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WeatherNet

**LEGAL WEATHER REPORT**
**CLIENT: XXXXXX XXXX**
**LOCATION: Cherry Willingham (LN3 4JT)**
**DATE: 21st January 2011**

**LEGAL METEOROLOGICAL REPORT PREPARED BY**

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**LEGAL METEOROLOGICAL REPORT PREPARED FOR AND INSTRUCTED BY**

XX XXXX XXXXXXX
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XXXXXX XX XXXXXX XXXXXXX
XXX XXX XXXX
XXXXXX XXXXX
XXXXXXXXXXX
XXX XXX

Telephone: XXXXX XXXXXX
Fax: XXXXX XXXXXX
Mobile: XXXXXXXXXXX
Email: XXXXXX@XXXXXX.XX.XX
Website: XXX.XXXXXXXXXXXX.XX.XX
Your Reference: XXXXXXXXXX

RTA on Hawthorn Road, Cherry Willingham, Lincolnshire (LN3 4JT) on the 21st January 2011
My Reference: XXXX (XXX)
Date: 3rd September 2012
"Bond Solon trained in the aspects of report writing"

*Legal Report Front Cover*

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# METEOROLOGICAL REPORT FOR POSTCODE AREA LN3 4JT (CHERRY WILLINGHAM, LINCS) FOR THE 21ST JANUARY 2011 (CASE: XXX XXXXXX)



## 1. Introduction

### 1.01 The writer

I am Dr Richard John Wild. I am the Weather Services Commercial Manager and Forensic/Senior Meteorologist at WeatherNet Ltd. My specialist field is in forensic meteorology. My qualifications include a BSc (Hons) in Geography (2:1) (obtained June 1994) and a PhD investigating the spatial and temporal analysis of heavy snowfalls across Great Britain betw[illegible]en [illegible] years 1861-1999 (obtained July 2005). WeatherNet Ltd is a private weather consultant a[illegible] is [illegible]lely r[illegible]sponsible for the conclusions and opinion expressed in this report. Weathe[illegible]t Ltd is a[illegible]thorise[illegible] Data user by agreement with the Meteorological Office, Exeter and its [illegible] private [illegible]gical network across the United Kingdom. The meteorological data from the [illegible]ffice ab[illegible] by the standards set by the World Meteorological organisation, based in Genev[illegible]the instruments at these meteorological stations, as well as the stations themselves are constantly [illegible]ked for reliability.

### 1.02 Summary background of the case

I have been asked to provide a detailed meteorological [illegible]givin[illegible] an expert opinion based on the meteorological facts as to the most likely meteorological c[illegible]ons in the above area on the date and time indicated. This meteorological repo[illegible]lies with [illegible]nd criminal procedures. As far as I am aware, I have no connection with any of th[illegible]s involve[illegible] the incident.

**1.03 Report prepared for** XXXX[illegible]XX XXXXXX

**1.04 Your reference** XX[illegible]XXXX[illegible]

**1.05 My reference** [illegible]XXXX (X[illegible])

**1.06 Place of incident** Ha[illegible] Road, Cherry Willingham (LN3 4JT)

**1.07 Dat[illegible] of incident** [illegible] January 2011

**1.08 Ti[illegible]** ~08:00

### 1.09 Summary of my c[illegible]nclusions

With these factors in [illegible]ind, I conclude, based on my opinion, meteorological facts and data stated in this report, that on the balance of probability that at the time of the collision, visibility and ambient light levels would have been adequate to see other road users within this civil twilight time. A hoar frost would have been present due to air and dew temperatures recorded across the area, as well as the light winds, clear skies and high humidity values. As no precipitation was noted to have fallen that morning prior to the incident across the area; it seems unlikely that glazed ice/black ice would have been present on the road surface, unless a secondary unnatural source of water had been present on the road, i.e. water seeping from neighbouring fields etc which then had become frozen on the road surface.

A hoar frost would have been present across the area since the early evening of the previous day due to temperature and humidity levels. A hoar frost would have affected all surfaces; however grass fields, verges and any unheated metal surfaces such as cars, unheated windows and road signs are more likely to have experienced this frost. This hoar frost would have also affected the road surface but less likely due to factors mentioned in section 4, with the road surface more likely to be damp. The hoar frost is likely to have continued after the incident area after the collision until the late morning as temperatures remained below freezing and humidity values remained high. It is in my opinion, that due to these weather conditions it would have been impossible for any person to be able to have seen through the windscreen if not appropriately been cleared.

### 1.10 The parties involved

I have prepared this meteorological report for and on behalf of XXXXXXXXXXXX XXXXXX.

### 1.11 Technical terms and explanations

If any technical terms are used within this meteorological report, then the explanatory notes section should be consulted in the appendices for further details.

## 2. The meteorological issues addressed and statement of instructions

I have prepared this meteorological report for and on behalf of XXXXXXXXXXXX XXXXXX, contained in their correspondence and instructions dated the [illegible] August 2012. The purpose of this meteorological report is to give an expert opinion based on the meteorological facts as to the most likely meteorological conditions in the above area on the date and time indicated. The meteorological issues addressed include examining meteorological data from professional meteorological stations, synoptic meteorological charts, lightning maps, amateur meteorological stations and rainfall radar imagery. This meteorological report complies with civil and criminal procedures. This meteorological report has been produced without the benefit of a site visit or investigation to clarify some of the opinions expressed; however I have familiarised myself with the incident site through other information made available to me. This meteorological report has been prepared for, with the full recognition that it may be presented in court as evidence. It is also accepted that this report may be submitted by another expert to the court, separate to or form part of a report.

## 3. My investigation of the facts

### 3.01 Details of meteorological stations utilised

To establish what meteorological conditions occurred around the surrounding area of the time of the incident, I investigated which were the closest meteorological stations that were operating at the time. The closest meteorological station to the incident, at which hourly weather data was available to me, was Waddington (5 miles to the south-west) and Scampton (5 miles to the north-west). The closest meteorological stations within 25 miles of the incident, at which daily weather data was available to me, was Scampton (8 miles to the north-west), Waddington (9 miles to the south-west), Coningsby (14 miles to the south-east), Louth (17 miles to the north-east), Cranwell (17 miles to the south) and Gringley on the Hill (24 miles to the north-west). This hourly and daily meteorological data (manned and automatic weather stations) should prove to be representative of the incident area (see-enclosed sheets in the appendices).

### 3.02 Details of rainfall stations utilised

To establish what precipitation conditions occurred around the surrounding area of the time of the incident, I investigated which were the closest rainfall stations that were operating at the time. The closest rainfall stations to the incident, at which daily rainfall data was available to me, were Lincoln: Broadway (2 miles to the west) and Riseholme (3 miles to the north-west). These daily rainfall stations (manned and automatic rainfall stations) should prove to be representative of the incident area (see-enclosed sheets in the appendices).

### 3.03 Meteorological reports/documents enclosed

Hourly meteorological report from Waddington and Scampton (see enclosed sheet in the appendices)
Daily meteorological report from Scampton, Waddington, Coningsby, Louth, Cranwell and Gringley on the Hill (see enclosed sheet in the appendices)
Daily rainfall report from Lincoln: Broadway and Riseholme (see enclosed sheet in the appendices)

### 3.04 Anecdotal reports enclosed

No anecdotal reports were included in this report.

### 3.05 Sun and moon data

All times are universal.

On the 21st January 2011: Sunrise: 08:03, Sunset: 16:24, Moonrise: 19:07, Moonset: 08:27, Phase of Moon: waning gibbous (96%)

### 3.06 Interview and examination

None were conducted for this meteorological report.

### 3.07 Research papers

None were consulted for this meteorological report.

#### 3.08 Measurements tests and experiments

None were conducted for this meteorological report.

#### 4. My opinion, interpretation and conclusion

In addition to the hourly and daily meteorological data presented in the appendices within this meteorological report, I have also examined (but not included) other meteorological data based from other meteorological sources, for example examining synoptic meteorological charts, lightning maps and amateur meteorological stations (where available for the incident date). Based upon data analysis, a study of the general meteorological situation and aspects of meteorological theory, my conclusions, interpretation, interpolation and opinion therefore are as follows based on the relevant data available to me within the given time frame to produce this report. The 21st January 2011 saw low pressure centred close to the Azores and over the western Mediterranean, while high pressure was located over Ireland. A warm and cold front lay close to Northern [illegible], while a warm front lay across East Anglia and SE England.

