification;
> (e) transient landscape values: including those related to natural processes, such as seasonal change and the presence of wildlife;
> (f) shared and recognised values: including the public profile and recognition of particular landscapes;
> (g) Mana Whenua: the value of the landscape to Mana Whenua;
> (h) historical: the landscape's known historical associations.

(2) Include a place identified as an outstanding natural landscape in Schedule 7 Outstanding Natural Landscapes Overlay Schedule.

(3) Protect the physical and visual integrity of Auckland's outstanding natural landscapes from inappropriate subdivision, use and development.

(4) Identify and evaluate a place as an outstanding natural feature considering the following factors:

(a) the extent to which the landform, feature or geological site contributes to the understanding of the geology or evolution of the biota in the region, New Zealand or the earth, including type localities of rock formations, minerals and fossils;
(b) the rarity or unusual nature of the site or feature;
(c) the extent to which the feature is an outstanding representative example of the diversity of Auckland's natural landforms and geological features;
(d) the extent to which the landform, geological feature or site is part of a recognisable group of features;
(e) the extent to which the landform, geological feature or site contributes to the value of the wider landscape;
(f) the extent of community association with, or public appreciation of, the values of the feature or site;
(g) the potential value of the feature or site for public education;

Although a conservative approach to the protection of landscapes may exclude the nightscape or skyscapes from the strict definition of a 'landscape', the broad principles which underpin the policy statements and the RMA provide a sound basis for principled inclusion of the IDA guidelines into the Unitary Plan as it is applied on Great Barrier, viz: environmental protection and enhancement, a precautionary approach, protection of amenity values, and in all situations the avoidance, mitigation and remediation of adverse effects on the environment.

Chapter B8 Coastal Environment

B8.2. Natural character
B8.2.1. Objectives
(1) Areas of the coastal environment with outstanding and high natural character are preserved and protected from inappropriate subdivision, use and development.
(2) Subdivision, use and development in the coastal environment are designed, located and managed to preserve the characteristics and qualities that contribute to the natural character of the coastal environment.
(3) Where practicable, in the coastal environment areas with degraded natural character are restored or rehabilitated and areas of high and outstanding natural character are enhanced.

These objectives have been expressed through the following applicable policies:

B8.2.2. Policies

(1) Identify and evaluate areas of outstanding natural character or high natural character considering the following factors:
…
(e) the natural darkness of the night sky;

Thus the Coastal Plan clearly includes the natural darkness of the night sky as a planning objective at the regional level. The entire coastline of Great Barrier falls within the coastal marine protection area, which provides high level support for the detailed prescriptions of the Operative District Plan.

Auckland Council District Plan Hauraki Gulf Islands Section (Operative 2013)

The Auckland Council District Plan Hauraki Gulf Islands Section (Operative 2013) crystallises the legal requirements of the Resource Management Act, and the directive strategies of the National and Regional Policy Statements. The Hauraki Gulf Islands District Plan covers all the offshore islands of the greater Hauraki on the Eastern seaboard of Auckland City. This is an extremely large area. For practical purposes the plan has to deal with two major inhabited islands: Waiheke and Aotea/Great Barrier Island. Waiheke island is in the inner gulf, in close proximity to the central city, and adjacent to the coastal eastern residential suburbs. Waiheke has a rapidly growing population and in respect of lighting has to deal with the normal demands of street lighting, signage, recreational lighting, and commercial lighting. Waiheke is in part a suburb of the metropolitan area. In contrast. Great Barrier Island is an isolated rural island largely covered by forest. Given its isolation, the time involved in getting to the island, its lack of development, and its lack of facilities, the controls and detailed prescriptions which are immediately relevant to Waiheke are largely superfluous on Great Barrier Island.

Great Barrier Island's point of difference

However, the lighting criteria and requirements in the plan do apply to Great Barrier Island, although the context is radically different from any part of the metropolitan city: our extremely small and widely distributed population, the absence of street lighting, and minimal commercial lighting. The initial Lighting Inventory below demonstrates the virtual absence of outdoor lighting in residential, commercial and light industrial areas. There is no likelihood that this situation will change in the foreseeable future.

The operative plan is the major planning document controlling design and development on the island. In respect of lighting, the plan's objectives and policies are as follows:

Hauraki Gulf Islands District Plan

4.10 Lighting

4.10.1 Objective

To provide for outdoor artificial lighting to enable travel, work, entertainment and recreation activities to be undertaken during the hours of darkness while ensuring that the lighting does not have any adverse effects on the environment or the amenity values of surrounding areas.

Policies

1. By controlling the intensity, location and direction of artificial lighting so as to avoid light spill and glare onto adjacent sites and the loss of night time viewing.
2. By controlling where appropriate, the use of artificial lighting where it will extend the operation of outdoor activities into night-time hours.
3. By controlling artificial lighting at the boundary of private land by bylaws made under the Local Government Act 2002.
4. By controlling the lighting of heritage items and their scheduled site surrounds.
5. By avoiding, remedying or mitigating the adverse effects of lighting on the night sky.

4.10.2 Resource management strategy

Outdoor artificial lighting is essential to enable travel, work, entertainment and recreation activities to be undertaken safely beyond daylight hours. Artificial lighting can also contribute to amenity and security. However, unless artificial lighting is used with care it can adversely affect neighbouring properties and public places, through light spill and glare. Inappropriate use of artificial lighting can also lead to the loss of night sky viewing. Therefore, appropriate controls have been placed on the lux illuminance throughout the islands.

4.10.3 Permitted activities

The use of artificial lighting producing an illuminance up to but not exceeding 150 lux, measured at any point on the site containing the light source, in a horizontal or vertical plane at ground level or at the exterior of any building within or adjacent to the site on which the lighting is placed, is a permitted activity.

4.10.4 Discretionary activities

The following are discretionary activities:

1. The use of artificial lighting producing an illuminance exceeding 150 lux, measured at any point on the site containing the light source, in a horizontal or vertical plane at ground level or at the exterior of any building within or adjacent to the site on which the lighting is placed.

2. Exterior lighting on any scheduled item or within its scheduled site surrounds.

4.10.5 Assessment criteria for discretionary activities

The council's assessment of an application for a discretionary activity under rule 4.10.4 will include consideration of the following matters:

1. The extent to which the outdoor lighting is located, directed and designed to ensure that glare is not directed at adjacent sites.

2. The extent to which glare from outdoor lighting causes loss of amenity to adjacent sites.

…..

4. Whether outdoor lighting appropriately lights public and semi-public areas in a manner consistent with the principles of crime prevention through environmental design.

Objectives of the District Plan

Objective 4.10.1 provides the basis for a high level of protection: ***"while ensuring that the lighting does not have any adverse effects of the environment or the amenity values of surrounding areas."*** This objective requires a precautionary approach to be adopted by the planning authorities towards any future development proposal and for common sense principles to be applied to lighting management of the extremely small number of affected sites. The objective was written before the Sanctuary status was conceived or considered by the island community. Application of the objective is achieved through policy 5: ***"By avoiding, remedying or mitigating the adverse effects of lighting on the night sky."*** The technical data indicate that the local lighting effects throughout the island are virtually nil. Critically, the major light polluters in urban, suburban, or even developed rural areas: street lights, major public amenity lights,

industrial lighting, etc. do not exist on Great Barrier, and are unlikely to ever be proposed for the island. The 'light dome' of the greater Auckland City area has no significant effect on the night sky light quality on the island. Residential outdoor lighting is virtually non-existent or at such a low level as to be not significant.

The luminance level set for lighting to fall within the class of Permitted Activities, those that do not currently require specific Council approval is outlined in 4.10.3. It is noted above that the luminance level of 150 lux determines whether activities are Permitted or Discretionary and thus subject to a much great level of scrutiny. In principle, it is unlikely this adjustment will be a problem. The new Unitary Plan for the metropolitan area of the city sets 100 lux above background levels with a curfew of 2200hrs with an illuminance level of 10 lux above background levels for areas in Lighting category 1 (Intrinsically dark). Details of the Unitary Plan and its relevance are considered below.
Under the operative District Plan outdoor lighting with luminance levels above 150 lux is set as a Discretionary Activity. This allows the Council a very high level of control over the installation, placement, design and use of any outdoor lighting. The assessment criteria which are applied by the Council's planners are set out in 4.10.5 above. For the purposes of this application, critically, criterion 3 requires the planners to assess: **"3. The extent to which glare from outdoor lighting detracts from the dark night-time sky environment. "**

Consequently, a high level of night sky protection is already available under the operative District Plan. Establishing the sanctuary with international recognition would give added salience to these provisions of the planning regime, and increase the awareness among planners, developers and property owners of their responsibilities under the Plan. This is not seen as being a major change for either plan implementation or local behaviours. The Resource Management Act and the District Plan call for adverse environmental effects to be avoided, remediated, or mitigated. In the context of the IDA application, the planning tools are immediately available: shielding or shading outdoor lights, curfews, and encouragement of the practical virtual curfew which already exists on the island. There are no street lights or large public/private lights on the island.

Development under the District Plan

The Auckland Council District Plan Hauraki Gulf Islands Section specifically sets out to limit inappropriate subdivision and development on the island. The District Plan seeks to restrict development to eight specified 'settlement' areas, which are themselves highly restricted geographically and in terms of the intensity and amount of development that is possible within their areas. The settlement areas are very small as can be seen in the section **Land ownership and community.** Given the limited growth of population anticipated for the island, no substantive change to the character of the settlement areas is likely, and any attendant effects on the night sky environment will be minimal. Light readings were taken for all settlement areas and the results were no different from the surrounding 'dark' natural and conservation areas. Large scale development on the island is not envisaged under the operative plan, nor is it in the scope of current planning strategies for the city. The geography of the island and its distance from urban areas mean that development at even a small low-grade suburban level is not a serious concern. Light pollution issues attendant on such development are, therefore, not a concern.

