STRATEGY AND PLANNING REPORT

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Prepared For: Strategy and Planning Committee 13 May 2020
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Date: 11 March 2020

Subject: Spatial variation of air quality in Wanaka

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1. Background

A new permanent, continuous air quality monitoring station is scheduled to be installed at Wanaka during the 2019/2020 year, as per the Long Term Plan for State of the Environment (SOE) monitoring. A study to confirm the most appropriate location for the station was conducted. A previous study was undertaken in 2013, but Wanaka has experienced a significant amount of urban growth since then. Comparing the results from the two studies will confirm the most appropriate place for monitoring.

2. Introduction

Otago Regional Council are expanding the monitoring network to ensure air quality is being monitored in areas of population growth. In recent years, some areas in Central Otago and Queenstown Lakes have expanded at a rapid rate. In Wanaka in particular, there has been significant growth both within and outside the air zone boundary – with 30% growth in Wanaka and 40% in Albert Town, since 2013 (Stats NZ, 2019).

ORC currently has four permanent, and three winter-only locations for monitoring PM_{10} (particulate matter with a diameter of less than 10 µg), however the National Environmental Standard for Air Quality (NESAQ) will be updated to include $PM_{2.5}$ (particles with a diameter of less than 2.5 µg). As $PM_{2.5}$ has a more dangerous impact on human health (WHO, 2006), and home heating emissions being mostly comprised of the smaller particle sizes (Environet, 2019), it was decided to look for newer technology to measure $PM_{2.5}$.

The NESAQ requires Councils to monitor particulate matter where particulate concentrations are likely to be highest, and/or the most people affected. The spatial study from 2013 (ORC, 2014) concluded that the offshore breezes from Lake Wanaka were strong enough to disperse the particulate matter during the night. Consequently, there was not an observed sharp increase at night time, as seen in other Central Otago towns. The study also concluded that the Holiday Park located just south of the main beach at Wanaka was the area of highest concentrations due to the accumulation of particulate matter. This study will aim to see if either the temporal or spatial pattern of concentrations are similar to the 2013 work and identify the most suitable site for the new instrument.

3. Method and Results

Three different DustTrak instruments were used to record real-time $PM_{2.5}$ at 31 sites on 20-21 August 2019 (Figure 1). These monitors had previously been operated together to confirm that they were reading levels in accordance to each other. At lower levels of particulate matter, they were reading within 2 µg of each other, and it was determined that they would be suitable to use in different parts of Wanaka simultaneously.

Wanaka was divided into three parts – North, South and Albert Town. Each section was sampled three times during night of the 20th August and once the following morning.

- Early evening (4-6 pm)
- Evening (6-8 pm)
- Night (8-10 pm)
- Morning (7-9 am)