The late morning period (~0800) of the 21st January 2011 across the Cherry Willingham, LN3 postcode area saw light west-north-westerly to westerly winds (Beaufort Scale 2). The highest gusts that occurred within the area during that late morning period were <=15mph. Other meteorological factors occurring over the incident time included, air temperatures were ~4°C, dew point temperatures were at similar or slightly colder values, humidity values were high (85-100%), visibility was ~5-9km (moderate to good) with haze being reported in the surrounding area, while the weather was dry with scattered cloud and clear spells as the incident occurred while still in civil twilight (see definition in section 7.16). Grass temperatures that morning fell to a minimum of ~ -6 to -7°C; however Scampton recorded a minimum grass temperature of -10.5°C.

As no precipitation was noted to have fallen that morning prior to the incident across the area; it seems unlikely that glazed or black ice (see definition in section 7.16) would have been present on the road surface, unless a secondary unnatural source of water had been present on the road, i.e. water seeping from neighbouring land etc which then had frozen on the road surface. Visibility and ambient light levels would suggest that drivers would be able to see other oncoming traffic quite easily. With the weather factors indicated above with light winds, clear skies and with ground and air temperatures significantly below freezing point across the area since the early evening of the previous day and humidity levels close to or at 100%, a severe hoar frost (see definition in section 7.16) would have formed on the road and the surrounding area such as grass fields, verges and any unheated metal surfaces such as cars, unheated windows and road signs. In theory, ice will form on a road surface when there is moisture lying on the ground and ground temperatures and the dew point fall to 0ºC or below. When road temperatures fall below the dew point, moisture will condense on the road surface forming a hoar frost unless the road surface has been treated by anti ice measures such as salt spreading. Based on the weather and temperature conditions, a hoar frost is likely to have continued across the incident area up until the late morning.

Hoar frost is very common on nights that are clear of cloud, when ground surfaces loses heat due to radiational cooling allowing the air in contact to the ground surface to cool with the potential to reach saturation point (i.e. condensation occurs and the relative humidity is 100%). This commonly occurs just below dawn when the maximum raditional cooling is at its greatest. However, as the road had been gritted (I am under the impression that the spread of salt was appropriate to the temperature conditions just prior to the incident and the previous evening as mentioned in the witness statement provided), it seems unlikely that any hoar frost formation would have occurred or any hoar frost that had developed on the road surface would have melted and therefore the road would have appeared damp, rather than frozen with icy patches.

There are; however, a number of different factors that can also play a part in determining whether ice will form on a road surface. These can include the levels of traffic at the time of the incident mixing the air above the road surface promoting increased turbulent flow and throughout the day/night (heat will be added to the road surface via sensible and latent heat (see section 7.16 for definition) and moisture fluxes from the engine and exhaust, as well as frictional heat dissipation from the tyres and braking). Thermal conductivity/diffusivity of the road surface (roads tend to retain more heat than surrounding surfaces and hence, ground frost or ice usually takes a longer amount of time to form on a road in comparison to grass), the presence of rock salt/sodium chloride, etc. (as mention above) and finally the interaction of geographical/topography surrounding the road is a major factor causing the difference in air temperature and road surface temperature across a road network.

As mentioned above, road surfaces are normally warmer than surrounding areas such as grass verges and fields as the movement of traffic commonly affects the formation of frosts to form etc.; however parked cars overnight due to their size are often colder than their surroundings and are more likely to experience a hoar frost first then road and grass surfaces. The build up of condensation due to the weather factors mentioned above either in form of water droplets or ice crystals taking on the form of hoar frost would certainly impair vision on a windscreen in a short period of time when the ideal conditions would allow formation of condensation or ice crystals or both to take place; however this would depend on the thermal properties of the glass and the thickness of the window. Window properties; however, can vary between makes of car. The amount of condensation/hoar frost present on the car at the incident is certainly problematic. The problems are that the formation of condensation is determined by many factors, these likely to be unknown or constantly changing. The relative humidity within a vehicle as well as the internal temperature is likely to be different than the natural environment outside. Fan power, air ventilation by the windows or the air grills and the heater settings would also affect the internal environment as constant changes in fan speed and heater settings as well as the time these facilities had been operating on any journey would not be constant. The driver and or any passengers would also affect internal environmental conditions by breathing and the number of ventilation options that could constantly change throughout the journey would also affect the optimum of the environment. I would advise that it is the court to decide to determine if the driver of the incident could see through this window; as it is out of my field to comment on the internal effects of a car's heating system.

After the collision, with air temperatures still significantly below freezing point and humidity values remaining high or saturated, the hoar frost would have commenced forming again on the car; however due to many unknown factors such as the internal environment of the car, I am unable to say precisely how long this would take for the hoar frost to commence. Again I think this is for the Court to determine on this.

With these factors in mind, I conclude, based on my opinion, meteorological facts and data stated in this report, that on the balance of probability that at the time of the collision, visibility and ambient light levels would have been adequate to see other road users within this civil twilight time. A hoar frost would have been present due to air and dew temperatures recorded across the area, as well as the light winds, clear skies and high humidity values. As no precipitation was noted to have fallen that morning prior to the incident across the area; it seems unlikely that glazed ice/black ice would have been present on the road surface, unless a secondary unnatural source of water had been present on the road, i.e. water seeping from neighbouring fields etc which then had become frozen on the road surface.

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## 5. Expert's declaration

I **Dr Richard J. Wild** declare that:

1. I understand that my duty in providing written meteorological reports and giving evidence is to help the Court to achieve the overriding objective by giving independent assistance by way of objective, unbiased opinion on matters within my expertise, both in preparing reports and giving oral evidence. I understand that this duty overrides any obligation to XXXXXXXXXXXX XXXXXX or their clients who has paid or is liable to pay me. I confirm that I have complied and will continue to comply with my duty.
2. I confirm that I have not entered into any arrangement where the amount or payment of my fees is in any way dependent on the outcome of the case.
3. I know of no conflict of interest of any kind, other than any which I have disclosed in my report.
4. I do not consider that any interest which I have disclosed affects my suitability as an expert witness on any issues on which I have given evidence.
5. I will advise XXXXXXXXXXXX XXXXXX if, between the date of my report and the trial, there is any change in circumstances which affect my answers to points 3 and 4 above.
6. I have shown the sources of all information I have used.
7. I have exercised reasonable care and skill in order to be accurate and complete in preparing this report.
8. I have endeavoured to include in my report those matters, of which I have knowledge or of which I have been made aware, that might adversely affect the validity of my opinion. I have clearly stated any qualifications to my opinion.
9. I have not, without forming an independent view, included or excluded anything which has been suggested to me by others, including XXXXXXXXXXXX XXXXXX.
10. I will notify XXXXXXXXXXXX XXXXXX immediately and confirm in writing if, for any reason, my existing report requires correction or qualification.
11. I understand that:
    - 11.1 my report will form the evidence to be given under oath or affirmation;
    - 11.2 the court may at any stage direct a discussion to take place between experts;
    - 11.3 the court may direct that, following a discussion between the experts, a statement should be prepared showing those issues which are agreed and those issues which are not agreed, together with the reasons;
    - 11.4 I may be required to attend court to be cross-examined on my report by a cross-examiner assisted by an expert;
    - 11.5 I am likely to be the subject of public adverse criticism by the judge if the Court concludes that I have not taken reasonable care in trying to meet the standards set out above.
12. I have read Part 33 and Part 35of the Civil Procedure Rules and the Criminal Procedure Act 2010 and I have complied with their requirements.
13. I confirm that I have acted in accordance with the Code of Practice for Experts.

## 6. Statement of truth

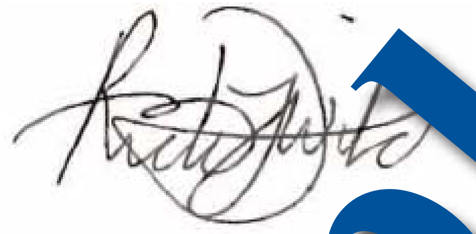
I confirm that the contents of this report are true to the best of my knowledge and belief and that I make this report knowing that, if it is tendered in evidence, I would be liable to prosecution if I have wilfully stated anything which I know to be false or that I do not believe to be true.