Status of the District Plan: Moving to the Unitary Plan

The Auckland Council District Plan Hauraki Gulf Islands Section is the current operative district plan. In the future, this plan will be brought within the ambit of the Auckland Unitary Plan that now applies to the entire city area. The regional policy statement and regional plan components of the Auckland Unitary Plan (Operative in Part) already apply on the island. The current low light levels on Great Barrier and the current regulatory structure have maintained the quality of night sky readings available across the entire island. Maintaining and enhancing this protection will fall under the normal planning process of moving the regulatory structure under the Unitary Plan. We believe that only minor changes to the regulatory structure and regime will be required, and these can be incorporated within the planning process that is already underway. Enhancing the planning regime to ensure the IDA guidelines are incorporated within the islands will not require a separate procedure or hearings process.

The process of incorporating the Hauraki Gulf Islands into the Auckland Unitary Plan will assess the appropriateness of the District Plan to current needs and assess what changes will be required to its provisions. The review will also assess the changes which the merger will require within the Unitary Plan itself to incorporate such a 'different' spot as Great Barrier Island. The city recognises that the island is a very distinct community and that its environmental character needs special treatment within the wider planning context. However, the principles on which the Unitary Plan is based are compatible with the Hauraki Gulf District operative plan. The Local Board has endorsed the strategy of bringing the island within the limits outlined in the IDA Sanctuary guidelines, and will propose amendments to the Unitary Plan to ensure these are incorporated when the Unitary Plan is amended to include Great Barrier Island.

Auckland Unitary Plan

Although Great Barrier is not included yet under the district rules of the Auckland Unitary Plan, it is pertinent to include a review of how the question of protection of dark sky qualities is treated under the Unitary Plan. Lighting is covered under Chapter E24 of the Auckland Unitary Plan. The Unitary Plan was prepared for a modern, expanding metropolitan area. No part of the city matches the combination of isolation, low population, lack of mains power, lack of street lighting, the general absence of outdoor lighting, or the existing threshold of dark sky qualities that are a feature of Great Barrier island. Thus the detailed rules and activity tables outlining lighting policies which are presented in the Unitary Plan are largely irrelevant to Great Barrier. However, the background statement gives considerable support to the principles on which the Dark Sky initiative is based:

> **E24.1. Background**
>
> Artificial lighting enables work, recreation and entertainment activities to occur beyond normal daylight hours. It also provides additional safety and security to sites and associated activities. However, unless used with care, it can adversely affect adjoining properties through light spill and glare. If screening or aiming of light is poorly controlled this can result in light pollution causing adverse changes to the view of the night sky.
>
> The provisions for artificial light provide for adequate lighting to support activities and enable safety and security for participants, while minimising potential adverse effects.

The resulting objectives and policy guidelines are as follows:

> **E24.2. Objectives**
>
> (1) Artificial lighting enables outdoor activities and the security and safety of people and property.
>
> (2) The adverse effects of outdoor lighting on the environment and safety of road users are limited.
>
> **E24.3. Policies**
>
> (1) Provide for appropriate levels of artificial lighting to enable the safe and efficient undertaking of outdoor activities, including night time working, recreation and entertainment.
>
> (2) Control the intensity, location and direction of artificial lighting to avoid significant glare and light spill onto adjacent sites, maintain safety for road users and minimise the loss of night sky viewing.
>
> (3) Use area or activity specific rules where the particular functional or operational needs of the area or activity make such rules appropriate.

The Resource Management strategies and policy guidelines of the Unitary Plan are therefore consistent with those outlined in the Hauraki Gulf District Plan. Dark Sky Sanctuary status for the island will help ensure that the IDA guidelines and determinations are fully considered in the process of moving the operative plan under the ambit of the wider Unitary Plan. Further comfort is provided within the details of the Unitary Plan. Lighting activities that do not comply with the permitted activity standards are a Restricted Discretionary activity where Council has matters of discretion that it is able to consider when making a decision on an application. Superficially, this appears to be slightly more lenient than applies under the operative District Plan. However, the council has specifically included amenity values and night-sky viewing within those matters over which it maintains control. The effective regulatory control, therefore, will be the same. However, the threshold for luminance levels under Zone 1 and Zone 2 activities is arguably lower under the Unitary Plan.

Lighting and Restricted Discretionary Activities

Under the Unitary Plan the Council has restricted its discretionary control of lighting as follows:

> **E24.8.1. Matters of discretion**
>
> The Council will restrict its discretion to all of the following matters when assessing a restricted discretionary activity resource consent application:
> (1) the effects of lighting on traffic safety; and
> (2) the effects of artificial lighting and glare on the amenity values and the character of the neighbourhood.
>
> **E24.8.2. Assessment criteria**
>
> The Council will consider the relevant assessment criteria for restricted discretionary activities from the list below:
> (1) for traffic safety:
> the extent to which any artificial lighting will adversely affect traffic safety;

(2) for the effects of artificial lighting and glare on amenity values:

(a)whether the number, placement, design, height, colour, orientation and screening of light fittings and light support structures minimises light spill, glare, and loss of night time viewing;

(b)the extent to which the amount of light falling beyond the site during the hours of darkness is minimised to control effects on indoor amenity values and sleep quality; and

(c)whether the artificial lighting is necessary, suitably designed and adequately protects the amenity values of the surrounding environment.

In fact, these provisions provide a high level of protection of dark sky values and status. Under NZ planning, 'amenity values' are very loosely defined, but provide for quite restrictive levels of protection to be applied for a considerable variety of factors. As factors such as 'light spill, glare, and loss of night time viewing' are explicitly listed in the assessment criteria along with generic terms such as 'amenity values of the surrounding environment, maintenance of local character, protection of natural character, etc.' It would appear that a relatively high level of protection will be available under the generic provisions of the Unitary Plan and Regional Policy Statements. Specific guidelines with regard to shielding and design of outdoor lighting will need to be included in any revised version of the Unitary Plan which incorporates Great Barrier. But, it was evident in the data collection exercise, that concerns about outdoor lighting affecting the quality of night skies on Great Barrier are largely theoretical and are not borne out in the actual night environment. If the island is adopted as a Dark Sky Sanctuary, the precautionary principle, which must be adopted as a planning strategy, will ensure that the IDA guidelines become an important aspect of the decision-making process for any building or development project, albeit the level of such activity will be extremely low.

Unitary Plan Lighting category classifications.

Table E24.6.1.1 (see appendix xx) breaks out the various land use zones that have been applied across Auckland City. We stress that these zones do not apply, as such, to Great Barrier Island, although the Settlement Areas on Great Barrier have some characteristics in common with Residential-Rural and Coastal Settlement Zone, and the Open Space-Conservation Zone, General Coastal Marine Zone, Rural Conservation Zone, Countryside Living Zone, and Rural Coastal Zones share attributes with some settlement areas and the range of Landforms designated under the District Plan. The Unitary Plan divides lighting into four categories:

a. **Lighting Category 1 (Intrinsically dark)**
b. **Lighting Category 2 (Low brightness)**
c. **Lighting Category 3 (Medium brightness)**
d. **Lighting Category 4 (High brightness)**

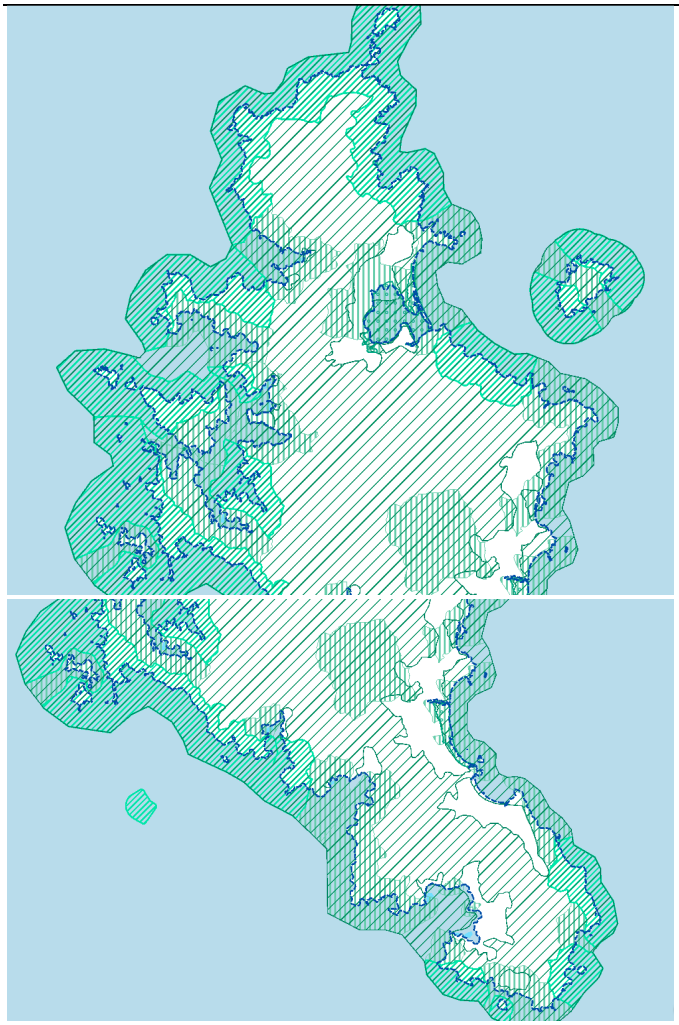
The categories determine permitted luminance levels and thresholds for different land use zones. In principle applying these categories would commit the Great Barrier Local Board and the Auckland Council to ensuring that the lighting luminance, brightness assessments and background thresholds would be not greater than Lighting category 2 in settlement areas and on private land in the other

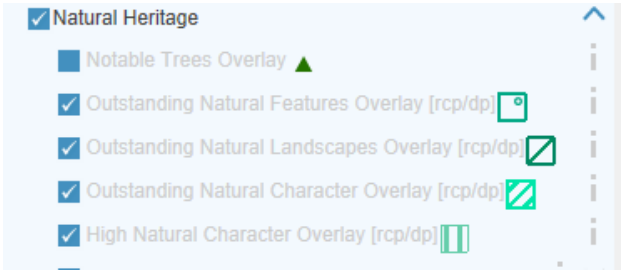
landforms. As over 50% of the island is within the estate managed by the Department of Conservation this large area will lie within the zone characteristics for Lighting 1. In practice these commitments deal with a theoretical issue of development, rather than the actual situation on the island. In practice the entire island falls within an 'intrinsically dark' definition, and the small groups of residential and private areas would fall at worst at the low end of Lighting category 2. (Low brightness).

