Rialtas na hÉireann
Government of Ireland

National Directorate for Fire and Emergency Management

Review Report on Severe Weather Events 2017 - 2018

Prepared by the Department of Housing, Planning and Local Government

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National Directorate for Fire and Emergency Management

REVIEW REPORT ON SEVERE WEATHER EVENTS 2017 – 2018

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The Department would like to acknowledge those in the Principal Response Agencies, Emergency Services, the Defence Forces, utilities and essential services who worked so diligently to maintain and restore the critical infrastructure and services which enable our society to function and protect the most vulnerable. The Department especially wants to acknowledge the background work of the Management Board of the National Directorate for Fire and Emergency Management and the Chief Executives of local authorities and their fire services in building Ireland's local co-ordination and emergency response capability over the past decade.

The Department would also like to acknowledge the political support at national level from our Minister Eoghan Murphy, TD, and Ministers of State Damien English, TD and John Paul Phelan, TD, and from the Government more generally, up to and including An Taoiseach, Leo Varadkar, TD, as well as the broader political support at national and local level.

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John McCarthy,
Secretary General,
Department of Housing, Planning and Local Government,
Custom House,
Dublin.

1 INTRODUCTION TO REPORT

1.1 Introduction

This is the Report of a Review of Severe Weather Events which affected Ireland between August 2017 and September 2018. These include ex-Hurricane Ophelia, which struck Ireland on Monday, 16 Oct 2017 and the snowstorms associated with storm Emma which impacted from 1 – 4 March 2018. Ex-Hurricane Ophelia was an extreme, high impact weather event, bringing record-breaking wind speeds and, tragically, three deaths to Ireland. The snowfalls, blizzard conditions and drifting associated with storm Emma are ranked with previous major snow events of 1982, 1963, 1947 and 1933. For the brief periods of these two events, nature asserted that its forces can dominate all our lives and its destructive and disruptive capabilities remind us of the fragility of our society in face of its forces.

This Report is prepared by the National Directorate for Fire and Emergency Management on behalf of the Department of Housing, Planning and Local Government. The Department has the role as the “Lead Government Department” for co-ordinating the response to severe weather events. The National Directorate has prepared review reports after each severe weather event since the major flooding of November 2009 as part of a systems approach to learning and developing from each event.

Since the publication of the Strategic Emergency Management (SEM) National Structures and Framework document approved by Government in 2017, under Clause 6.16, recommendations in a Lead Government Department’s Review Report that impact on other Government Departments or relate to national co-ordination are to be finalised at Government Task Force (GTF) on Emergency Planning. In this context, this final report takes account of the inputs from relevant Departments and the GTF since the first draft report was circulated in 2018.

This Report is based primarily on reports and data received from the Government Departments, specialist agencies and local authorities involved in the responses to the various events and debriefs held after the events. These organisations participated in the “National Emergency Co-ordination Group” (NECG) convened at national level to

manage the response to these events, as well as the local authorities and other organisations that were involved in the front-line response.

The Report is intended also as a record of the severe weather events which occurred. It describes the wind storm, the snow storm, the three flooding events and the hot weather/ drought in separate chapters. It draws conclusions and makes 'agent' specific (i.e. flooding, wind-storm, snow blizzard, and hot weather/ drought) recommendations at the end of each of these chapters.

The Report is presented in 9 chapters. As well as being a report recording the main features associated with the events, each chapter contain conclusions and recommendations intended to capture learning points specific to the weather 'agent' (i.e. flooding, storm and snow). Chapter 8 looks at issues associated with our Critical Infrastructure. Chapter 9 then looks at Societal Resilience and Essential Services.

The period from August 2017 to September 2018 was a testing one. Our overall conclusion is that most aspects of the State's response to these severe weather events, and in particular Ophelia and Emma, worked well from an emergency management perspective. Public services are well aligned and focussed on working with the private, voluntary and community sectors, to manage the preparedness for and response to weather related crises and critically are able to provide appropriate information to the public which enables them to make judgements for their own safety.