## 7. Date and signature

Date: 3rd September 2012

To: XXXXXXXXXXX XXXXXXX
XXXXXXXXXXXX XXXXXX
XXXXXX XXXXX XXXXXX XXXXXXX
XXXXXXX XXXX
XXXXXX XXXXX
XXXXXXXXXXXX
XXX XXX

Signed:



**Dr Richard J. Wild** **BSc (Hons) PhD FRMetS FRGS MAE ME**
<u>Weather Services Commercial Manager/Senior Forensic Meteorologist, WeatherNet Ltd</u>

## Appendices

### 1. My experience and qualifications

I am the Weather Services Commercial Manager and Forensic/Senior Meteorologist at WeatherNet Ltd. WeatherNet Ltd is a subsidiary of Cunningham Lindsey Ltd, the UK's largest Claims and Incident Management Company. I have been employed by WeatherNet Ltd as a Senior Meteorologist since the 10th July 1997 and have held my current titles and post since the 1st January 2000. My qualifications include a BSc (Hons) in Geography (2:1) (obtained June 1994), while in July 1997, I obtained a City and Guilds certificate in Teaching (stage 1) in further and adult education. In July 2005, I obtained a PhD investigating the spatial and temporal analysis of heavy snowfalls across Great Britain between the years 1861-1999.

I am a Fellow of the Royal Meteorological Society (since October 1990), a Member of the National Geographic Society (since January 1993), a Member of the Association of British Climatologists (since January 1995) and a Fellow of the Royal Geographical Society (since [illegible] 2005). I have produced thirty-seven research articles about snow/snowfall/blizzards [illegible] several academic publications (including the Journal of Meteorology and Weather) [illegible] books since 1995. I have also made numerous talks at Universities, had local chats/written quotes [illegible] local/national radio, TV and newspapers. Finally, I have been credited on numerous [illegible] and [illegible] programmes including Wrath of the Titans, Skyfall, Harry Potter and the Half-Blood Prince, Harry Potter and the Deathly Hallows: Part I/II and Britain's Worst Weather.

I am also a staff member of TORRO (Tornado and Storm Research Organisation (based at Oxford Brookes University)). My role is Research Leader of Heavy Snowfalls which is a part of the Thunderstorm and Severe Weather Division and [illegible] held this post since July 1998.

To date, I have prepared in excess of [illegible] meteorological reports since the year 1997 and in the last five years, I have given evidence in court on two occasions (December 2009 and May 2012).

I am (in association with WeatherNet Ltd) currently listed as an expert witness on several expert witness websites including [illegible]intota.com, www.expertwitness.co.uk, www.expertsearch.co.uk, www.xproexperts.co.uk, [illegible]pages.com, www.insurance-directories.com, www.your-witness.co.uk, www.law[illegible].co.uk, www.witnessdirectory.com, www.thesolicitorsgroup.co.uk, www.solicitorsjournal.com, www.supplierhub.co.uk, www.expertwitness.com, www.hgexperts.com and www.waterlowlegal.com. I have also (in association with WeatherNet Ltd) been vetted by the Expert Witness Directory (www.legalhub.co.uk/legalhub/app/appinit) since January 2005, the Expert Witness Directory of Ireland (www.expertwitnessireland.info) since October 2010 and the Expert Witness Directory of Scotland (www.expertwitnessscotland.info) since October 2010. I have also obtained membership of the UK Register of Expert Witnesses (www.jspubs.com) since February 2007, the Association of Personal Injury Lawyers (www.apil.org.uk) since April 2007, the Academy of Experts (www.academy-experts.org) since June 2007, the Round Table Group (www.roundtablegroup.com) since October 2007 and the Forensic Science Society (www.forensic-science-society.org.uk) since June 2009. Since July 2008, I have been trained by Bond Solon (www.bonsolon.com) in the aspects of report writing and since September 2010, I have been included on the NPIA (National Policing Improvement Agency) Expert Advisers Database (this was transferred into the Serious Organised Crime Agency (SOCA) in April 2012 (www.soca.gov.uk)).

## 2. Hourly meteorological report for Cherry Willingham (LN3 4JT) for the 21st January 2011

See enclosed inserted sheets

## 3. Daily meteorological report for postcode area LN3 4JT for the 21st January 2011

See enclosed inserted sheet.

## 4. Daily rainfall data for the 21st January 2011

**Daily Rainfall Data for the 21st January 2011**

| Daily Rainfall Station | Rainfall (mm) |
|---|---|
| Lincoln: Broadway | [illegible] |
| Riseholme | 0[illegible] |

## 5. UK radar sequence for the period 21st January 2011

Rainfall radar data/images were available for this date a[illegible]d w[illegible]wed; however permission was not granted from the originator for them to be shown w[illegible]in this re[illegible].

## 6. Beaufort scale

See enclosed inserted sheet

## 7. Explanatory notes

### 7.01 General

All meteorological readings presented [illegible]s report have been made using acknowledged instrumentation and in ac[illegible]e with p[illegible]ocedures laid down by the World Meteorological Organisation (WMO). All meteo[illegible]ical readings in this report have been subject to careful quality control by WeatherNet [illegible] A[illegible] ti[illegible]own is Greenwich Mean Time (GMT) unless otherwise stated. These [illegible] will be 1-h[illegible]r BEHIND clock time for the period late March-late October when British S[illegible]mer Time (BST) is [illegible]eration in the United Kingdom.

### 7.02 Th[illegible]strument enclosure

Most meteorological instru[illegible]ents are located in an enclosure, a flat area of ground approximately 10 metres by 7 metre[illegible]ed by short grass and surrounded by fencing. The enclosure should be well away from trees or a[illegible]y other large obstructions. The distance of any object should be not less than twice the height of the object, and preferably four times the height.

## 7.03 Meteorological stations

At most meteorological stations, meteorological observations of the highest integrity are made by professional meteorological observers on a routine hourly basis throughout the 24-hour day, 365 days a year. Many meteorological parameters are monitored by automatic equipment (SAWS, SAMOS, CDL) and during periods when (some) meteorological stations are unmanned, evaluations of certain meteorological parameters (present weather, visibility for example) may go unrecorded. Certain other meteorological stations (i.e. Auxiliary Meteorological Stations (e.g. Coastguard Stations)) only make routine meteorological observations at certain fixed times of the day - often at 3-hourly intervals. At cooperating Climatological Stations, the meteorological observer normally makes only one routine meteorological observation per day at 0900 GMT. This meteorological observation represents the past 24 hour's e.g. maximum and minimum air temperatures, rainfall, state of ground, sunshine etc. Not all meteorological stations record all meteorological parameters. They are manned by a large variety of persons and in some cases the meteorological observer is available to monitor certain meteorological elements during the daytime, recording a very brief description in the form of a diary. At rainfall stations only, the previous days' 24-hour daily rainfall reading is taken at 0900 GMT.

## 7.04 Significant weather

Significant weather includes details of the occurrence of air and ground (grass) frosts; gales; details of any heavy or continuous rain; fog; freezing rain; hail; sleet; snow, lying snow; thunder, lightning; squalls and tornadoes to occur at the meteorological station in the 24 hours ending midnight. 'None' means that none of these types of weather occurred. [illegible] means that no meteorological observation of weather was made.

## 7.05 Rainfall

The enemies of rainfall measurement are wind and in-splashing. Wind blows rain drops around a rain gauge and therefore the lower the rim (and the lighter the wind) the better. However, if the rim of the rain gauge is too close to the ground then in-splashing occurs. As a compromise, the standard rain gauge has its rim 30cm above the ground. The diameter is 5 inches (127mm) and rainfall can be measured to a resolution of 0.1mm. From a tipping bucket rain gauge perspective, this does not provide details of the timing of small amounts of rain. A tip of the rain gauge may be triggered in one hour when most of the rain fell in a previous hour. Rainfall (noted in millimetres and tenths), includes any solid precipitation such as snow or hail which is melted and measured in the same way as rain. There may also be small additions due to deposition of dew, hoar frost and rime ice on the collecting surface of the rain gauge. Rainfall amounts below 0.05mm are usually recorded as 'trace'. In some instances, with automatic meteorological equipment, precipitation amounts less than 0.2mm (i.e. a few spots) will not be registered. [illegible]ns in the UK are sited on Water Authority property, at reservoirs, sewage works and pumping stations. Daily rain gauges are normally read just once per day at 0900 GMT, the recorded value being a single measurement of the rainfall of the previous 24 hours. To convert rainfall in millimetres to inches multiply by 25.4.