In summary, the operative Auckland Council District Plan Hauraki Gulf Islands Section and the Auckland Unitary Plan(Operative in part) currently provide adequate protection of the island's dark sky qualities as outlined in the IDA Dark Sky Sanctuary guidelines. **Dark Sky Sanctuary Status will ensure the IDA guidelines are included in any review of the Unitary Plan insofar as it will apply to Great Barrier Island.**

Outstanding Natural Landscapes (ONL)

In addition to the layers of protection provided by the National Policy Statements, Regional Policy Statements and the Operative version of the Hauraki Gulf District Plan, Great Barrier Island carries a further layer of environmental protection - designation as an Outstanding Natural Landscape. This categorisation is identified through planning map overlays which planners and developers are required to consult prior to any development. Although the skyscape and the dark sky nightscape do not strictly qualify as 'landscapes' under planning law, the overlay requires that a precautionary principle be applied to development within the area. As has been noted earlier, Sanctuary status, especially when incorporated into the new Unitary Plan may require a more proactive approach from planning and development specialists. As can be seen from the following map, virtually the entire island is affected by the ONL designation.




Natural Heritage
Notable Trees Overlay
Outstanding Natural Features Overlay [rcp/dp]
Outstanding Natural Landscapes Overlay [rcp/dp]
Outstanding Natural Character Overlay [rcp/dp]
High Natural Character Overlay [rcp/dp]

Attachment 3 – Lighting Inventory Significant Sites

Existing Light Sources

Informal approaches to owners of each nominated site or potential site on the '5 sites' inventory have been undertaken by Board members and the Dark Sky group to discuss options: fixture updating, colour temperature, shielding and/or curfews. All owners approached so far have been enthusiastic and have expressed willingness to meet the standards by either reviewing the fixtures on their sites or by enforcing a curfew of 22:00 hours to ensure they create no light pollution, subject to legal requirements to provide a safe environment for their normal functions. Light use at these 5 sites has been erratic as on several occasions when observations were planned, no outdoor lighting was being used. No technical readings were possible at any other potential site of possible systemic pollution as no lights have been observed on any surveys, or no outdoor lighting is currently installed or used at the site. There are fewer than 30 potential sites in the 'pubic/private monitoring inventory' on the entire Island of 288 sq km. Outdoor lighting at other private sites has been erratic and not noticeable on the assessment trips we have undertaken.

Light readings have been taken using a Digitech QM1587 meter. This meter is limited to readings of not less than 0.1lux but we believe this gives sufficient information to assist owners make the necessary decisions regarding shading and shielding. Colour temperatures have been assessed informally. There has been a bias towards fixtures of colour temperature >3000K in the past, as until recently the higher temperature lights have been more efficient 'power-saving' fixtures. New technology means 'softer and warmer' fixtures with colour temperatures in the range 2400K to 3000K will be promoted in the Board's information material and in the guidelines for planning consists in the Unitary Plan.

The Currach Irish Bar

The Currach is a small bar/restaurant set back from the road in the settlement area of Tryphena. Outdoor lighting consists of two advertising signs. From 25m these lights gave a combined lux reading of 0.3lux. Neither sign is shaded or shielded. Management of these signs have been discussed with the owners of the pub, who have expressed enthusiasm for the project. The pub is not open for most of the winter months of July and August. Given legal requirements on the owners for the protection of their patrons, management will involve some planning shading and shielding. The bar's licence means it is regularly open until midnight.

Currach Pub lighting

Tipi & Bob's

Tipi & Bob's is a small hotel, bar and restaurant complex in Tryphena. The outdoor lighting fixtures consist of wall-mounted neon lighting for security and illumination of outdoor stairways and a number of unshielded area lights. The owner of the hotel has expressed considerable enthusiasm for the Dark Skies project and has indicated a willingness to review fittings to ensure appropriate shading and shielding. The lighting has been monitored 3 times. The first was on the night of the Island-wide survey when the outdoor security lighting was identified. At a subsequent test on 15 December 2016 the outdoor security lighting was off; lobby lights gave a lux reading of 1.0lux from 25m at the road entrance to the complex. The management has indicated that the lobby lights are extinguished at c11:00pm every night when the restaurant and bar are closed. Security lights are only used when guests are assigned to the side rooms of the complex. The owner has sent a letter to the Dark Sky outlining her support for the application and her willingness to bring the venue within the specified targets.

Tipi and Bob's safety and security lighting

Great Barrier Island Social Club, Tryphena

The club has outdoor lights over the parking and tennis courts areas. Informal discussions have confirmed that the club will review the fixtures when possible and that it does apply a curfew on both the tennis courts and parking areas. Tennis lighting is always off before 10:00pm, and parking no later than 11:00. The club is only open 3 nights per week. No readings of the club's outdoor lights have been possible as they have always been off whenever the assessor has visited the club. The club's lighting is more a potential than real issue.

Tryphena Club safety lighting and tennis court lighting

Great Barrier Sports and Social Club, Claris

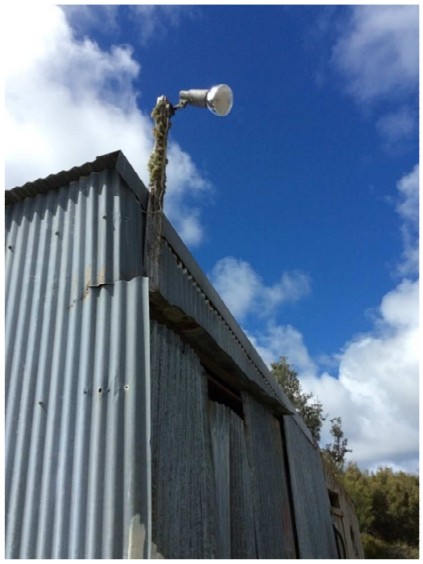
The club uses a number of large fixtures to illuminate the parking lot and outdoor children's play areas on Club nights (3 times per week: Wednesdays, Fridays, and Saturdays.) The club committee has discussed the issues and has indicated it will replace or alter the problem fixtures in the near future. The club applies a normal curfew, but will take steps to ensure the dark sky status is protected. The lights are powered from a diesel generator which is not in use outside club hours. Light surveys have been regularly undertaken at the club which is the venue for astronomy group evenings. There are two major light sources at the club:

i) Car Park security light. This outdoor security light is unshaded and unshielded. Light readings from the fixture have consistently been 0.7lux from 25m, dropping to 0.1 lux at the property boundary at 50m (Readings 17 March 2017, and several previous occasions).

ii) Deck Lighting and building security light. The second set of lights consist of globe lights under the deck roofing and one corner outdoor security light.

The globe lights are well shaded by the overhang of the deck roofing. The security light has given consistent readings of 0.3lux at 25m, dropping to <0.1 at 50m. The security light is unshaded and unshielded. The club has indicated it will review lighting fixtures and shielding to bring the lights within the Board's targets, subject to the need to provide sufficient outdoor lighting for reasonable safety in the parking lot and for the children's play area. The club has an automatic curfew. No lights are on when the club is closed, so by at least 11:00pm for all but a few nights per year. (Readings 17 March 2017, and several previous occasions).





Claris Club outdoor lighting and car park security lighting

Department of Conservation, Okiwi

The DOC lights are used at the Department's work yards at Okiwi. We have had positive indications that the fixtures will be reviewed in the near future. The DOC work yard is covered by 3 elevated security lights. These are unshielded and unshaded. These were surveyed on 14 December, 2016. The readings taken at 25m were: 1.0lux, 1.7lux, and 1.5 lux. A second reading taken at the entrance to the yard at 100m gave: 0.1lux; 0.2lux, and 0.2lux. The lights were only faintly visible from the Whangapoua DOC campground site which is approximately 1000m away and gave no measurable reading. The campground site was included in the dark sky survey.

Department of conservation safety and security lighting

Management of Significant Outdoor Lights

These sites have been noted as producing light spillage which is outside the minimum IDA requirements for special purpose lighting (>500 Initial lumens and/or >3000K). Details on site and fixture management are provided in the body of the application, but the summary table outlines the lux readings and preliminary management notes agreed with site owners to date.