1.2 Three Flooding Events

Chapter 4 of this Report provides details of three significant flooding events which have occurred over the period covered by this report. These were:

- Inishowen Pluvial Flooding event – August 2017
- Mountmellick Fluvial Flooding event – November 2017
- Galway City Tidal Flooding event – January 2018

1.3 Ex-Hurricane Ophelia

Ex-Hurricane Ophelia crossed Ireland on Monday 16 October 2017. It was predicted to be an 'unprecedented' weather event and record-breaking wind-speeds were recorded across the country during the storm. [1] While the south and south-east of the country was worst impacted, trees were knocked down or broken in most areas making road conditions extremely hazardous. Warnings about the arrival of ex-Hurricane Ophelia and advice on self-protection were disseminated to the public by the national and local response services. The aim of the National Emergency Coordination Group (NECG) was to prevent serious injury and loss of life of the type that occurred during a storm in January 1991 when 14 people were killed. The NECG issued advice "to stay indoors" during the storm and as a result the country effectively shut down on Monday 16 October. Sadly, three fatalities are directly attributed to the impacts of ex-Hurricane Ophelia on the day. While not all areas of the country experienced the worst of the storm, the application of the "precautionary principle" in the interest of public safety was generally accepted as appropriate. The storm was followed by intense rainfall in some areas. However, the bulk of the rain associated with the storm passed to the west of the country and fell over the Atlantic Ocean.

Schools remained closed for a further day on Tuesday 17 October to enable school management to ensure that any building damage was appraised and downed electricity lines could be made safe and to take account of hazardous travelling conditions.

The storm caused huge disruption to electricity supply services, with a 'domino' effect on other infrastructure and services. 385,000 premises lost electricity supply which in turn caused severe disruption to water treatment and wastewater systems. ESB Networks and Irish Water worked together for over a week after ex-Hurricane Ophelia to restore electricity and water supply, prioritising vulnerable customers and co-ordinating with the Principal Response Agencies to provide humanitarian assistance to those left without water and power.

[1] Gusts of up to 191km/h were recorded at Fastnet Rock off the coast of County Cork, the highest wind speeds ever recorded in Ireland. 10-minute sustained wind speeds at Roches Point reached 111km/h

Chapter 6 of this report provides a record of the events of 16 October 2017 and the actions taken before, during and after the storm to mitigate its impacts. The report reviews the event with a view to learning and enhancing future response to emergency events in Ireland.

Ex-Hurricane Ophelia stands out as an unprecedented wind-storm in terms of impacts, average wind-speeds and gusts. However, previous storms have severely impacted on Ireland and led to loss of life and widespread damage across the country. In living memory, storm Debbie (September 1961) resulted in 18 fatalities (including 7 fatalities in N.I.). Hurricane Charlie (August 1987) resulted in severe rainfall and flooding along the east coast. As noted above, a wind-storm which occurred during a protracted episode of severe weather in January 1991 caused 14 fatalities, including seven people in a minibus killed by a falling tree. The most recent comparable event was storm Darwin (12 February 2014) which tracked rapidly across the country resulting in disruption to the power supply for over 200,000 premises, with trees knocked and blocking many parts of the road network.

1.4 Snow Storm Emma

On Saturday 24 and Sunday 25 February 2018 Ireland lay in a south-easterly airflow as an area of high pressure extending from northern Europe into Russia began to drift eastwards. This area of high pressure, of Arctic origin, was an exceptionally cold air mass. On Monday 26 February and Tuesday 27 February 2018**,** the area of high pressure had extended westwards over Ireland, with colder air gradually becoming established over the country in an easterly airflow. Daytime air temperatures fell from near normal values (5-8 degrees Celsius) to just slightly above freezing. On Tuesday, 27 February 2018 snow showers began to affect coastal areas in the south and east as the very cold, dry, unstable air picked up moisture while crossing the Irish Sea. During Tuesday night and Wednesday these snow showers moved further westwards across the country bringing accumulations of snow to many locations.

The initial objectives of the National Emergency Co-ordination Group, which was convened to coordinate the State's response to the weather event, was to keep the country moving and to keep the public informed, particularly on public safety.

However, at the same time storm ‘Emma’, which had been named by the Portuguese Meteorological Service was moving from the Azores towards mainland Portugal. During this period, storm Emma had brought heavy rain to Portugal and Spain and was situated off the west coast of Portugal, and began to move quickly northwards on Wednesday night. The day of Thursday 1 March 2018 was bitterly cold with daytime air temperature not rising above freezing in many locations. Early on Thursday snow showers continued to feed in across the country from the Irish Sea.

As well as being forecast to bring much more significant quantities of snow fall, storm Emma would also bring very strong winds with the snow. This was predicted to result in blizzard conditions, a dangerous combination of snow and wind, something not experienced here for more than 35 years. The National Emergency Coordination Group issued public safety advice “to be off the roads and stay indoors” during the blizzard conditions which were forecast from Thursday afternoon through the night and into Friday. For the second time in less than 5 months, the country effectively closed down because of public safety concerns arising from nature’s impact.