### 7.06 Intensity of rain

Rain (as opposed to rain showers) falls from dynamically produced stratiform (layered) cloud like stratus and nimbostratus in association with frontal zones. Slight rain is rain of low intensity; which usually consists of scattered large rain drops, or more numerous smaller rain drops. The rate of accumulation in a rain gauge is less than 0.5mm per hour. Moderate rain is rain falling fast enough to form puddles quickly, to make down pipes flow freely and to give some spray over hard surfaces. The rate of accumulation in a rain gauge is between 0.5mm and 4.0mm per hour. Heavy rain is sufficiently intense to produce a roaring noise on roofs, forms a misty spray of fine rain droplets by splashing on road surfaces etc. and accumulates in a rain gauge at a rate greater than 4.0mm per hour. Moderate and heavy rain is normally associated with layered cloud of great vertical depth, normally in association with frontal zones, or troughs of low pressure. Drizzle is precipitation where the rain droplet size is very small - true drizzle droplets does not make a splash, or circular waves in a puddle. Drizzle is normally associated with very low cloud of the type stratus, and is often experienced in fog, or hill fog (cloud enveloping high ground). Freezing rain/drizzle is liquid water drops, with an air temperature below the zero Celsius mark (super-cooled water), which freeze on impact with a ground surface with a temperature also below the zero Celsius mark. This form of precipitation produces a particularly hazardous surface for foot and wheeled traffic. The ground effects of rain on a surface are determined by its rate of impact. In general terms, isolated periods of rain giving a 'trace' or 0.1mm of rainfall would do little more than dampen the ground, whereas 0.2mm falling in less than an hour would wet the ground but without any puddle formation or puddles will form only slowly. Small puddles would form on some previously dry metalled surfaces (tarmac/concrete) if 0.5mm falls in a relatively short period say, one hour. Clearly, the size of puddles at any one location/time is, in part, a product of the natural/artificial drainage characteristics. The above criteria based on the ground effects of rainfall are only an approximate guide. The state of ground will depend on the intensity of rainfall and the rate of evaporation. Evaporation is very low in winter but averages about 3mm per day in summer. Rainfall can also be described as continuous (rainfalls of one hour or more without a break) or intermittent (a period of less than one hour, or a longer period of rainfall with noticeable breaks). Intermittent rain should not be confused with rain showers (the cloud type from which the precipitate falls is different). With respect to the classification for showers, which are associated with convective cloud, are often of short duration and are characterised by rapid fluctuations of intensity. As a general rule showers are regarded as slight if the rate of accumulation is <2.0mm/hr, moderate 2.0 to 10.0mm/hr, heavy 10.0 to 50.0mm/hr and violent >50.0mm/hr.

### 7.07 Rainfall equivalent

1mm of rain measured in a standard rain gauge is the equivalent of 1mm depth over an area of 1 square metre. 1cm. of snow is very roughly equal to 1mm. of rain. The range is from about 8 to 12 multiplied by the amount of rainfall, depending on the water content of the snow.

### 7.08 Rainfall radar

The methods of collecting rainfall data from rainfall stations are explained in sections 7.5 and 7.6; however this section will explain rainfall accumulation from rainfall radar. Rainfall Radar (RAdio Detection And Ranging) is an echo-sounding system, which uses the same aerial for transmitting a signal and receiving the returned echo. Short pulses of electro-magnetic waves are transmitted in a narrow beam for a short time (typically 2 microseconds). When the beam hits a suitable target, some of the energy is reflected back to the radar, which 'listens' out for it for a much longer period (3300 microseconds in the case of Met Office radars) before transmitting a new pulse. The distance of the target from the transmitter can be worked out from the time taken by a pulse to travel there and back. Corrections have to be made to the raw data collected, including amendments for attenuation by intervening rain and range, elimination of ground clutter and the conversion of radar reflectivity to rainfall rate.

Each radar completes a series of scans about a vertical axis between four and eight low-elevation angles every 5 minutes (typically between 0.5 and 4.0 degrees, depending on the height of surrounding hills). Each scan gives good, quantitative data that shows detailed distribution of precipitation intensities (1 and 2 km resolutions) out to a range of about 75 km and useful qualitative data that provides a good overall picture of the extent of precipitation at a national/regional scale (5 km resolution) to 255km.

**Disadvantages of rainfall radar:**
The radar rainfall display may not fully represent the rainfall observed at the ground due to:
• Permanent echoes (occultation) caused by hills or surface features.
• Spurious echoes caused by ships, aircraft, sea waves, chaff used on military exercises, technical problems or interference from other radars.
• Radar beam above the cloud at long ranges: difficulty in detecting low-level rain clouds.
• Evaporation of rainfall at lower levels beneath the beam giving an over-estimate of the actual rainfall.
• Orographic enhancement of rainfall at low levels- light precipitation generated in layers of medium-level cloud can increase in intensity by sweeping up other small droplets as it falls through moist, cloudy layers at low levels.
• Bright Band Radar echoes from both raindrops and snowflakes are calibrated to give correct intensities on the rainfall display. However, at the level where the temperature is near 0°C, melting snowflakes with large, reflective surfaces give strong echoes. These produce a false band of heavier rain, or bright band, on the radar picture.
• Anomalous propagation (anaprop) - radar beams travel in straight lines through a uniform medium but will be refracted when passing through air of varying density. When a low-level temperature inversion exists, the beam is bent downwards and strong echoes are returned from the ground, in a manner similar to the formation of mirages.



**Advantages of rainfall radar:**
• Detailed, instantaneous and integrated rainfall rates
• Areal rainfall estimates over a wide area
• Information in near-real time
• Information in remote land areas and over adjacent seas
• Location of frontal and convective (shower) precipitation
• Monitoring movement and development of precipitation areas
• Short-range forecasts made by extrapolation
• Data can be assimilated into numerical weather prediction models

## 7.09 Temperature

To convert temperatures in Celsius (°C) to Fahrenheit (°F), multiply by 9, divide by 5 and then add 32. The main problem in measuring air temperature is shielding thermometers from radiation, mainly short wave radiation from the sun but also long wave radiation from the ground. Mainly, due to the effect of radiation, the air (or dry bulb) temperature varies markedly with height above the ground and the type of surface. Thermometers also need to be kept dry as evaporation produces cooling. The solutions to these problems are resolved by recording the temperature of the air (recorded in degrees and tenths, Celsius) by housing the thermometers in the shade, at a height of 1.25 metres above the ground (normally over short grass, except in a few cities where roof top sites are used) in a louvered white box called a Stevenson Screen. The Stevenson Screen protects the thermometers from radiation and precipitation while the louvres permit ventilation. Air temperature values below zero degrees Celsius are preceded by a minus sign, while recordings are made at each (nominal) clock hour. In most modern day meteorological stations, the thermometers are of electrical resistance whereas in older meteorological stations they are in form of liquid-in-glass. Different thermometers are used for recording the maximum and minimum temperature. The highest and lowest temperature recorded during the previous 24-hour period finalises at 0900 GMT. The wet bulb temperature records the temperature of a wet surface by means of a piece of muslin wrapped around the bulb of a thermometer and kept moist by capillary action from a reservoir of distilled water. The wet bulb thermometer indicates the 'temperature of evaporation' which is, in normal circumstances, lower than the air (dry bulb) temperature. The difference between the dry bulb and wet bulb temperature is known as the wet bulb depression. From the dry and wet bulb readings, relative humidity and vapour pressure can be obtained. The maximum, minimum and wet bulb thermometers are all housed in the Stevenson Screen as mentioned above. The dew point is the temperature to which air must be cooled before it becomes saturated with water vapour. It is so called because it is also the temperature to which a surface must be cooled before dew will be deposited. With reference to thermometers housed outside the Stevenson screen, the grass minimum temperature is recorded by a thermometer exposed to the air one or two inches above the ground. The bulb is in contact with the tips of the grass blades, and refers to the period ending at 0900 GMT on the date of entry. The concrete minimum temperature, like the grass minimum temperature, is recorded by a thermometer but in this instance, the bulb is positioned in the centre of and just touching the slab and again refers to the period ending at 0900 GMT on the date of entry. Finally, soil temperatures are read at 0900 GMT in the morning at selected weather stations. Bent stem thermometers record the soil temperature at 5cm, 10cm and 20cm under a bare soil surface.

## 7.10 Sun

The total amount of bright sunshine (in hours and tenths) recorded on the date of entry. Measurement of the duration of sunshine refers to so-called 'bright' sunshine. Since different meteorological instruments differ in their response characteristics to solar radiation, this term has lacked precise definition. However, The World Meteorological Organisation decided in 1962 to adopt the Campbell-Stokes Recorder, as used in the British Isles, as the standard meteorological instrument for recording sunshine amount.

## 7.11 Total cloud

Total cloud amounts are estimated as the fraction, in eighths (oktas), of the sky covered by cloud. At manned meteorological stations, this is assessed by human observers. Some automatic meteorological stations make this assessment from cloud recording equipment.

### 7.12 State of ground

At manned meteorological stations, the state of ground refers to a bare patch of soil about 2m square and described accordingly. The state of ground includes descriptions such as dry, moist, wet, flooded, frozen, glazed, sand, ice, snow or dust covered.