LOCATION/Site	**Date**	**Lux Reading**	**Management Notes**
TRYPHENA			
The Currach Two advertising lights above entrance lobby.	17 March 2017	25m=0.3lux	Lighting essential for safety ingress and exit from the bar/restaurant area: legal requirement on owners. Owners have agreed to review shading and shielding options . Owners are highly supportive of DSS initiative.
Tipi & Bob's Two light sources: lobby	15 Dec 2016	Lobby lights 25m= 1.0 lux	Lobby lights are extinguished at c10:30 every night. Security lights only used when clients are assigned western rooms. Management has agreed to shade and shield lighting and take other steps to reach

lights and security lighting on western wall.		Security lights—no reading possible	compliance. Letter from management attached to the application.
Great Barrier Social Club Security lighting above car-park area (rarely used), Tennis/netball court lighting	No readings taken over numerous visits. Outdoor lights are rarely used.	No readings possible.	The outdoor lights are rarely used. Tennis/netball lighting is off <9:30pm. Parking lights rarely consistently used. Management will be approached regarding formalisation of curfew and shielding.
CLARIS			
Great Barrier Sports and Social Club. Three outdoor light sources: parking lot security light and security light at edge of the children's play area.	The site is used for the Astronomy Group, so numerous readings have been taken. The last date was 17 March 2017	Parking Lot 25m=0.7lux 50m=0.1lux Verandah globe lights are shaded with minimal upward spill. No separate reading possible. Verandah corner security light 25m=0.3lux 50m=0.1lux	Club management faces requirements for safety and reasonable lighting for the parking lot and play area. The club is only open 3 days per week, and a normal curfew of c10:30 applies on those nights. However, the club management has agreed to review lighting fixtures and if possible to arrange appropriate shading and shielding.
OKIWI			
Department of Conservation Estate working yard Three security lights (a,b &c) mounted on the corners of the storage sheds illumining the work yards. Lights at approx. 8-10metres height from ground.	14 December 2016	a) 25m=1.0lux b)25m=1.7lux c)25m=1.5lux a)100m=0.1lux b)100m=0.2lux c)100m=0.2lux a,b&c at 1000m. Lights faintly visible but not measurable with current equipment. Assessed from Whangapoua DOC camp-ground.	The Board has an excellent relationship with the Department of Conservation. The lighting fixtures and options will be discussed with senior management in the near future. No problem is forseen in adapting the DOC estate to the IDA specifications and the Board's outdoor lighting policies.

Attachment 4 – Lighting Inventory

The inventory table below summarises the intrinsically dark quality of the island. This survey includes all sites seen as potentially offering systemic lighting management issues. Residential sites have not been included, and did not pose any measurable light pollution after c11:00pm on the various occasions lighting was assessed for the inventory.

Sites of significance

Location	**Fixture**	**Fully-Shielded**	**Special Purpose (>=500 initial lumens)**	**Application & Management Proposed**	**Conformity with Lighting Management Plan**
Shoal Bay Wharf marshalling area	High tower lights.	NO	YES	Lighting for wharf marshalling area. For emergency use only. Requires generator to be brought on site for use. Will be subject to Council management. .	YES
Currach Pub, Pah Beach , Tryphena	Two outdoor advertising signs.	NO	**YES**	Currach Pub has two outdoor signs. Readings of 0.3lux were noted (17 March 2017). Lights are turned off at the end of trading; normally <11:00pm. Curfew has been agreed.	YES
Hotel security Lights (Tippi & Bob's)	2+ wall-mounted security neon lights on western wall. Lobby and entrance way lighting.	NO	**YES**	External wall security lights. Shielding to be reviewed with owner. Owner has agreed to review fixtures Ambient light of the lobby and entrance area was assessed from the road side at less than 0.3 lux. Curfew applies at <10:30pm	YES

Great Barrier Social Club	Outdoor Tennis/ netball Court Lights. Outdoor lights in parking area.	NO	YES	Only available when the club's generator is operating, so during club opening hours. In winter the club is open 3 nights per week until approx.. 10:00pm Summer hours are longer, but courts are not used past 10:00pm. Outdoor lights in the parking area are generator- dependent. No outdoor light readings have been possible as they have not been on for any assessment visit. Lighting issues to be discussed with management and curfew plan discussed. As with other clubs, (2) lighting is seen as essential for security and recreational amenities, but is managed by a realistic curfew and the de facto need to manage generator use.	YES
Great Barrier Sports and Social Club	Outdoor recreational lighting; outdoor light for parking area.	NO	YES 1x large area light is used to illuminate the generator shed and parking area; glove lights under porch roof and one security light for the children's play area.	See management strategy in body of report.	YES
Whangaparapara Wharf	NA	NA	NA	Lighting for wharf marshalling area. Only used for night ferry loading, which no longer occurs. Requires generator to be used. Not currently used. De facto curfew restricted to ferry sailing and loading. Lighting management will be discussed with Auckland Transport to set out procedures and plan.	YES

Okiwi Department of Conservation Settlement Area	3x External Security light arrangements(each with 2 bulbs)	NO	YES	Lighting provides illumination of the marshalling and security areas. The lights are minimal on assessment (14 Dec 2016), but shielding and placement will be discussed with the Department of Conservation. Measurement data is in the body of the report.	YES
Orama Camp	No external light apparent.	NA	NO	The site is the largest accommodation site on the island. No outdoor lighting has been observed.	YES
Port Fitzroy Wharf	Tower mounted lights for marshalling yard.	NA	YES	Lighting for wharf marshalling area. Only used for emergency lighting.. Requires generator to be used, linked to the shop. Lighting has been discussed with wharf management. The wharf is owned by a community organisation. The light management procedures will be discussed with the committee, but as the lights are not used this will be merely a confirmation of principles. No change is required.	YES

Sites warranting future monitoring

Location	**Fixture**	**Fully-Shielded**	**Special Purpose (>=500 initial lumens) and/or >3000K colour temperature**	**Application & Management Proposed**	**Conformity with LMP**
Shoal Bay Wharf marshalling area	High tower lights.	NO	YES	Lighting for wharf marshalling area. For emergency use only. Requires generator to be brought on site for use. Will be subject to Council management. .	YES

Mulberry Grove Shop	Advertising sign	NO	NO	Advertising neon light. Light is generally turned off after 10:00pm. Owner has voluntarily ceased use at night.	YES
Mulberry Grove School	Wall-mounted security lights	YES	YES	Only used during school hours or for after-hours meetings. Automatic curfew applies given power and generator constraints.	YES
Pah Beach, Stonewall Commercial centre	Nil	YES	NO	No outdoor lighting.	YES
Pah Beach, Currach Pub	Two outdoor advertising signs.	NO	YES	Currach Pub has two outdoor signs. Readings of 0.3lux were noted (17 March 2017). Lights are turned off at the end of trading; normally <11:00pm. Curfew has been agreed.	YES
Hotel security Lights (Tippi & Bob's)	2+ wall-mounted security neon lights on western wall. Lobby and entrance way lighting.	NO	YES	External wall security lights. Shielding to be reviewed with owner. Owner has agreed to review fixtures Ambient light of the lobby and entrance area was assessed from the road side at less than 0.3 lux. Curfew applies at <10:30pm	YES

Great Barrier Social Club	Outdoor Tennis/Basketball Court Lights. Outdoor lights in parking area.	NO	YES	Only available when the club's generator is operating, so during club opening hours. In winter the club is open 3 nights per week until approx.. 10:00pm Summer hours are longer, but courts are not used past 10:00pm. Outdoor lights in the parking area are generator- dependent. No outdoor light readings have been possible as they have not been on for any assessment. Lighting issues to be discussed with management and curfew plan discussed. As with other clubs, (2) lighting is seen as essential for security and recreational amenities, but is managed by a realistic curfew and the de facto need to manage generator use.	YES
Kaitoke Primary School	Nil	NA	NA	No external lighting	YES
Auckland Council Service Centre	Nil	NA	NA	No external lighting	YES
Great Barrier Medical Centre	Nil	NA	NA	No external lighting	YES
Arts & Heritage Village	No outdoor lighting. No indoor lighting left on after closing hours.	NA	NA	No external lighting	YES
Hooked on Barrier	1x OPEN sign	Neon sign	NA	Sign is shaded and only used during daylight hours. No action required	YES
Claris Shopping Centre	Security lights are irregularly left on inside each shop or cubicle/office. These consist of a Petrol Station kiosk,	Low level of vertical light emissions. Lights shielded by large overhang verandas.	Internal security lighting only, so no outdoor lighting >500 lumens.	Lights are effectively shielded from vertical light emission by large shades/veranda areas. Vertical pollution is very small. Some horizontal emission. In practice these lights are rarely left on. Several	YES

	a general goods store, a post office/shop and a small café, a laundromat and a small professional services office.			random reading attempts were unsuccessful as the lights had been turned off at close of business. Power requires a generator, so a natural curfew tends to be applied. No externally mounted lighting.	
The Rocks	Licenced liquor shop.	No outdoor/ external lighting	NO	No external lighting	YES
Angsana	Internal lights only	No	NO	No external lighting	Yes
Claris Airport	No Outdoor lighting. No runway lights. Visual flights rules apply, so no flights after sunset. No indoor lighting after the terminal building is closed.	NA	NA	No external lighting	YES
Great Barrier Sports and Social Club	Outdoor recreational lighting; outdoor light for parking area.	NO	YES 1x large area light is used to illuminate the generator shed and parking area; glove lights under porch roof and one security light for the children's play area.	See management strategy in body of report.	YES
Whangaparapara Wharf	NA	NA	NA	Lighting for wharf marshalling area. Only used for night ferry loading, which no longer occurs. Requires generator to be used. Not	YES

				currently used. De facto curfew restricted to ferry sailing and loading. Lighting management will be discussed with Auckland Transport to set out procedures and plan.	
Okiwi Department of Conservation Settlement Area	3x External Security light arrangements(each with 2 bulbs)	NO	YES	Lighting provides illumination of the marshalling and security areas. The lights are minimal on assessment (14 Dec 2016), but shielding and placement will be discussed with the Department of Conservation.	YES
Okiwi Airport	No night light provision. No lit terminal building.	NA	NA	No action required	YES
Okiwi Primary School	No outdoor lighting	NA	NA	No action required	YES
Motairehe Marae	No external lighting outside operating hours	NA	NA	No action required	YES
Kawa Marae	No external lighting outside operating hours	NA	NA	No action required	YES
Orama Camp	No external light apparent.	NA	YES	The site is the largest accommodation site on the island. Outdoor lighting limited to 3 fixtures. Lighting curfew applies @10:00pm	YES
Port Fitzroy Shops	No external lighting	NA	NA	No external lighting	YES
Port Fitzroy Boating Club	Club infrequently used. No major outdoor	NA	NA	No lighting noted during data collection	YES

	lighting detected.				
Port Fitzroy Wharf	Tower mounted lights for marshalling yard.	NA	YES	Lighting for wharf marshalling area. Only used for emergency lighting.. Requires generator to be used, linked to the shop. Lighting has been discussed with wharf management. The wharf is owned by a community organisation. The light management procedures will be discussed with the committee, but as the lights are not used this will be merely a confirmation of principles. No change is required.	YES