The heavy snowfall associated with storm Emma occurred as the moisture-rich air with the storm coming from the south met the sub-zero temperature air mass which had become established over Ireland. Storm Emma continued to move northwards and by 6pm Thursday 1 March persistent outbreaks of snow had begun to affect the south and southeast of the country, and this spread to the rest of the country overnight. Strong winds associated with storm Emma caused blizzard conditions for a time through Thursday night, causing snow drifting effects in many areas.

The “stay indoors” advice was withdrawn early on Friday 2 March 2018 as the winds abated. However, snow continued to fall heavily on the eastern part of the country during Friday, as storm Emma became slow-moving to the southeast, and continued to steer bands of snow across the country, with the east and southeast worst affected.

During Friday 2 and Saturday 3 March 2018 storm Emma passed westwards close to the south coast of Ireland. Somewhat milder air slowly extended northwards across the country, with snow showers turning to rain or sleet from the south. Sunday saw a further slow rise in temperatures, but still some sleet or rain showers and a continuing slow thaw of lying snow.

While the thaw cleared the snow in many areas and life returned to normal from Sunday 4 March 2018, parts of Wexford, Wicklow, Carlow, South Dublin, Kildare and Meath remained covered in deep drifts of snow and huge efforts were made by public authorities and communities themselves to clear snow and facilitate a return to normal.

1.5 Heat Wave and Drought Conditions – June August 2018

The summer season for 2018 was unusually dry and warm. The weather patterns for June, July and August 2018 were dominated by high pressure resulting in warm, dry and sunny weather up to mid-August. Very high temperatures (for Ireland) were recorded in late June and early July (described as heat-wave conditions).

A heat-wave is defined as five days with temperatures over 25 degrees and drought is defined as a period of 15 or more consecutive days, on which no significant rain fell.

Temperatures peaked for the week ending 29 June 2018 with temperatures reaching 32° Celsius. During July temperatures were less extreme, ranging from the low to high twenties degrees Celsius. Throughout the summer period night-time temperatures remained within normal ranges, which lessened the impact on public health.

Drought conditions were recorded across the country from late June onwards. Despite the temperatures having fallen back in July, rainfall amounts remained well below average for the summer season. This meant that there was little or no alleviation in the drought conditions.

The soil moisture deficit is a measure of how much rainfall would be required to restore moisture levels in the soil to seasonal norms. The soil moisture deficit remained very high throughout the country, typically in the range of 70 to 100 mm, with the highest deficits recorded in the east and southeast regions.

These drought conditions were reflected by falling water levels in rivers and groundwater, with many rivers reaching their lowest levels on record. Sustained rainfall was needed during autumn to restore both groundwater and river levels to near normal conditions. These conditions are compounded by the normal seasonal cycle where the

driest period usually occurs from August through to the end of September, thus leading to a longer recovery time for normal moisture levels.

The warm/ dry weather event in 2018 is comparable to the summers of 1976 and 1995. The features in common include low rainfall from late spring/ early summer, coinciding with high temperatures from late May/ early June onwards.

Water temperatures in our rivers and lakes were significantly higher than normal during June and July, with low flows adversely affecting fish and aquatic life at some locations.

2. DEVELOPMENT OF EMERGENCY MANAGEMENT IN IRELAND

2.1.1 Introduction

The national arrangements for the delivery of emergency management in Ireland have developed in the decade since the publication of **"A Framework for Major Emergency Management"** in 2006. This document set out the structures and approach to enable the Principal Response Agencies (An Garda Síochána, Local Authorities and the Health Services Executive) to prepare for and make a co-ordinated response to emergencies of all kinds.

The emergency management arrangements at national level were developed out of experience and are set out now in a further document approved by Government and published in 2017 **"Strategic Emergency Management – National Structures and Framework"**. This outlines the structures for coordinating a "whole-of-Government" approach and the framework for achieving a systems approach to emergency management. This national approach is designed primarily to enhance the protection, support and welfare of the public in times of emergency, by ensuring that fit-for-purpose national structures and procedures are in place to deal with a broad spectrum of emergencies, whether of internal or external origin. These arrangements are also designed to enhance national resilience so that disruption to the functioning of society and the economy is minimised.

2.2 Categories of Emergency

2.2.1 'Normal' Emergencies

Every country experiences a range of emergencies such as fires, transport accidents, incidents involving hazardous substances, and severe weather emergencies. These are described as "normal" emergencies and thousands of such events are routinely responded to by the principal emergency services [2] every year in Ireland.