### 7.13 Snow

Snow is much more difficult to measure than rain because the snowflakes blow around, rather than into, a rain gauge. The snow that does enter the gauge blocks it and prevents the normal operation of the rain gauge. Nevertheless, the aim is to record the amount of water substance that falls as snow. At manned meteorological stations this is achieved by melting the snow and recording the amount of water as 'rain'. Automatic rain gauges do not work well at temperatures below freezing point. Any solid precipitation that falls collects in the rain gauge and no precipitation is registered. When the temperature rises above freezing, the snow melts and the rain gauge starts registering, even though the current weather may be dry. Daily rainfall amounts are quality controlled to overcome this deficiency and estimates of the correct daily rainfall are made. For hourly rainfall, it is more likely that original and erroneous data remain on the computer archive. There is a close relationship between the intensity of snowfall and visibility. Thus if it is known that poor visibility is due to falling snow, the intensity of the precipitation can be inferred from the following table.

| Visibility | Description of snowfall intensity | Equivalent rainfall intensity |
|---|---|---|
| 5km | Slight snow | 0.2mm/hr |
| 2km | Slight /moderate snow | 0.5mm/hr |
| 1km | Moderate snow | 1.0mm/hr |
| 250m | Moderate/heavy snow | 4.0mm/hr |
| 110m | Heavy snow | 10.0mm/hr |

Dry snowflakes result in visibilities only about half of those given above. Visibility in wet snow is somewhat better, as wet snowflakes collapse to a smaller volume and become translucent. Blowing snow (most likely when the snow is dry and powdery) gives very low visibilities.

### 7.14 Snow depth

At manned meteorological stations, snow depth is measured with a ruler at three different locations and the average is then taken. The area chosen for these measurements should be as close as possible to the rain gauge and not affected by drifting or scoured by the wind. Some automatic meteorological stations measure snow depth by an optical technique.

## 7.15 Wind

Wind direction is measured in degrees from north (360 degrees of a circle) and relates to the direction from which the wind is blowing from. The quoted figures represent the wind direction averaged over the hour ending at the time of entry. A direction reported as 360 degrees represents a wind from due north (a northerly wind); 090 degrees is from due east (an easterly wind) etc. Wind speeds are recorded in knots (where 1 knot = 1.1515 mph), and they refer to the average speed (which includes all gusts and all lulls) during the hour ending at the time of entry. The mean wind speed refers to the highest mean wind at 10m above ground in an open level situation measured in the 10 minutes immediately preceding each hour. The maximum gust speed is also recorded in knots; the highest value (even if only of momentary duration) attained during the hour ending at the time of entry. The maximum wind gust refers to the highest 3-5 second gust at 10m above ground level by an anemometer. Gale force gusts are gusts >=39 mph. A gust is a rapid, but momentary increase in the speed of the wind, relative to the mean wind speed at the time. Equally, a lull is a momentary decrease below the mean wind speed. Wind speed generally increases with height according to a power law expression i.e. Speed at height H = speed recorded at 10 metres x Pow ((Height H in metres/10 metres) p) where the power p takes a value between 0.067 and 0.29 depending upon local terrain roughness and whether it is mean or gust speed under consideration. Beaufort Force = Pow(Pow((“Wind Speed (mph)” / 1.87), 2), 1/3). Beaufort Forces apply only to mean wind speeds and must not be used in reference to gusts.

## 7.16 Glossary

*Black ice* - is a thin coating of ice on a ground surface, formed when moisture from either natural or unnatural sources (for example, rain, freezing rain or drizzle, surface run-off, etc.) becomes present on exposed objects with a surface temperature below or at freezing (0ºC). It is near transparent due to the fact it is only a thin accumulation of ice, making it much harder to see in comparison to snow, frozen slush or thicker ice layers. The ‘black’ term comes from the fact that when the ice or ‘glaze’ forms on a road surface, the black tarmac underneath can be seen clearly through it presenting a distinct risk of pedestrians and automobiles.

*Civil twilight* - is defined to begin at sunset and ends when the geometric centre of the sun is 6º below the horizon. This is the limit at which twilight illumination is sufficient, under good weather conditions, for terrestrial objects to be clearly distinguished. At the end of evening civil twilight, the horizon is clearly defined and the brightest stars are visible under good atmospheric conditions in the absence of moonlight or other illumination.

*Cloud Cover* – The total cloud amount or cloud cover is the fraction of the celestial dome covered by all clouds visible. The assessment of the total amount of cloud, therefore, consists in the weather observer estimating how much of the total apparent area of the sky is covered with cloud. The international unit for reporting the cloud amount is the ‘okta’ or eighth of the sky, with 0 oktas equating to a clear sky and 8 oktas equating to an overcast sky.

*Condensation* – In meteorology, the formation of liquid water from water vapour. Since the capacity of air to hold water in the form of vapour decreases with temperature, cooling of air is the normal method by which first saturation, then condensation, is produced. Such cooling is effected by three main processes:

(i) adiabatic expansion of ascending air,
(ii) mixing with air at lower temperature,
(iii) contact with earth’s surface at lower temperature.

The water vapour condenses as cloud in (i), as fog or cloud in (ii), and as dew or hoar frost in (iii). Condensation in the atmosphere occurs at or near the temperature appropriate to the saturation vapour pressure, which is defined in terms of equilibrium between the vapour and a plane water surface, because of the presence in all parts of the troposphere of an adequate supply of 'condensation nuclei', which are hygroscopic. In the absence of such nuclei a high degree of supersaturation (several hundred percent) would be required to produce condensation – so called 'homogeneous condensation'.

*Dew* – Condensation of water vapour on a surface whose temperature is reduced by radiational cooling to below the dew-point of the air in contact with it. Of the two recognized processes of dew formation the more common occurs in conditions of calm (wind at two metres less than one knot) when water vapour diffuses from the soil upwards to the exposed cooling surface in contact with it (e.g. grass) and there condenses. The second of the processes is one of 'dewfall' when, in conditions of light wind, downward turbulent transfer of water vapour from the atmosphere to the cooled surface occurs.

*Dew-Point* – The dew-point of a moist air sample is that temperature to which the air must be cooled in order that it shall be saturated with respect to water at its existing pressure and humidity mixing ratio. Dew-point may be measured indirectly from wet- and dry-bulb temperature readings with the aid of humidity tables, or directly with a 'dew-point hygrometer'.

*Freezing drizzle, freezing fog, freezing rain* – Supercooled water drops of drizzle (or fog or rain) which freeze on impact with the ground to form glazed frost, or in the case of smaller droplets which comprise of fog to form rime.

*Freezing-point* – The constant temperature at which the solid and liquid forms of a given pure substance are in equilibrium at standard atmospheric pressure. For pure-water substance the temperature is 0°C and is termed the 'ice-point' or 'freezing-point'. In practice, a cooling liquid may not freeze at the freezing-point due to pressure variation from standard atmospheric pressure, or the presence of impurities, of the phenomenon of supercooling.

*Frost* – Frost occurs when the temperature of the air in contact with the ground or at screen level (about four feet), is below the freezing-point of water ('ground frost' or 'air frost', respectively). The term is also used of the ice deposits which may form on the ground and on objects in such temperature conditions.

*Frost Hollow* – A local hollow-shaped region in which, in suitable conditions, cold air accumulates by night due to a katabatic air flow. Such regions are subject to a greater incidence of frosts and to more severe frosts than the surrounding areas of non-concave shape.

*Funnel cloud* – Is a funnel shaped cloud of condensed water droplets, associated with a rotating column of wind and extending from the base of a cloud (usually a cumulonimbus or towering cumulus cloud) but not reaching the ground or a water surface. A funnel cloud is usually visible as a cone-shaped or needle like protuberance from the main cloud base. Funnel clouds form most frequently in association with supercell thunderstorms. If a funnel cloud touches the ground it becomes a tornado. Most tornadoes begin as funnel clouds, but many funnel clouds do not make ground contact and so do not become tornadoes.

*Glazed Frost* – A coat of ice, generally smooth and clear, formed by the falling of rain or drizzle (or sleet) on a surface whose temperature is below freezing-point: It may also form due to a sudden onset of warm, moist air following a severe frost, by the condensation and freezing of water on surfaces at temperatures still below freezing-point.

*Grass Minimum Temperature* – The minimum temperature indicated by a thermometer freely exposed in an open situation at night with its bulb in contact with the tips on the grass blades on an area covered with short turf.

*Ground Frost* – The term in forecasts signifies a grass minimum temperature below 0°C (32°F).