Attachment 5 - Local Board Resolutions and supporting documents regarding Lighting Policy

Extract from Minutes of the Great Barrier Local Board Meeting, 21 March 2017

Resolved that the Great Barrier Local Board:

a) *note that it has applied to the International Dark Sky Association (IDA) for recognition of Aotea-Great Barrier Island as a Dark Sky Sanctuary;*

b) request that the Auckland Council Planning Committee supports the inclusion of the IDA minimum specifications for Dar Sky Sanctuary status for Aotea-Great Barrier Island within proposed planning rules when the Hauraki Gulf Islands District Plan transitions into the Unitary Plan;

c) note that while the levels of outdoor lighting on Aotea-Great Barrier are extremely low and it is not aware of any proposals that would create issues for the proposed sanctuary, it requests that the Planning Committee asks officers to advise what steps can be taken to ensure that the island's day sky environment has adequate protection until such time as the Hauraki Gulf Islands Plan is transitioned into the Unitary Plan;

d) confirm that it is committed to a public education programme explaining the Dark Sky Sanctuary to the wider Aotea-Great Barrier community, and asks that the IDA guidelines be made available to any resource consent application for outdoor lighting on Aotea-Great Barrier;

e) establish an advisory group chaired by the local board Chair and including key island representatives with a role in the proposal to support and monitor the implementation of the Dark Sky Sanctuary and provide a forum to address issues and opportunities;

DRAFT GUIDELINES FOR OUTDOOR LIGHTING

Great Barrier Local Board has been confirmed as an International Dark Sky Sanctuary. This recognises that the night sky above Great Barrier is among the clearest in the world. The level of light pollution from outdoor lighting and light spill from commercial and residential lighting is extremely low or non-existent over most of the island. The Local Board and Auckland Council are working to keep it that way so that we can preserve the clarity of the island's night skies for future generations. We're asking for everyone's help.

Simple principles

A few very common sense principles will help keep the island's skies at their outstanding best. Simply put: Limit the amount and brightness of outdoor lighting to the minimum necessary; shade and shield all outdoor lighting to reduce horizontal and vertical light spillage—point the lights down; and turn lights off when you don't actually need them. It's also important to keep a check on the colour of the light you use. Lights in the reddish-yellow range are better than lights in the blue range. This is determined by the color temperature of the light. The international standard we are working towards sets 500 Initial lumens as the illuminance standard for unshielded or unshaded lights, and 3000K as the standard for colour temperature.

The Great Barrier Local Board and Auckland Council encourage residents and landowners to adopt these guidelines for outdoor lighting on the island.

G*uideline 1*: Limit outdoor lighting to what is absolutely necessary. Shield lighting fixtures and direct lights to reduce light spill and vertical light pollution.

Guideline 2: Ensure all outdoor lighting is fully shielded with light shades extending below the horizontal level of the bulb. This will reduce the amount of overspill of any lighting and prevent vertical light affecting the night sky. The island's target is to reduce lightspill from all outdoor light fixtures to between 0.05 lux and 0.1 lux at 1 metre (or higher) above ground level from the property boundary.

Guideline 3: Retrofitting and fixture replacement. Landowners and residents are encouraged to review all outdoor lighting and the move to light fixtures which are fully shielded wherever possible and practical. The Council can provide information of standard light fixtures which meet the accepted standards.

Guideline 4: Public land and reserves must have a standard of brightness of not greater than 500 Initial lumens and 3000K colour temperature unless fully shielded to IDA standards.

Guideline 5: Where sites are available for public use and public activities, for example clubs, the Board encourages development of site-specific light management plans to fully shield lighting to prevent light spill. The Board encourages the adoption of voluntary outdoor lighting curfews of 11:00pm for normal operations.

Guideline 6: The board encourages the adoption of an island-wide voluntary outdoor lighting curfew of 11:00pm.

Supporting Documents

1. Memo from Auckland Council

2. Outdoor Lighting Plan

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Memo

20 March 2017

To: John Nash, Relationship Manager Great Barrier Island Local Board

From: Warren Maclennan, Manager Planning North West & Islands

Subject: Planning Advice for Aotea Great Barrier Island Dark Sky Sanctuary Application

Background

1. A community-led group, with support from the Great Barrier Island Local Board, is preparing an application for Aotea Great Barrier Island to be considered for Dark Sky Sanctuary status. Dark Sky Sanctuary Accreditation is an international recognition for public or private land possessing an exceptional or distinguished quality of starry nights. The accreditation is awarded by the International Dark Sky Association (IDA) following a formal application process. The application is supported by the Auckland Astronomical Association and the Royal Astronomical Society of New Zealand.

2. Aotea Great Barrier Island has a permanent population of less than 1000 and more than 60% of the land is held as public reserve by the Department of Conservation and Auckland Council. There is no reticulated electricity or street lighting on the island and all power is generated locally through domestic solar panels and with generators. The island has a high level of darkness that qualifies it for Dark Sky Sanctuary status. If the application is successful Aotea Great Barrier Island will be the only Dark Sky Sanctuary in New Zealand and one of only three in the world.

3. At a meeting on 6 March 2017 with Mr Richard Sommerville-Ryan, representing the group seeking Dark Sky Sanctuary Accreditation for the island, and John Nash, the Relationship Manager for the Great Barrier Island Local Board, the North West and Islands Planning team undertook to provide written advice on the relevant regional and district plan provisions that may be applicable to the application.

4. This advice is provided on the understanding that it will form part of the application to the IDA.

District Plan rules

5. The relevant district plan for Aotea Great Barrier Island is the Auckland Council District Plan Hauraki Gulf Islands Section (Operative in part 2013). The lighting provisions are contained in Section 4.10. The relevant objective is 4.10.1:

   To provide for outdoor artificial lighting to enable travel, work, entertainment and recreation activities to be undertaken during the hours of darkness while ensuring that the lighting does not have any adverse effects on the environment or the amenity values of surrounding areas.

   The relevant policies to achieve the objective include the following policies:

   1. *By controlling the intensity, location and direction of artificial lighting so as to avoid light spill and glare onto adjacent sites and the loss of night time viewing*;

   5. *By avoiding, remedying or mitigating the adverse effects of lighting on the night sky.*

6. District plan rule 4.10.3 states that the following is a permitted activity:

   The use of artificial lighting producing an illuminance up to but not exceeding 150 lux, measured at any point on the site containing the light source, in a horizontal or vertical plane at ground level or at the exterior of any building within or adjacent to the site on which the lighting is placed, is a permitted activity.

7. Any lighting that does not comply with the permitted status of 150 lux requires resource consent as a discretionary activity. The assessment criteria for consideration of discretionary resource consent includes consideration of *the extent to which glare from outdoor lighting detracts from the dark night-time sky environment.*

IDA requirements and Future Regulatory requirements.

8. The IDA Guidelines for a Dark Sky Sanctuary includes the requirement for a Lightscape Management Plan that contains the minimum requirements for fully-shielded lighting fixtures apart from where fixtures contain lamps of no greater than 500 initial lumens, and lighting of a colour temperature no greater than 3000K.

9. The IDA Guidelines require a commitment for 100% of the lighting in the sanctuary to conform to the standards within 10 years of the sanctuary status being granted. The IDA requirements are based on containing light spill and controlling the brightness of any lighting, in order to protect the night sky viewing conditions. Although the district plan objective and policies relevant to Aotea Great Barrier Island broadly offer protection to the night sky, the explicit rules and the 150 lux permitted activity status do not offer the level of protection required by the IDA standards.

10. The IDA standard of a maximum of 500 initial lumens before shielding of the fixture is required is a measure taken at source that equates to the total amount of light emitted from the light source. The district plan standard of a maximum measure of 150 lux is generally applied at the site boundary and the measure takes into account the distance and area of measure, as well as the amount of light emitted at source. Lux is a way to measure what we see as brightness, and if the light is focussed in a small area it will appear brighter than if it is diffused across a large area. Under the district plan permitted standard of 150 lux, the light luminance at source could be considerably greater than 500 initial lumens, depending on the site size, the view angle and the distance of the light source from the point where the lux measure is taken. In this way the existing district plan rules are not strictly compatible with the requirements of the IDA.

11. The Auckland Unitary Plan (Operative in part 2016) (AUP) contains the regional level objectives and policies that apply to Aotea Great Barrier Island. Within the Regional Policy Statement, and where the island is subject to regional level overlays including Outstanding Natural Features and Landscapes, there is a level of protection offered to the 'natural darkness of the night sky' through relevant objectives and policies. However these sections of the AUP are not yet fully operative and are either partially subject to appeal or, in the case of the Regional Coastal Plan provisions require Minister of Conservation approval before becoming fully operative.

12. The AUP lighting rules contained in chapter E24 do not currently apply to Aotea Great Barrier Island and there is at present no clear timeframe for when the island will be brought into the AUP at the district plan level.

13. If Aotea Great Barrier Island is successful in its bid to be awarded Dark Sky Sanctuary status, the process for incorporating the island into the AUP would provide an opportunity for the requirements of the IDA to be included in the lighting rules for the island. Objectives, policies and specific rules could be put forward by council that limit lighting in order to protect night sky viewing. Specific lighting rules could potentially include requirements on the colour temperature

of lamps, the type of directional shielding required on fixtures, specific lux level limits for both inhabited and public reserve areas of the island, and lighting curfews.