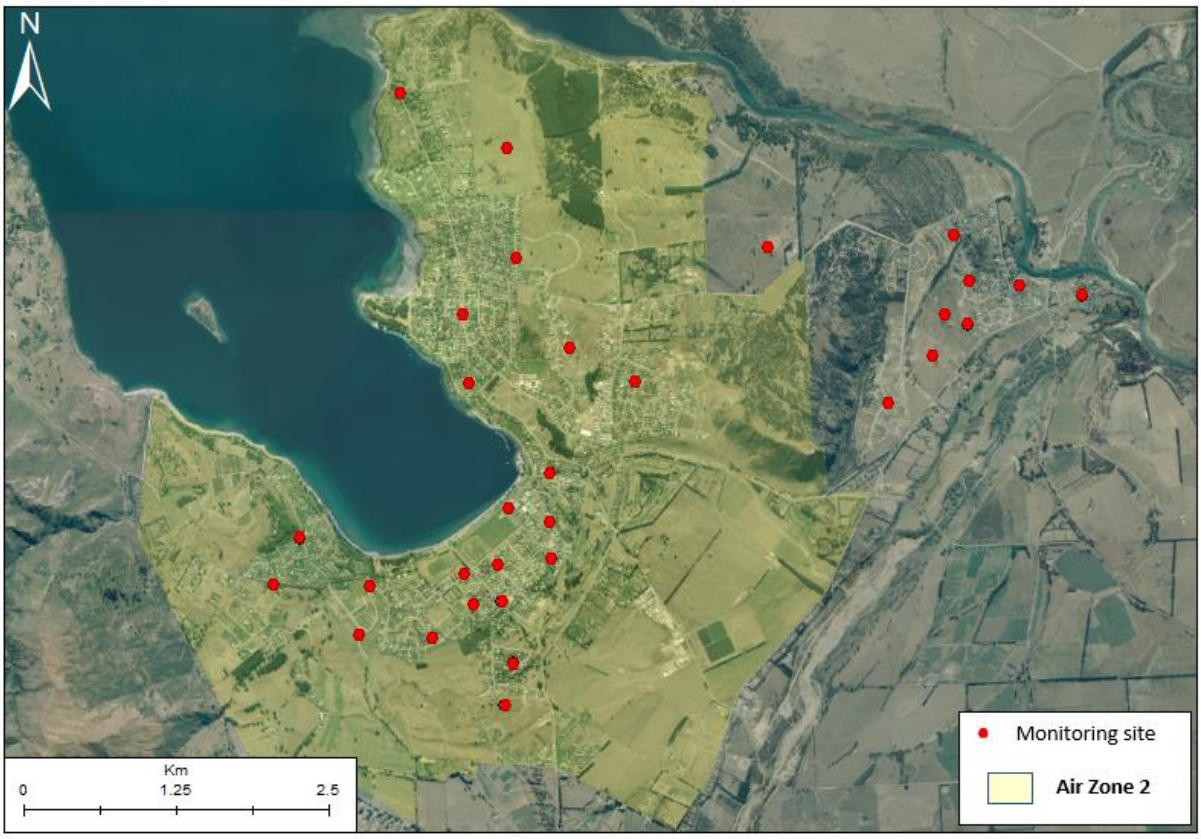

Figure 1. Monitoring locations for 20-21 August 2019

The first evening run covered the start up time, when individuals would light their fires for the evening, emitting maximum amounts of particulates as the burners came to temperature. The evening and night rounds covered the times when the burners are operating at high efficiency, and particulate matter may be dispersing and/or gathering. The morning round was conducted to confirm if morning start-up period in Wanaka was similar or less intense than Air Zone 1 towns, and the afternoon run was to obtain background data, when concentrations were lowest.