*Gust front* - is a leading edge/boundary (squall line) that separates a cold downdraft (outflow (winds that flow outwards from a thunderstorm)) of an organised line of thunderstorms (convective storm) from warm, humid surface (environmental) air. Its passage at the surface resembles the passage of a cold front. This squall line is marked by upward motion along it and downward motion behind it. It is normally followed by a surge of gusty winds on or near the ground. A gust front is often associated with an atmospheric pressure rise, wind shift, an air temperature drop and sometime heavy precipitation.

*Hoar/Grass Frost* – This is a series of interlocked ice crystals that develop on surfaces during cold, typically clear nights where the exposed surface is chilled below the dew point of the surrounding air and the surface itself is colder than 0ºC. Similarly, where air cooled by ground-level radiation loss travels downhill to form pockets of cold air in depressions, valleys and frost hollows, hoar frost can form even where the air temperature above ground is above freezing.

*Humidity* – This is the term used to describe the amount of water vapour in the air and can indicate the likelihood of precipitation, dew or fog. A device used to measure humidity is called a hygrometer. At an official weather station, humidity is recorded by a wet bulb and dry bulb thermometer. The difference between the two temperature readings allows the observer to calculate the dew point and also the humidity in a percentage form.

*Katabatic wind* – On a 'radiation night' of clear skies and low pressure gradient, terrestrial radiation from the earth's surface causes a layer of cold air to form near the ground, with an associated inversion of temperature. If the ground is sloping, the air close to the ground is colder than air at the same level but at some horizontal distance. A downslope gravitational flow of the colder, denser air beneath the warmer, lighter air ensues and comprises the 'katabatic wind'.

*Occlusion* – A front which develops during the later stages of the life-cycle of a frontal depression. The term arises from the associated occluding (shutting off) of the warm air from the earth's surface.

*Okta* – Unit equal to area of one eighth of the sky, used in specifying cloud amount.

*Sensible and Latent Heat (Hidden Heat)* – In meteorology, latent heat flux is the flux of heat from the Earth's surface to the atmosphere that is associated with evaporation or transpiration of water at the surface and subsequent condensation of water vapor in the troposphere. It is an important component of Earth's surface energy budget.

*Sleet* – Precipitation of snow and rain together or of snow melting as it falls.

*Squall* - is a sudden, sharp increase in wind speed which is usually associated with active weather, such as rain showers, thunderstorms, or heavy snow. Squalls refer to an increase in the sustained winds over a short time interval, as there may be higher gusts during a squall event. They usually occur in a region of strong mid-level height falls, mid-level tropospheric cooling, which force strong localised upward motions at the leading edge of the region of cooling, which then enhances local downward motions just in its wake.

*Straight-line winds* - are very strong winds that can produce damage, demonstrating a lack of a rotational damage pattern. Such rotational damage patterns are associated with cyclonic storms including tornadoes and tropical cyclones. Straight-line winds are common with the gust front of a thunderstorm or originate with a downburst from a thunderstorm. These events can cause considerable damage, even in the absence of a tornado. Long lived straight-line winds can cause considerable damage. The winds can reach 80mph (130km/h) or more and can last for periods of twenty minutes or longer.

*Synoptic Meteorological Charts* – This is a weather chart that reflects the state of the atmosphere over a geographical area at a certain time based on information gathered from weather stations at surface level. The chart is created by plotting or tracing the values of relevant quantities (including sea level pressure, temperatures, etc.) and show the presence or potential de[illegible]ent of weather fronts and systems.

*Thaw* – The transition by melting from snow or ice to water. T[illegible]m is esp[illegible]lly use[illegible] to indicate the end of a spell of frost, which in the British Isles in winte[illegible]nerally [illegible]ed with the displacement of a stagnant or continental air mass by one of maritime [illegible]

*Tornado* - is a violently rotating column of air that is in cont[illegible]ith both [illegible] surface of the earth and a cumulonimbus cloud. Tornadoes come in many shap[illegible] but they are typically in the form of a visible condensation funnel, whose narrow end [illegible]ches th[illegible]th and is often encircled by a cloud of debris and dust. Most tornadoes have [illegible]eeds le[illegible] than 110 miles per hour (177km/h), are about 250 feet (76m) across, and travel [illegible] mil[illegible] (several kilometers) before dissipating.

*Trough* - A non frontal line on a synoptic [illegible]art [illegible] associate[illegible] with an organised band of generally cloudy, showery weather.

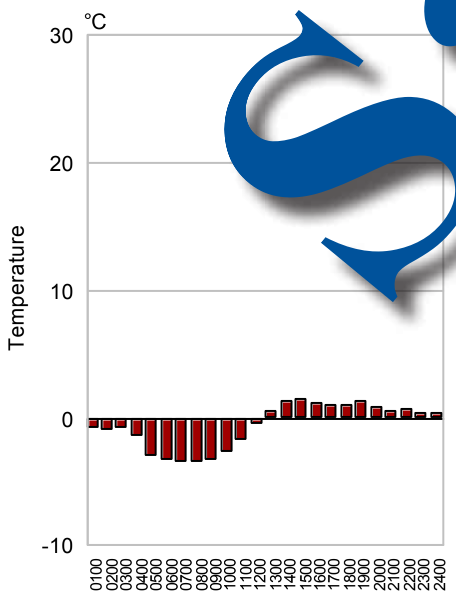
*Visibility* – Meteorological visibility i[illegible]fined a[illegible]greatest distance at which a black object of suitable distance can be seen and recog[illegible]gainst [illegible]e horizon sky. The simplest determinations of daylight visibility have, for many years, b[illegible]duced by how well a series of objects or lights of known distance can be seen fr[illegible] certain po[illegible] of a meteorological station. The estimated distance is then noted in the record[illegible]ecently; however, automated weather systems including a "forward scatter sensor" ha[illegible] bee[illegible]articularly at airports. This instrument produces pulsed flashes of light, [illegible]me of w[illegible] is scatt[illegible] at an angle towards a nearby detector. Visibility is then estimated fr[illegible] the intensity of [illegible]attered light. The sensors report a visibility based on one minute sa[illegible]ples averaged over the [illegible] ten minutes leading up to each observation.

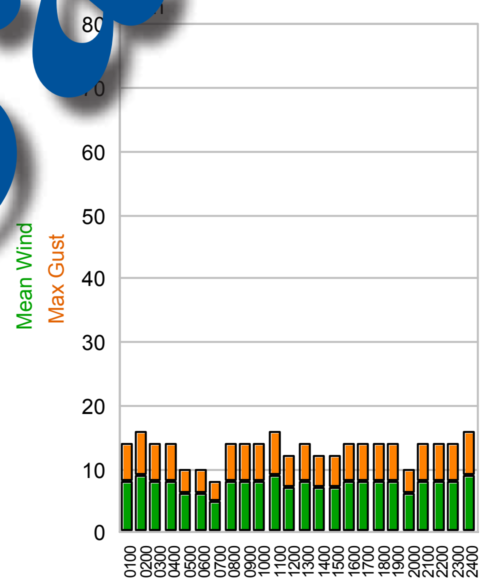
*Warm Fro[illegible]*[illegible]al sys[illegible]n whose movement is such that the warmer air mass is replacing a colder air mass.

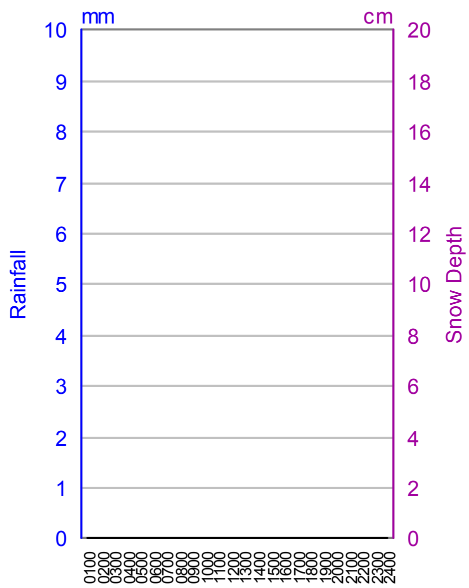
# Weather Report for Waddington (68m AMSL) @ 5.2 miles from LN3 4JT