14. Although it is the role of council to determine the lighting rules that will be proposed, significant factors that would influence this would include if the island had been awarded Dark Sky Sanctuary status and the Local Board's support for specific lighting limits. The consultation process required to incorporate the island into the AUP would also provide for consideration of public submissions on the proposed rules before they are finalised, and the plan and rules are made operative.

15. As there is no timeframe for when Aotea Great Barrier Island will be incorporated into the AUP, in the interim we understand from the information provided by Richard Sommerville- Ryan and the Great Barrier Local Board that there are virtually no sites on the island where outdoor lighting impacts on the night sky. To further support the IDA standards there is potential for the minimum IDA standards to be adopted on council owned land where outdoor lighting exists, such as Shoal Bay wharf. These discussions have been initiated with the relevant council departments.

16. We understand that the Local Board supports the bid for Dark Sky Sanctuary accreditation and will be confirming their support at the Local Board meeting to be held on 21 March 2017. In the event the application for Dark Sky Sanctuary accreditation is successful, and until an appropriate regulatory regime can be put into place through the AUP plan change process, council can continue to support the Local Board aspirations for keeping outdoor lighting on the island at a minimum. This could include making information available on the council's Local Board website and providing written information about the Dark Sky Sanctuary through the Claris service centre and as part of the pre-application and consenting process for developments requiring resource consent on the island. We understand that budget can be made available through the Local Board for producing educational information and leaflets on the Dark Sky Sanctuary should the IDA application be successful.

Conclusion

17. This information has been provided by the North West and Islands planning team in support of the application by the local community and the Great Barrier Island Local Board for IDA Dark Sky Accreditation for Aotea Great Barrier Island. Should Dark Sky Sanctuary status be granted, and at such time that Aotea Great Barrier Island is to be incorporated into the AUP, the North West and Islands planning team will continue to offer ongoing planning advice and support to the Local Board in relation to their aspirations for the specific lighting rules that are proposed for the island.

Outdoor Lighting Basics

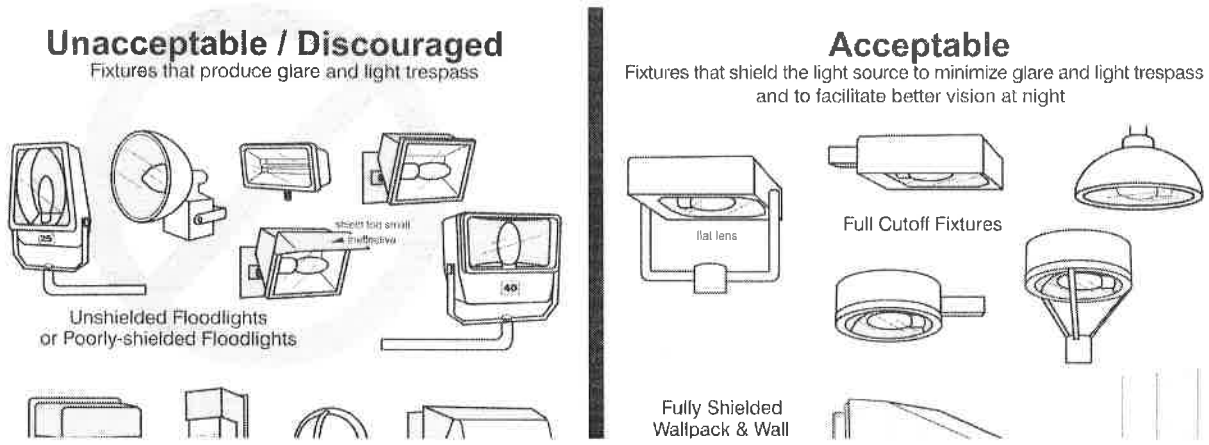
Modern society requires outdoor lighting for a variety of needs, including safety and commerce. IDA recognizes this but advocates that any required lighting be used wisely. To minimize the harmful effects of light pollution, lighting should

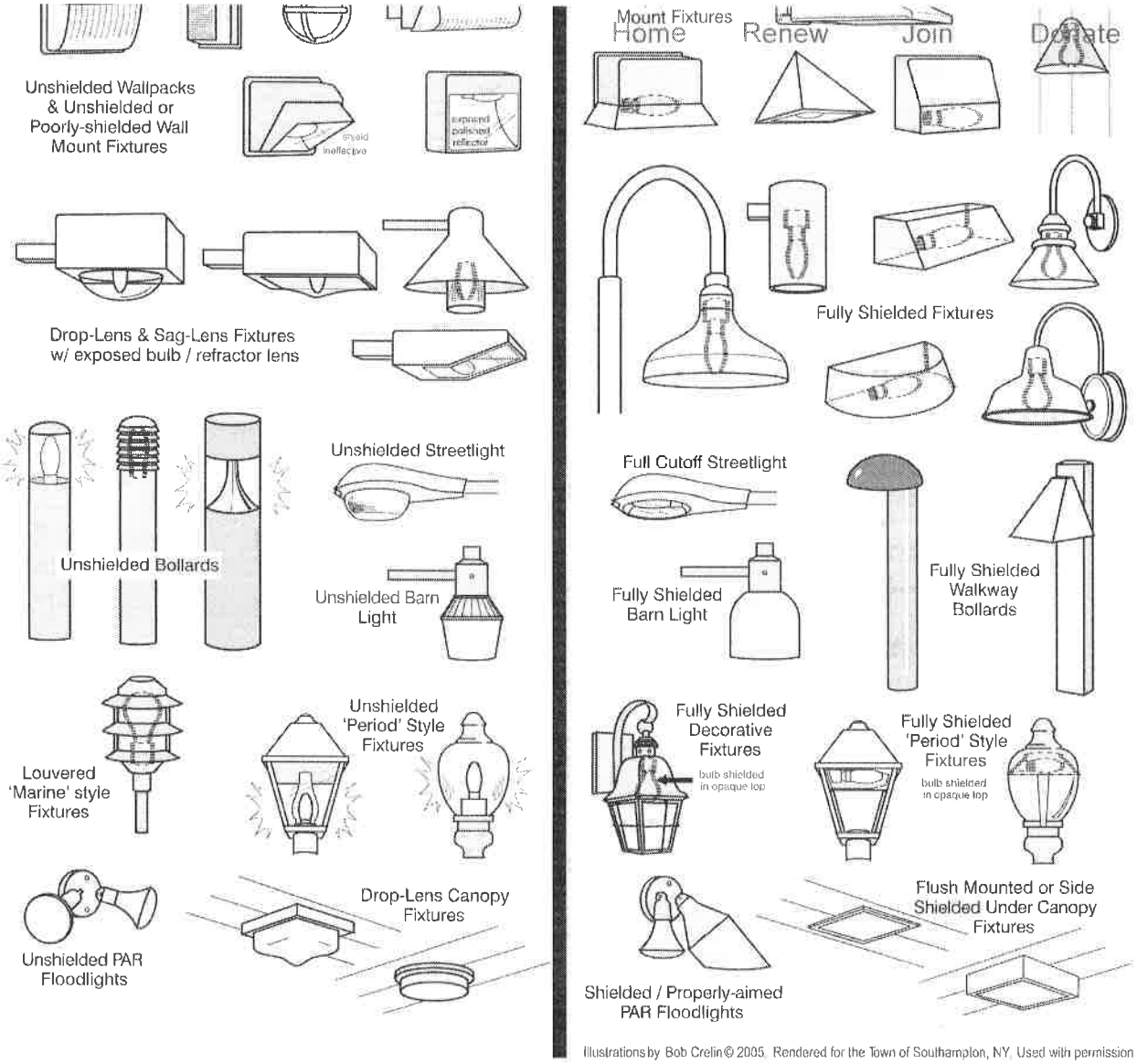
- Only be on when needed
- Only light the area that needs it
- Be no brighter than necessary
- Minimize blue light emissions
- Be fully shielded (pointing downward)

The illustration below provides an easy visual guide to understand the differences between unacceptable, unshielded light fixtures and those fully shielded fixtures that minimize skyglow, glare and light trespass.

Glossary of Lighting Terms

Examples of Acceptable / Unacceptable Lighting Fixtures





Are you looking for dark sky friendly lighting fixtures? Search our Fixture Seal of Approval database.

Types of Light

Most people are familiar with incandescent or compact fluorescent blubs for indoor lighting, but outdoor lighting usually makes use of different, more industrial, sources of light. Common light sources include low-pressure sodium ("LPS"), high-pressure sodium ("HPS"), metal halide and light emitting diodes ("LEDs").

LPS is very energy efficient, but emits only a narrow spectrum of pumpkin-colored light that some find to be undesirable. Yet, LPS is an excellent choice for lighting near astronomical observatories and in some environmentally sensitive areas.

HPS is commonly used for street lighting in many cities. Although it still emits an orange-colored light, its coloring is more "true to life" than that of LPS.

In areas where it's necessary to use white light, two common choices are metal halide and LEDs. One of the advantages of LED lighting is that it can be dimmed. Thus, instead of always lighting an empty street or parking lot at full brightness, LEDs can be turned down, or even off, when they aren't needed and then brought back to full brightness as necessary. This feature both saves on energy and reduces light pollution during the night.

Because of their reported long life and energy efficiency, LEDs are rapidly coming into widespread use, replacing the existing lighting in many cities. However, there are important issues to consider when making such a conversion. See our LED Practical Guide for more information.

Color Matters

As the illustration above, it is crucial to have fully shielded lighting, but we now know that the color of light is also very important. Both LED and metal halide fixtures contain large amounts of blue light in their spectrum. Because blue light brightens the night sky more than any other color of light, it's important to minimize the amount emitted. Exposure to blue light at night has also been shown to harm human health and endanger wildlife. IDA recommends using lighting that has a color temperature of no more than 3000 Kelvins.