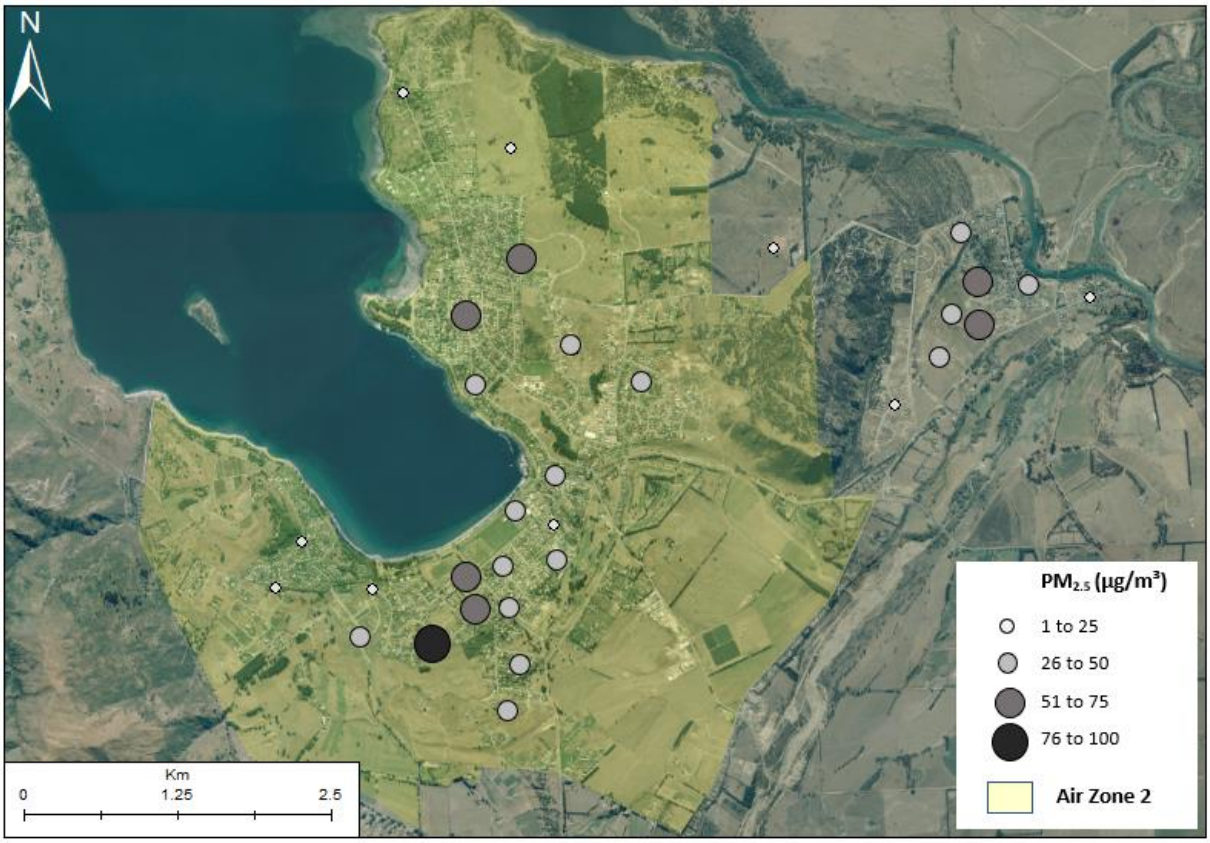

Figure 2. Night-time spatial concentrations of $PM_{2.5}$ in Wanaka on 20 August 2019 (2-minute average)

The highest two-minute average concentration of $PM_{2.5}$ (76 µg/m³) was found in the south western area, within the Meadowstone subdivision, south-west of the Holiday Park on Brownston Street. There were other high concentrations of 59 and 56 µg/m³ found at the Holiday Park and the corner of Warren and Connor Street respectively (Figure 2).

Figure 3. Inversion layer over Albert Town on 21st August, a mixture of the low cloud over the Clutha river seen on the left, and smoke from chimneys on the right

Other sites which had high concentrations were central Albert Town (Finch St/Frye Cres), and a newer subdivision to the west of Mt Iron (Mercury Pl/Raglan Ln). Both of these areas are relatively low-lying areas, with Mt Iron in between, acting as a barrier to wind dispersion. Albert Town is likely to be susceptible to high morning concentrations caused by an inversion layer, which was observed during the morning of the 21st (Figure 3). Both areas had very high morning concentrations (Figure 4). Other pockets of high concentrations were found in the north at Beacon Point Road, and Rata Street, both of these sites are located in the older suburbs of Wanaka.

The spatial patterns indicate that topography plays a large role in creating small pockets where particulate matter can accumulate on still nights. Over the Holiday Park area in Wanaka South, the gentle wind created a moving area of higher concentrations that seemed to oscillate over the southern suburbs.