Friday, January 21, 2011

| Hour Ending (GMT) | Temperature (°C) | Humidity (%) | Rainfall (mm) | Sunshine (hours) | Wind Direction | Wind Speed (mph) | Max Wind Gust (mph) | Snow Depth (cm) | Significant Weather |
|---|---|---|---|---|---|---|---|---|---|
| 0100 | -0.9 | 78 | 0.0 | 0.0 | WNW | 8 | 14 | | Air frost |
| 0200 | -1.0 | 77 | 0.0 | 0.0 | WNW | 9 | 16 | | Air frost |
| 0300 | -0.8 | 73 | 0.0 | 0.0 | WNW | 8 | 14 | | Air frost |
| 0400 | -1.5 | 77 | 0.0 | 0.0 | W | 8 | 14 | | Air frost |
| 0500 | -3.0 | 88 | 0.0 | 0.0 | WNW | 6 | 10 | | Air frost |
| 0600 | -3.4 | 86 | 0.0 | 0.0 | WNW | 6 | 10 | | Air frost; Frozen ground |
| 0700 | -3.5 | 89 | 0.0 | 0.0 | W | 5 | 8 | | Air frost |
| 0800 | -3.5 | 84 | 0.0 | 0.0 | W | 8 | 14 | | Air frost; Haze |
| 0900 | -3.3 | 88 | 0.0 | 0.4 | W | 8 | 14 | | Air frost |
| 1000 | -2.7 | 90 | 0.0 | 0.9 | WNW | 8 | 14 | | Air frost; Haze |
| 1100 | -1.8 | 84 | 0.0 | 0.9 | NNW | 9 | 16 | | Air frost |
| 1200 | -0.5 | 80 | 0.0 | 1.0 | NNW | 7 | 12 | | Air frost |
| 1300 | 0.6 | 78 | 0.0 | 1.0 | NW | 8 | 14 | | |
| 1400 | 1.3 | 74 | 0.0 | 1.0 | NNW | 7 | 12 | | |
| 1500 | 1.5 | 79 | 0.0 | 1.0 | NW | 7 | 12 | | |
| 1600 | 1.2 | 83 | 0.0 | 0.7 | NW | 8 | 14 | | |
| 1700 | 1.1 | 83 | 0.0 | 0.0 | NW | 8 | [illegible] | | |
| 1800 | 1.1 | 83 | 0.0 | 0.0 | NW | 8 | [illegible] | | |
| 1900 | 1.3 | 82 | 0.0 | 0.0 | NNW | 8 | [illegible] | | |
| 2000 | 0.9 | 83 | 0.0 | 0.0 | NW | [illegible] | 10 | | |
| 2100 | 0.6 | 85 | 0.0 | 0.0 | NW | 8 | 14 | | |
| 2200 | 0.7 | 86 | 0.0 | 0.0 | NW | 8 | [illegible] | | |
| 2300 | 0.4 | 87 | 0.0 | 0.0 | NW | [illegible] | [illegible] | | |
| 2400 | 0.5 | 78 | 0.0 | 0.0 | [illegible] | [illegible] | 16 | | |
| Total | | | 0.0 | 6.9 | | | | | |
| Average | -0.6 | | | | | | | | |
| Maximum | 1.5 | 90 | | | | 9 | 16 | | |
| Minimum | -3.5 | | | | | | | | |




Notes

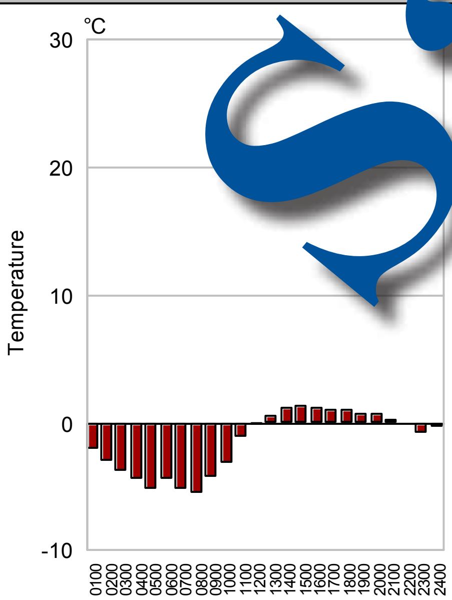


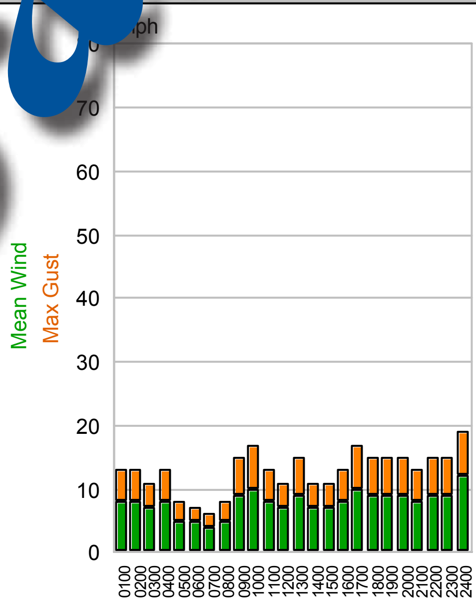
Tel: 01202-296396; Fax: 01202-314064; www.weathernet.co.uk

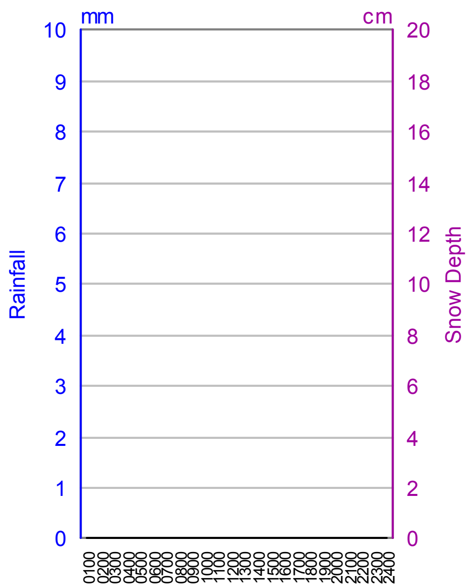
**Weather Report for Scampton (57m AMSL) @ 5.3 miles from LN3 4JT**

Friday, January 21, 2011

| Hour Ending (GMT) | Temperature (°C) | Humidity (%) | Rainfall (mm) | Sunshine (hours) | Wind Direction | Wind Speed (mph) | Max Wind Gust (mph) | Snow Depth (cm) | Significant Weather |
|---|---|---|---|---|---|---|---|---|---|
| 0100 | -2.1 | 100 | 0.0 | | WNW | 8 | 13 | | Air frost |
| 0200 | -3.0 | 100 | 0.0 | | WNW | 8 | 13 | | Air frost |
| 0300 | -3.8 | 100 | 0.0 | | W | 7 | 11 | | Air frost |
| 0400 | -4.4 | 96 | 0.0 | | W | 8 | 13 | | Air frost |
| 0500 | -5.2 | 100 | 0.0 | | NW | 5 | 8 | | Air frost |
| 0600 | -4.4 | 99 | 0.0 | | NW | 5 | 7 | 0 | Air frost |
| 0700 | -5.2 | 100 | 0.0 | | WNW | 4 | 6 | | Air frost |
| 0800 | -5.5 | 100 | 0.0 | | WNW | 5 | 8 | | Air frost |
| 0900 | -4.3 | 100 | 0.0 | | WNW | 9 | 15 | | Air frost |
| 1000 | -3.2 | 100 | 0.0 | | NW | 10 | 17 | | Air frost |
| 1100 | -1.2 | 96 | 0.0 | | NNW | 8 | 13 | | Air frost |
| 1200 | -0.2 | 92 | 0.0 | | NW | 7 | 11 | | Air frost |
| 1300 | 0.6 | 92 | 0.0 | | NW | 9 | 15 | | |
| 1400 | 1.2 | 87 | 0.0 | | NW | 7 | 11 | | |
| 1500 | 1.3 | 89 | 0.0 | | NNW | 7 | 11 | | |
| 1600 | 1.2 | 92 | 0.0 | | NW | 8 | [illegible] | | |
| 1700 | 1.0 | 91 | 0.0 | | NW | 10 | 17 | | |
| 1800 | 1.0 | 92 | 0.0 | | NW | 9 | [illegible] | | |
| 1900 | 0.7 | 93 | 0.0 | | NW | 9 | [illegible] | | |
| 2000 | 0.8 | 91 | 0.0 | | NW | [illegible] | 15 | | |
| 2100 | 0.3 | 91 | 0.0 | | NW | [illegible] | 13 | | |
| 2200 | -0.1 | 91 | 0.0 | | [illegible] | 9 | [illegible] | | Air frost |
| 2300 | -0.8 | 92 | 0.0 | | [illegible] | [illegible] | 15 | | Air frost |
| 2400 | -0.4 | 91 | 0.0 | | [illegible] | [illegible] | 19 | | Air frost |
| Total | | | 0.0 | | | | | | |
| Average | -1.5 | | | | | | | | |
| Maximum | 1.3 | 100 | | | | 12 | 19 | 0 | |
| Minimum | -5.5 | | | | | | | | |