Lighting with lower color temperatures has less blue in its spectrum and is referred to as being "warm." Higher color temperature sources of light are rich in blue light. IDA recommends that only warm light sources be used for outdoor lighting. This includes LPS, HPS and low-color-temperature LEDs. In some areas, the white light of even a low-color-temperature LED can be a threat to the local nighttime environment. In those cases, LPS or narrow-spectrum LEDs are preferred choices.

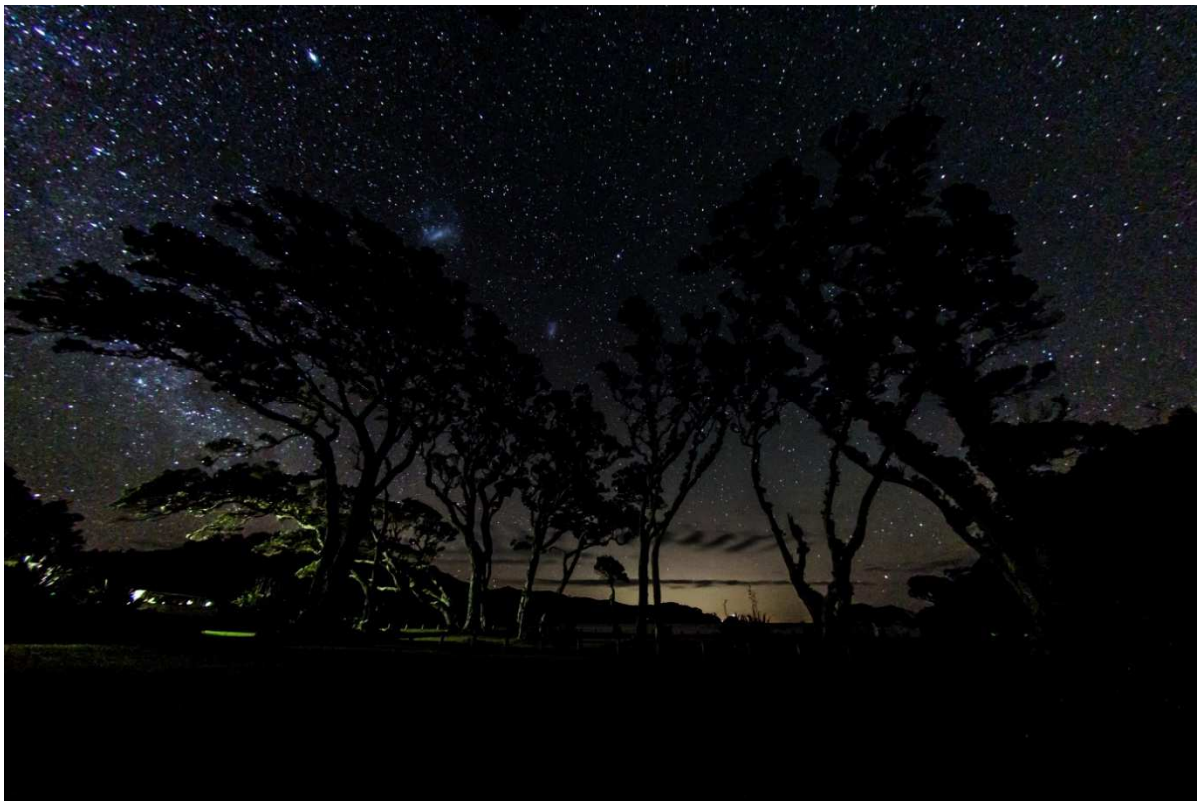
Finding What You Need

IDA doesn't sell dark sky friendly lighting, but our Fixture Seal of Approval program makes it easy for you to find the right products. The FSA program certifies dark sky friendly outdoor lighting – these are fixtures that are fully shielded and have low color temperature. Search our database and then check with your local retailer.

IN THIS SECTION

Lighting

Attachment 6 - Lighting Photographs

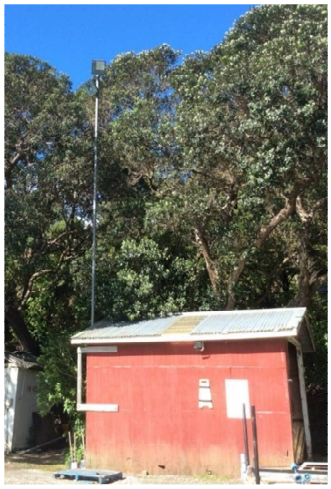


Above: Auckland's light dome does not impact on dark sky readings.

Above: The Island's main wharf at Tryphena. Emergency lighting only is powered by generator which needs to be brought on site.

Above: Lighting at Whangaparapara Wharf, powered by generator and only used in emergencies

Below: Lighting at Port Fitzroy Wharf. Again, powered by generator and only used in emergencies.




Claris Airfield runway

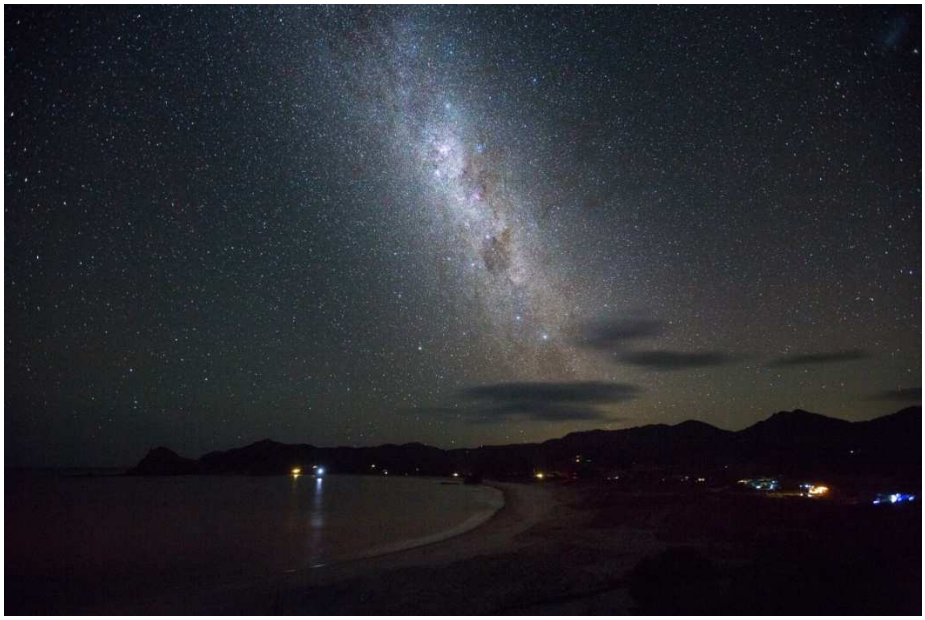

Okiwi Airfield runway

Below: The marae and settlement area at Motairehe

Below: The settlement area of Awana

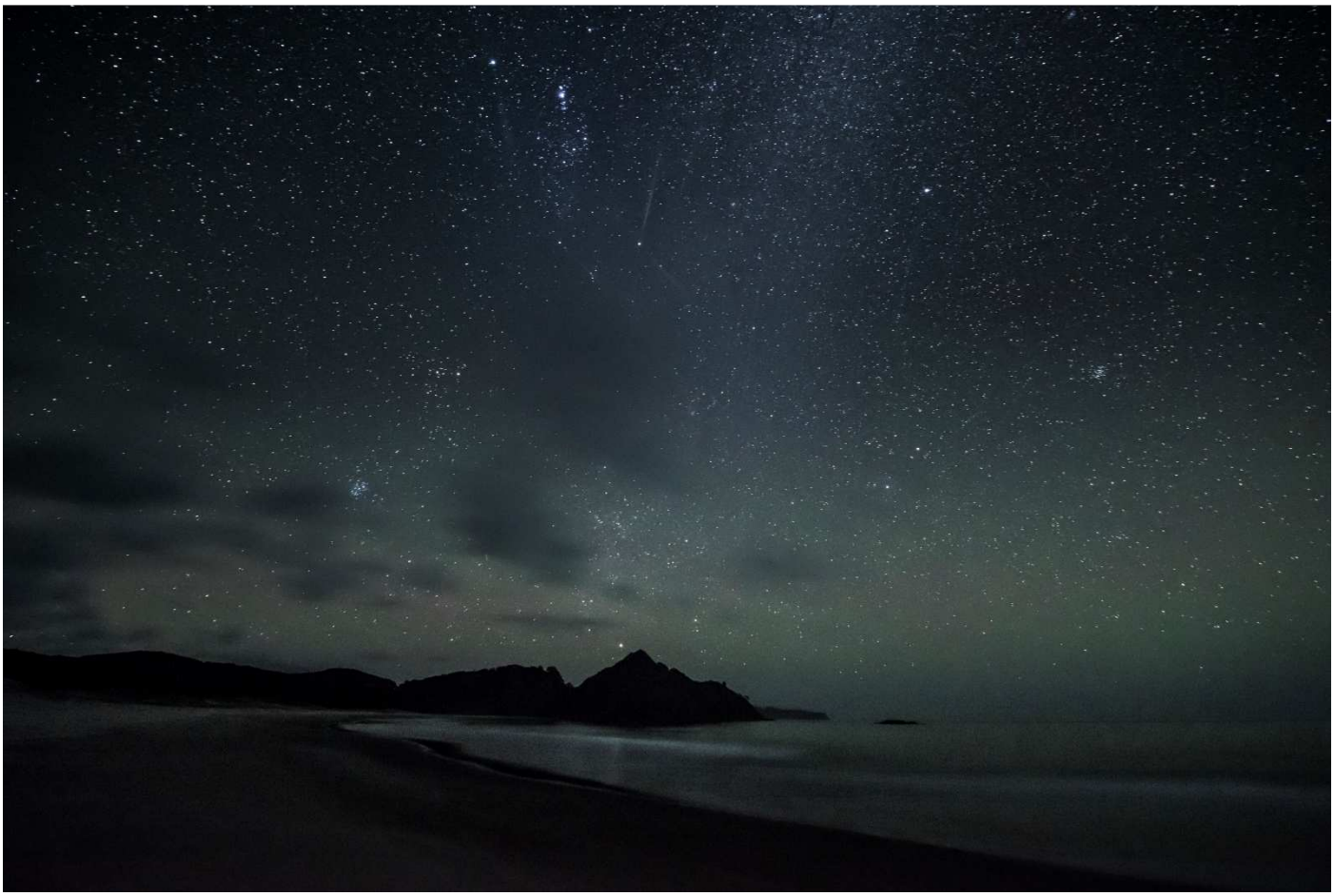
Above: Main shopping area in Tryphena by day, and by night.