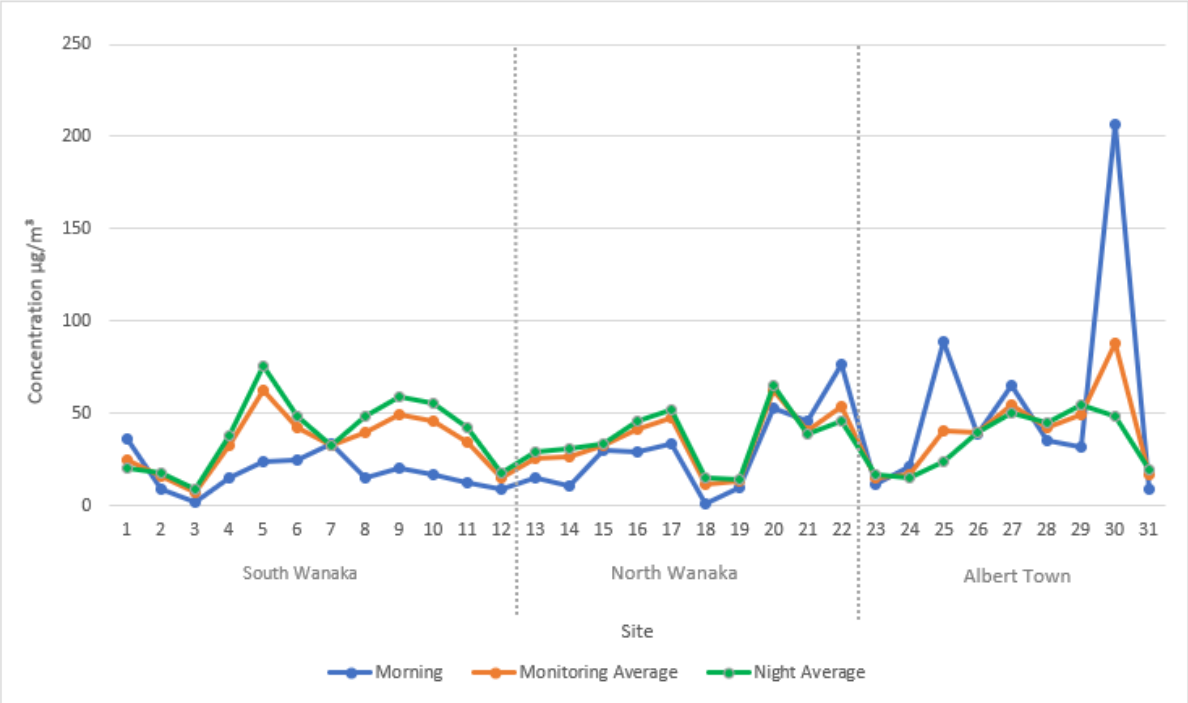

Figure 4. Comparison of night time and morning concentrations at different sites

Wind data obtained from the NIWA station showed that the wind was coming from the east and north-east directions for most of the sample evening. Wind speed was below 1.1 m/s during the monitoring hours, and it had noticeably reduced to an almost indiscernible speed from about 5 pm.

The wind direction data from the last four years shows that most of the wind comes from the west to west-northwest directions in Wanaka, with the next most dominant wind coming from the east and southeast. This suggests the predominance of onshore and offshore breezes from and to the lake that would alternate during the day/night periods (Figure 5).