Notes



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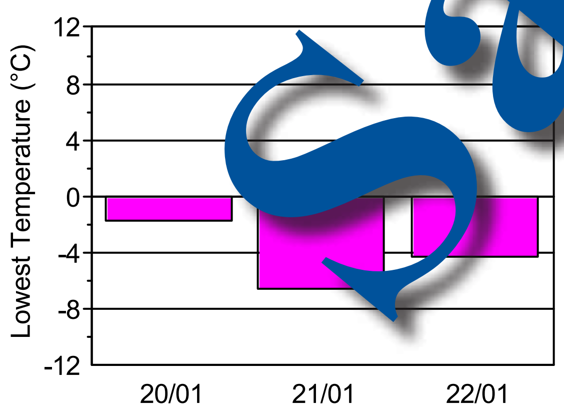
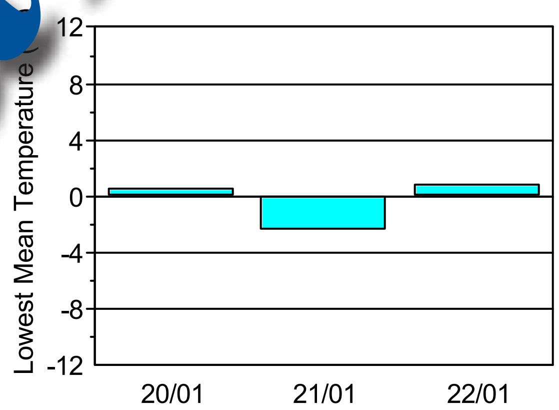
## Freeze Report for 25 Miles around LN3 21/01/2011 ± 1 Days

| Weather Station | Miles from LN3 | Temperature (°C) Max | Min | Mean | Sun (hrs) | Rain (mm) | Max Wind (mph) Dirn | Mean | Gust | Significant Weather |
|---|---|---|---|---|---|---|---|---|---|---|
| **Thursday 20 January 2011** | | | | | | | | | | |
| Scampton | 8 | **3.0** | **-1.9** | **0.6** | | 0.0 | | | | Frost 0200-0900 & 1900-2000; Ground frost (-3.5°C) |
| Waddington | 9 | **3.7** | **-0.7** | **1.5** | 1.8 | 0.2 | NW | 12 | 20 | Frost 0500-0800 & 2400; Ground frost (-1.9°C) |
| Coningsby | 14 | **4.0** | **-0.9** | **1.6** | | 0.3 | NW | 10 | 17 | Frost 0400-0900 & 2300-2400; Ground frost (-2.8°C) |
| Louth | 17 | **5.8** | **2.4** | **4.1** | | 0.4 | N | 8 | 14 | None |
| Cranwell | 17 | **3.8** | **0.1** | **2.0** | | 0.2 | NW | 13 | 21 | Ground frost (-1.6°C) |
| Gringley on the Hill | 24 | **5.0** | **-0.2** | **2.4** | | 0.0 | | | | Frost 0800 & 2400; Ground frost (-2.5°C) |
| **Friday 21 January 2011** | | | | | | | | | | |
| Scampton | 8 | **1.9** | **-6.7** | **-2.4** | | 0.0 | | | | Severe [illegible]rost; Severe ground frost (-[illegible]0.5°C) |
| Waddington | 9 | **1.8** | **-3.9** | **-1.0** | 5.9 | 0.0 | NW | [illegible] | 15 | F[illegible]100-120[illegible]; Severe ground frost (-6[illegible] |
| Coningsby | 14 | **3.3** | **-3.3** | **0.0** | | 0.0 | NW | 13 | [illegible] | Frost 0[illegible]100 & 2300-2400; Ground [illegible]st (-5.7°C) |
| Louth | 17 | **5.3** | **-3.7** | **0.8** | | 0.1 | N | 7 | 11 | [illegible]; Ground frost (-5.6°C) |
| Cranwell | 17 | **2.3** | **-5.2** | **-1.4** | | 0.0 | NW | [illegible] | 16 | Fr[illegible] 0100-1200 & 2400; Severe ground frost (-7°C) |
| Gringley on the Hill | 24 | **2.5** | **-3.3** | **-0.4** | | 0.0 | | | | Frost 0100-1100; Severe ground frost (-6.7°C) |
| **Saturday 22 January 2011** | | | | | | | | | | |
| Scampton | 8 | **6.0** | **-4.4** | **0.8** | | [illegible] | [illegible] | 15 | [illegible] | X |
| Waddington | 9 | **5.8** | **-3.3** | **1.3** | 0.0 | 0.6 | [illegible] | 14 | [illegible] | None |
| Coningsby | 14 | **7.4** | **-3.0** | **2.2** | | [illegible] | [illegible] | 16 | 27 | None |
| Louth | 17 | **7.5** | **-2.8** | **2.4** | | [illegible] | NE | 16 | 28 | Air frost; Ground frost (-3.8°C) |
| Cranwell | 17 | **5.8** | **-3.4** | **[illegible]** | | 0.4 | N | 16 | 25 | None |
| Gringley on the Hill | 24 | **5.8** | **-3.0** | **1.4** | | 0.0 | | | | X |

**Summary for Period**





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# Beaufort Scale

1 mph = 0.868 Knots

| Beaufort Force | Description | Mean Speed (mph) | Lower Limit (mph) | Upper Limit (mph) | Specification on Land | As Used at Sea: State of Sea | As Used at Sea: Specififcation at Sea | Height of Waves (ft) |
|---|---|---|---|---|---|---|---|---|
| **0** | **Calm** | 0 | 0 | 1 | Calm; smoke rises vertically | **Calm** | Sea like a mirror | 0 |
| **1** | **Light Air** | 2 | 1 | 3 | [illegible]ection of wind shown by smoke [illegible]t but not by wind vanes | **Calm** | Ripples with the appearance of scales are formed, without foam crests | 0.3 |
| **2** | **Light Breeze** | 5 | 4 | 7 | [illegible]nd felt [illegible]e; leaves rustle | **Smooth** | Small wavelets, still short but more pronounced; crests have a glassy appearance and do not break | 0.6 |
| **3** | **Gentle Breeze** | 10 | 8 | 12 | Le[illegible]s in constant m[illegible] wind[illegible]ds light flag | **Smooth** | Large wavelets; crests begin to break; foam is of glassy appearance; scattered white horses | 2 |
| **4** | **Moderate Breeze** | 15 | 13 | 18 | Dust & lo[illegible]per raise[illegible]all branches [illegible]ved | **Slight** | Small waves; becoming longer; fairly frequent white horses | 3 |
| **5** | **Fresh Breeze** | 21 | 18 | 24 | Small trees in leaf [illegible]o sway crested wavelets [illegible]n wat[illegible] | **Moderate** | Moderate waves with more pronounced long form; many white horses; chance of some spray | 7 |
| **6** | **Strong Breeze** | 27 | 24 | 31 | Large branches in motion; [illegible]ng heard in telegraph wires | **[illegible]h** | Large waves begin to form; white foam crests are more extensive everywhere; probably some spray | 10 |
| **7** | **Near Gale** | 35 | 31 | 38 | Whole trees in motion; inconvenience felt when walking against the wind | **[illegible]ery Ro[illegible]** | Sea heaps up and white foam from breaking waves begins to be bl[illegible]n in streaks along the direction of the wind | 13 |
| **8** | **Gale** | 42 | 39 | 46 | Twigs break off trees; difficult to walk against wind | **H[illegible]** | M[illegible]ately hig[illegible]s of greater length; edges of crests begin to [illegible] into sp[illegible], foam blown along the direction of the wind | 18 |
| **9** | **Strong Gale** | 50 | 47 | 54 | Slight structural damage to chimney pots, aerials & roof slates | **[illegible]ry Hig[illegible]** | [illegible]igh wav[illegible]se streaks of foam along the direction of the wind; crests o[illegible]s topple, tumble and roll over; spray may affect visibil[illegible] | 23 |
| **10** | **Storm** | 59 | 55 | 63 | Trees uprooted; considerable structural damage | **Very High** | Very [illegible] wave[illegible]long o[illegible]erhanging crests; foam patches blown in dense white [illegible]aks; [illegible] "tumbling" of sea; visibility affected | 30 |
| **11** | **Violent Storm** | 68 | 64 | 72 | Widespread structural damage | **Phenomenal** | Exceptionally [illegible] waves (ships sometimes lost to view behind the waves); everyw[illegible] the edges of the wave crests are blown into froth | 38 |
| **12** | **Hurricane** | - | 73 | - | Devastation | **Phenomenal** | Air is filled with foam and spray; sea completely white with driving spray; visibility very seriously affected | 47 |



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