2.2.2 Major Emergencies

[2] An Garda Síochána, the National Ambulance Service, the local authority Fire Services and the Irish Coast Guard.

Some emergencies may be beyond the normal response capabilities of the emergency services in the area in which they occur, and require a degree of additional local support from, and coordination by, the 'Principal Response Agencies' [3]. The level of coordination is outlined in the Framework for Major Emergency Management, 2006 (the MEM Framework), which enables the Principal Response Agencies (PRAs) to work together to prepare for and respond to major emergencies.

2.2.3 National-Level Emergencies

Some emergencies have characteristics which will require a national dimension of response to be invoked. In an increasingly 'globalised' society and inter-connected world, an emergency in Ireland may have its genesis in natural or man-made events at home or elsewhere. There are a range of diverse emergency scenarios which could require a national level response and over 50 such scenarios are identified in Annex A of the 'Strategic Emergency Management National Structures and Framework' document.

In a national context, an emergency [4] is defined as:

> An event which, usually with little or no warning, causes or threatens to cause death, serious injury, serious disruption to essential services, the economy or critical infrastructure, significant damage to property or the environment, and which requires the activation of national resources to ensure an effective coordinated response and recovery.

[3] An Garda Síochána, the Health Service Executive, and the local authorities.

[4] The term 'Emergency' is interpreted to include such terms as 'crisis', 'disaster' and 'catastrophe' which are often used interchangeably in international publications.

2.3 Emergency Management in Ireland

2.3.1 The Systems Approach to Emergency Management

Ireland has adopted the Five-Stage Systems Approach to emergency management, drawing on an internationally-recognised safety paradigm. This is illustrated in Figure 2.1 and involves a continuous cycle of activity, rather than preparation of static emergency plans. The principal elements of the systems approach are;

- Hazard Analysis
- Mitigation
- Planning and Preparedness
- Response
- Recovery

Figure 2.1

The Five–Stage Systems Approach

2.3.2 The Objectives of Emergency Management

Effective emergency management encompasses identification of hazards, mitigation of risks, planning for events which may occur, responding when they do occur and recovery or restoration of normal life after the event. The principle objectives for emergency management at national level are:

- To protect the safety of the public and to minimise or prevent damage to the economy, critical infrastructure and property;
- To provide clear leadership in times of emergency, including arrangements for warning and informing the public;
- To facilitate timely and effective response through efficient and co-ordinated operations;
- To ensure that essential services are maintained and efficient and timely return to normal conditions;
- To foster and encourage resilience and community spirit, including supporting the provision of services by the voluntary emergency services and communities affected;
- To co-ordinate the recovery phase of operations, thereby facilitating a timely return to normal life within the shortest practicable timescale.
-

2.3.3 Principles of Emergency Management

The following principles have been adopted by Government, and underpin emergency management at all levels in Ireland:

- **An All Hazards Approach**

Common features of emergency management are recognised, regardless of the origin/ cause of the emergency;

- **Subsidiarity**

The initial emergency response takes place at the nearest appropriate level, with co-ordination at other levels as the situation escalates;

- **Co-ordination**

The task of co-ordination is recognised as a distinct function and also as a critical determinant of effective response. The mandate/ responsibility for this is assigned to a “Lead Government Department” at national level and “Lead Agency” at local level. Coordination is required at ‘horizontal level’ between organisations operating at each of

the local, regional and national levels, as well as 'vertical co-ordination' between these different levels.

2.3.4 Fundamentals of Emergency Management

In implementing an emergency management approach, the following fundamentals are applied:

- Lead Government Departments (LGDs) are nominated for a range of scenarios. They collaborate with other Departments, Agencies, and key stakeholders in preparing for emergencies and co-ordinate the response when they occur;
- Departments and relevant agencies communicate clearly with the public and key stakeholders, issuing timely and authoritative advice, alerts and warnings and sharing relevant information;
- Maintain an open and transparent approach using all available channels to keeping the public informed of what is being done to protect them and how they can help themselves and others;
- Cooperate and collaborate as required with the private sector, the voluntary emergency services and communities themselves;
- Foster the concept of societal and community resilience; Compliance with relevant legislation and any regulations made thereunder; and
- Assess risk, and balance risk, needs and resources as part of the risk management system.