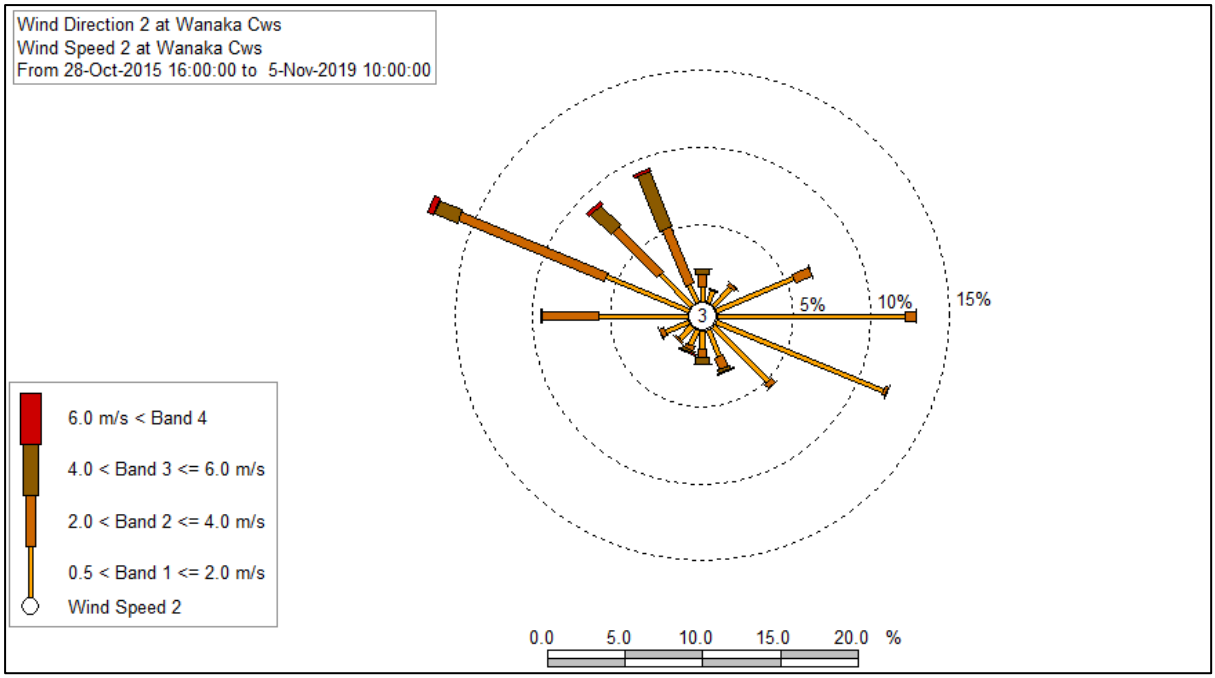

Figure 5. Wind rose for Wanaka NIWA met station – 2015-2019

In comparison with the 2013 PM_{10} data, the spatial pattern was quite similar, with the highest concentrations centred around the northern subdivision, the main shopping area at Ardmore street, but most significantly near the holiday park on the southern lakefront (Figure 6).

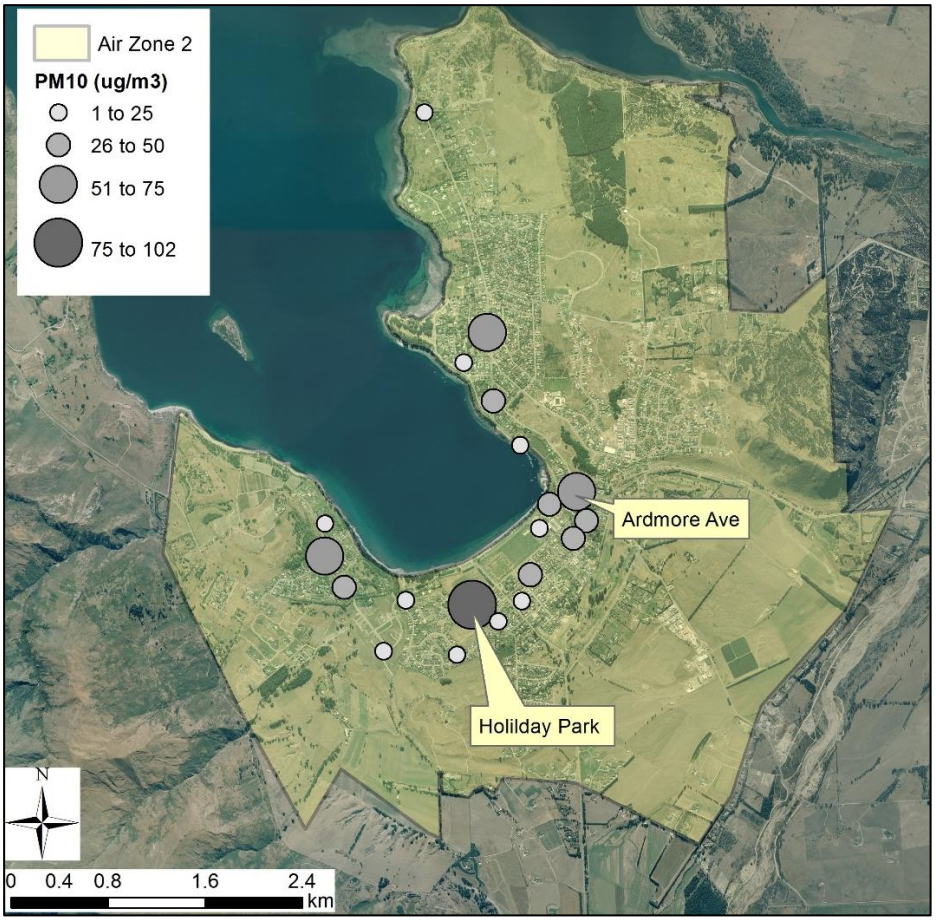

Figure 6. Results of 2013 Spatial Study

4. Conclusions

The particulate matter concentrations in Wanaka vary spatially and temporally over a typical calm and cold winter's night. The results of this study indicate that while there are many areas with elevated levels of $PM_{2.5}$, the southern part of Wanaka may accumulate among the highest concentrations in any given night, and this agrees with the 2013 study.

The evidence that Albert Town also experiences elevated $PM_{2.5}$ levels indicates that it should be within the Wanaka Air Zone boundary. Visual observations and data collected during this study have shown that Albert Town can experience inversion layers independently of Wanaka, so more work to address the implications of this is recommended in future.