Below. Mulberry Grove Store, Tryphena, when the lights are on before 10pm.



Medlands settlement area by day and by night in early summer and by night in the height of the summer season.

Below: Kaitoke Beach in the direction of the airport.



Below: Campground

View South across Palmers Beach and Kaitoke Beach by day and by night
at the height of the summer season

Attachment 7 – Department of Conservation Campgrounds and Huts; Council maps of reserve land at Tryphena and Medlands


Auckland Council
Map
N
DOC
Beach Rec Reserve
Reserve
Road
Campground
Medlands

Attachment 8 – Additional Letters of Support

1. Brett O'Reily, Chief Executive, Auckland Tourism, Events and Economic Development (ATEED)
2. Caroline Leys, Chairperson, Destination Great Barrier Island Trust
3. Simon Mackenzie, Group Chief Executive, Vector Limited
4. Gendie Sommerville-Ryan, President, Awana Rural Women
5. Gordon Bishop, President, Great Barrier Island Sports and Social Club Inc. (aka Claris Club)
6. Margery Harris, Tipi and Bob's Waterfront Lodge

Auckland Tourism, Events and Economic Development
An Auckland Council Organisation

AUCKLAND

1 November 2016

Subject: Letter of support for GBI Dark Skies

Auckland Tourism, Events and Economic Development (ATEED) is pleased to support Great Barrier Island's application to become a Dark Sky Sanctuary through the International Dark-Sky Association.

Great Barrier Island is a place of rugged beauty and untouched wilderness, and is one of the most tranquil and unspoilt places in the wider Auckland region.

The island is home to a community focused on protecting and preserving its stunning natural beauty which makes it the ideal location for achieving Dark Sky accreditation.

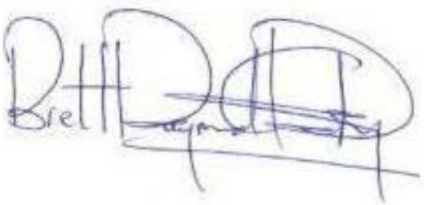
This stunning natural beauty and remoteness makes the island a popular place for visitors wanting to reconnect with nature and marvel at the night skies.

Whether it's walking and tramping in more than 12,000 hectares of the spectacular scenery at the Aotea Conservation Park or getting out on the water, swimming, surfing, diving or fishing there's something on Great Barrier to appeal to all visitors.

As Auckland's economic growth agency a key part of our work is to help the regions' develop their tourism offering and we believe having a Dark Sky Sanctuary established will further strengthen the island's appeal as a destination.

We thank you for taking the time to consider this application and look forward to hearing the outcome.

Nga Mihi



Brett O'Riley
Chief Executive

139 Quay Street, PO Box 5561, Wellesley Street,
Auckland 1141, New Zealand P +64 9 365 0500 **aucklandnz.com/ateed**

PO Box 30,
Claris, Great Barrier Island
Auckland 0961

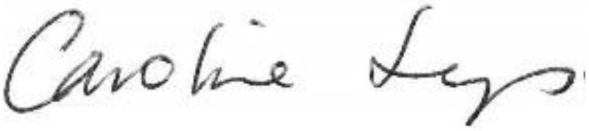
Regarding the Dark Sky Sanctuary initiative by the Great Barrier Island Local Board

Destination Great Barrier Island is a trust formed to assist the development of the Great Barrier Island economy through the expansion of tourism. A small, rural, island community places great reliance on offering experiences to our visitors which cause them to return and even to consider becoming part of our resident community. A remote community such as ours faces the challenge of maintaining our vulnerable 9environment even whilst we plan and strategize together to raise our profile and population. There is no doubt that the best way through this dilemma is to provide the best experience of our natural and cultural environment and especially build on characteristics which make us unique so that our community and children can see a path for education and employment.

Sharing the Dark Sky Sanctuary with others is a fine example of this type of experience. We already have a dark sky which is virtually unpolluted by light flare from the closest major city (Auckland). We already have a group of extremely interested residents who are willing and keen to learn how to explore and observe major visible objects via binoculars and telescopes. We are keen to develop educational packages to offer to our resident schoolchildren and to visiting student groups, and to widen this educational experience to local, national and international travellers.

I am delighted to support this initiative by our Local Board to apply for Dark Sky status and to legislate in order to protect this status for generations to come.

Yours sincerely,



Caroline Leys,
Chairperson, Destination Great Barrier Island Trust.

VECTOR LIMITED
101 CARLTON GORE ROAD
PO BOX 99882
AUCKLAND 1149
NEW ZEALAND
+64 9 978 7788 / VECTOR.CO.NZ

22 November 2016

Izzy Fordham
Chair, Great Barrier Local Board
Auckland Council
Private Bag 92300
Auckland 1142

Dear Izzy

Great Barrier Dark-Sky Sanctuary Accreditation

Thank you for your letter received today regarding your project to achieve Dark-Sky Sanctuary Accreditation for Aotea Great Barrier Island, and your enquiry regarding future mains power supply to the Island.

I can confirm that Vector has no plans to provide traditional network mains power supply from Auckland City to Great Barrier Island as this would be extremely cost prohibitive. Our focus in on providing alternative energy solutions for customers such as solar and batteries.

I wish you every success with your accreditation application.

Yours sincerely

Simon Mackenzie
Group Chief Executive

CREATING A NEW ENERGY FUTURE

The Marion Barleyman Memorial Cottage
RURAL WOMEN NZ AWANA BRANCH INC
P.O. Box 103
Claris
Great Barrier Island 0961

Izzy Fordham
Chair
Great Barrier Local Board
Claris

Dear Izzy

Awana Rural Women is a branch of Rural Women New Zealand, a charitable, membership based organisation which supports people in rural communities through learning opportunities, advocacy and connections. Our branch has served the community on Great Barrier Island for over 68 years, supporting education and economic development as well as arranging activities to mitigate the loneliness that comes with isolation.

That is why our members strongly support your application for International Dark Sky Sanctuary status for the Island. We can see opportunities for education, particularly for our school aged children who have limited opportunities for enrichment outside the basic curriculum and limited resources on Island. We can see opportunities for economic development through the sharing of our night skies with visitors. We can see opportunities for the elderly to become more involved in learning and in the community through the newly formed Astronomy Enthusiasts group.

But most importantly of all, we can see an opportunity to protect the amazing night sky all of us appreciate and love. This is one occasion where off-the-grid is a huge advantage. Our night sky should be shared with our nearest neighbours, the 1.5 million Aucklanders, as well as all New Zealanders and the rest of the world.

We strongly support your application and look forward to being involved in protecting and promoting dark sky values.

Gendie Somerville-Ryan
President, Awana Rural Women

GREAT BARRIER ISLAND SPORTS & SOCIAL CLUB INC.
Whangaparapara Road
Great Barrier Island
Telephone: (09) 429 0260
Fax: (09) 429 0209

Chairperson
Great Barrier Local Board
P O Box 61
Claris
GREAT BARRIER ISLAND

ATTENTION: Izzy Fordham

17th March 2017

RE: Sports Cub's Exterior Lighting

Dear Izzy

It has been brought to our attention that a couple of the Club's exterior lights exceed the lighting requirement necessary for the Local Board's application for Dark Sky Sanctuary status.

We would like to assure you that these lights will be remedied and brought up to the standard necessary. We are only open 3 days a week from 4pm to 11pm and the lights in question are our car park and front deck lights, both necessary for safety reasons. However, we have sought advice from the club's certified electrician and we will be able to replace these lights accordingly.

We would like to take this opportunity to wish the Local Board all the best in its application for Dark Sky Sanctuary Status for Great Barrier Island.

Yours sincerely

Gordon Bishop
PRESIDENT

Margery Harris
Tipi and Bob's Waterfront Lodge
38 Puriri Bay Road
Tryphena
Great Barrier Island

March 17th 2017

Izzy Fordham
Chair, Great Barrier Local Board
Claris
Great Barrier Island

Dear Izzy

I am writing to support your application to the International Dark Sky Association for Sanctuary Status for the whole of Great Barrier Island.

The numerous visitors to our Lodge and Restaurant know how special our Island is. And our night sky is an integral part of our appeal. We know too, after a visit from a representative of the Great Barrier Astronomical Group, that we will need to review our current outdoor safety lighting to make our lighting arrangement fit in with IDA requirements. We are more than happy to do this and will consult with the experts to replace lighting or change lighting where necessary to ensure we meet the appropriate standards.

The Island largely depends on tourism for its economic well-being and attaining Sanctuary status would complement our current reputation as an unspoilt paradise. We are more than happy to meet any requirements for outdoor lighting the IDA suggests as protecting our environment, including our dark sky, makes good business sense and protects our most valuable assets for future generations.

Yours sincerely

Margery Harris