2.3.5 International Context and Best Practice in Emergency Management

Ireland participates in various international arenas dealing with emergency management. A range of staff in Government Departments and other public authorities have been involved in international training and exercises, and have developed their operational skills and adapted/ incorporated international practices and procedures for Irish conditions.

Ireland is also party to a number of bilateral and multilateral arrangements relating to emergency management and cooperates at various international levels, principally within the United Nations (UN), the European Union (EU), and the Organisation for Economic Cooperation and Development (OECD).

For the past decade, emergency management practitioners have had the benefit of a Master's Degree Programme in Emergency Management in DCU. The 100 + graduates from this programme, who are working across a range of public and private organisations, have helped shape the development of emergency management in Ireland in line with best practice as identified in relevant international literature.

2.4 Local Level Co-ordination

In May 2006, the Government approved the document - ***"A Framework for Major Emergency Management",*** together with a proposed two year Major Emergency Development Programme. The Framework for Major Emergency Management designates local authorities as the "Lead Agency" for co-ordinating the response to nine emergency scenarios, including severe weather. Local authorities are recognised as being best placed to lead and co-ordinate emergency response in terms of capability, experience and knowledge. They work with the other two Principal Response Agencies (An Garda Síochána and the HSE) and together form the hub around which local response is mobilised, directed and co-ordinated.

Local authorities are designated Lead Agency also for response to flood emergencies under the Government approved Framework and they lead and co-ordinate both the response and the recovery operation in accordance with established protocols and guidance, under the overall umbrella of their Major Emergency Plans.

The Framework was embedded over a two year period 2006-2008 through implementing a Major Emergency Development Programme (MEDP). The MEDP provided tangible assistance to the PRAs, ensuring that the Framework was implemented in a consistent way across eight MEM regions.

Kildare County Council

Severe Weather Plan
2016

Title:	Kildare County Council Severe Weather Plan
Version:	Final
Status:	Working Draft for approval of MEMC
Prepared By:	Severe Weather Project Team
Approved By:	

To: Chief Executive
I recommend acceptance and approval of this Severe Weather Plan 2016 for Kildare County Council

21st April, 2016

Niall Morrissey
Director of Services
Roads Transport and Public Safety

Approved

21st April, 2016

Peter Carey
Chief Executive

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All local authorities have participated fully in emergency management capability development programmes over the last decade. In addition to the 2006 Framework document (which is currently under review), the following are some of the documents which detail preparedness and response arrangements for flooding:

- “A Guide to Flood Emergencies” (2013);
- “A Guide to Managing Evacuation & Rest Centres” (2015);
- “A Protocol for Multi-Agency Response to Flood Emergencies” (2016); (this document was an update of a 2011 version which incorporated lessons learned after the flooding of Dec 2015/ Jan 2016.
- “A Guide to Works and Development Consents for Repairing Infrastructure Damaged in storms or other Emergency Events” (2014).

In keeping with the principle of local management of the emergency response, staff of local authorities are accountable in the first instance to the local elected members/ Councillors for their response to severe weather emergencies.

A National Steering Group (NSG) on Major Emergency Management was established by Government decision to oversee the ongoing development of major emergency management. This is chaired and supported by the National Directorate for Fire and Emergency Management (NDFEM) within the Department of Housing, Planning and Local Government, and continues to guide further development and to monitor and appraise PRA preparedness. An extensive range of guidance documents and protocols have been prepared and updated under the aegis of the NSG dealing with all aspects of major emergency management.

2.5 National Level Co-ordination

Over the years since 2006, a generic emergency management system has been developed and put in place at national level which engages and co-ordinates a “whole-of-Government” approach to emergencies and crises of all kinds.

The Department of Housing, Planning and Local Government (D/HPLG) is designated as Lead Government Department for co-ordinating the response at national level to severe weather and flooding situations. Arrangements for co-ordination of the response to severe weather events at both national level and at local level have been developed significantly over the past number of years, as have arrangements for linking national and local levels.

The National Directorate for Fire and Emergency Management (NDFEM) was created within the Department in 2009 and is assigned the role of leading and supporting development of the full range of emergency management functions which the Department undertakes. The NDFEM is tasked with receiving and assessing weather warnings and reports on weather events around the country. The severe weather team in the National Directorate monitors official forecasts and warnings from Met Éireann regarding severe weather and the OPW regarding and tidal conditions.

The National Directorate assesses each situation using available information and makes decisions about the appropriate action to take. This may include convening a National Emergency Co-ordination Group, in line with procedures developed over the years and now set out in the recent Government-approved "**Strategic Emergency Management - National Structures and Framework" (2017)** document and the D/HPLG's own Standard Operating Procedures [5] (SOPs).