The wind speed data from the last four years shows that wind speed is less than 0.5 m/s (10-minute average) about 3% of the time. In comparison, Arrowtown's wind speed is <0.5 m/s 37% of the time. This indicates that as previously concluded, Wanaka experiences fewer calm periods than the Air Zone 1 towns, and therefore higher emission dispersal.

5. Emission Trends

In September 2019 an emissions inventory was performed by Environet in the towns of Wanaka, Clyde and Cromwell. It was found that in Wanaka (including Albert Town) domestic heating contributes to 97% of daily winter particulate matter emissions (36 tonnes of $PM_{2.5}$ per year). Over half of these (56%) emissions come from pre 2006 wood or multifuel burners (39% of all solid fuel burners) which would be non-compliant in Air Zone 1 towns.

In comparison to a 2013 estimate, the amount of emissions between then and now have not changed greatly. This suggests that as newer wood burners are replacing older ones with the effect of improving the air quality, this has been counter acted by the residential growth and installation of more burners.

The Wanaka air shed is currently Air Zone 2 (not including Albert Town, which is Air Zone 3). This means that the types of burners installed in either Wanaka or Albert Town only need to meet an emission standard of 1.5 g/kg as per the NESAQ and ORC Air Plan, and have not been subject to further wood burner restrictions like the Air Zone 1 towns.

6. Recommendations

That this report be noted.

That the results from this report be used to inform the siting of the Wanaka $PM_{2.5}$ instrument.

That the airshed is extended to the east to include Albert Town, and that consideration be made for the southern edges of Wanaka which are currently being developed.

That the results be shared with the community.

7. References

ORC Committee Report, 2014. *Spatial variability of air quality in Arrowtown and Wanaka*. Presented to Technical Committee 4 June 2016.

Stats NZ, 2019. *Statistical area 1 dataset for 2018 Census, total New Zealand*. Retrieved from https://www.stats.govt.nz/information-releases/statistical-area-1-dataset-for-2018-census

Wilton, E. 2019. *Wanaka, Cromwell and Clyde Air Emission Inventory – 2019*. Environet Limited, Objective ID A1344874.

World Health Organisation, 2006. *Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide: Global update 2005: Summary of risk assessment.* Retrieved from https://www.who.int/airpollution/publications/aqg2005/en/

Appendix

Site Number	Easting	Northing	Site Name	Area
1	1291931	5043252	Bills Way/Sargood	
2	1291708	5042883	Wanaka-Mt Aspiring Dr/Far Horizon	
3	1292498	5042871	Meadowstone/Kelliher	
4	1292413	5042471	Galloway/Kelliher	
5	1293021	5042441	Meadowstone/Willowridge	
6	1293413	5041914	End of Niger St	Wanaka South
7	1293681	5042244	Kennedy Cres, near no. 28	
8	1293583	5042741	McDougall/Tenby – Bowling Club	
9	1293359	5042716	Warren/Connor	
10	1293284	5042965	Lakeview Holiday Park, Brownstone St	
11	1293558	5043044	Upton/Roche	
12	1293998	5043090	Dungarvon/Tenby	
13	1293642	5043506	Dungarvon	
14	1293979	5043399	Helwick/Upton	
15	1293783	5043681	Ardmore	
16	1293317	5044535	Beacon Point/Lismore	
17	1293268	5045097	Beacon Point/Eely	Wanaka North
18	1292753	5046908	Beacon Point/Penrith Park	
19	1293628	5046456	Infinity Dr	
20	1293700	5045567	Rata/Kowhai	
21	1294137	5044817	Mcleod/Penrow	
22	1294680	5044545	Raglan/Mercury	
23	1295774	5045650	Glen Dene/Mount Linton	
24	1296760	5044371	Old Racecource Rd/Ewing	
25	1297126	5044759	Sherwin Ave/Mallard	
26	1297225	5045096	Sherwin/Rifleman	
27	1297410	5045011	Finch/Frye	Albert Town
28	1297302	5045747	Lagoon/Bernard	
29	1297422	5045375	Lagoon/Hunt	
30	1297838	5045335	Dale/Alison	
31	1298343	5045244	Kingston/Arklow	