Each emergency event provides a learning opportunity and the response to Ophelia and Emma provides quite a number of 'positive' lessons, where examples of best practice were seen in action. These include:

- Met Éireann's forecasting and warning systems which are identified as a key enabler of early and effective pre-event preparation;
- Activation and operation of effective co-ordination structures at both local and national level;
- Visible leadership in times of crisis;
- The provision of information, including official warnings, advice and safety information to the public before the events and keeping the public fully informed during the storms;
- The approach and management by Critical Infrastructure providers (ESB Networks and Irish Water principally) to the task of restoring power and water supply to their customers and keeping them informed of progress and expected restoration times and also the work undertaken by Transport Infrastructure Ireland (TII) to keep motorways open during storm Emma.

[5] D/HPLG "Activation and Operation of a National Emergency Coordination Group (NECG)" (Jan 2019)

A National Emergency Coordination Group meeting in the National Emergency Coordination Centre during a Severe Weather Event

2.6 Co-ordination between Local and National Levels

The current emergency management system is intended to pre-define roles and expectations and to prepare for events in advance in so far as this is practicable. However, one of the tenets of emergency management is identifying issues that emerge during events and which need to be addressed, and current co-ordination arrangements are particularly focused around this task.

One of the perceived strengths of current emergency management arrangements is that there are strong, pre-established communication links between the local government system, and the Department of Housing Planning and Local Government. This includes well-established working relationships between senior local authority staff and the Department.

Fire Services in Ireland have been to the fore in the development of concepts and approaches to Emergency Management at both local and national level in Ireland. The

fire services have been mandated to act as leaders on the development of emergency management function within their sector, including facilitating inter-agency collaboration, communication and coordination. The National Directorate for Fire and Emergency Management has played a leading role in the development of emergency management capability since it was formed in 2009.

3. WEATHER AND FLOOD FORECASTS; ADVISORIES, ALERTS, WARNINGS AND INFORMATION FOR THE PUBLIC

3.1 Met Éireann's Weather Forecasting Service

Met Éireann is the National Meteorological Service of Ireland as recognised by the UN Convention of the World Meteorological Organisation (WMO)[6]. It is a division of the Department of Housing, Planning and Local Government, which is the Lead Government Department for co-ordinating the response to severe weather events.

Ireland's weather is part of a global system and Met Éireann therefore works with a range of international partners in its forecasting work. Met Éireann is a member of the HIRLAM (HiRLAM Aladin Regional Mesoscale Operational Numerical Weather Prediction in Europe) research consortium which develops the high resolution HARMONIE [7] model, which is used mainly for short-range weather forecasting. Met Éireann currently runs the model four times a day and uses the model as guidance for forecasts, advisories, alerts and warnings out to 54 hours ahead.

Met Éireann also uses output from the European Consortium, the European Centre for Medium-Range Weather Forecasts (ECMWF) for medium range forecasting. This is an independent inter-governmental organisation supported by 34 states and is both a research institute and a 24/7 operational service, producing and disseminating numerical weather predictions to its Member States. Ireland is a long-standing and active member of ECMWF and is represented by Met Éireann. The ECMWF Global 10-Day weather model predictions are used throughout the world, including the tropics, and it is considered the best medium range model worldwide.

Both HARMONIE and ECMWF meteorological modelling systems require the input of real-time meteorological observations. Met Éireann operates a countrywide network of

[6] The World Meteorological Organization (WMO) is a specialized agency of the United Nations with 191 Member States and Territories. The WMO is the UN system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the land and oceans, the weather and climate it produces and the resulting distribution of water resources.

[7] HARMONIE: The high resolution Numerical Weather Prediction model developed by the HIRLAM consortium

meteorological ground observation stations and a meteorological RADAR network. Additionally, through Met Éireann, Ireland is a member of EUMETSAT, an inter-governmental organisation which supplies meteorological satellite data for ingestion into meteorological model systems. This satellite information is particularly vital for ensuring accurate prediction of weather over otherwise data sparse ocean regions. The input of meteorological satellite data was essential in the prediction of the evolution of Hurricane Ophelia over the eastern Atlantic Ocean.

3.2 Met Éireann's Public Service and Severe Weather Forecasting System

Met Éireann's Forecast Division provides weather forecasting for Ireland. The forecasting team work with a range of advanced computer weather modelling systems, assessing how weather systems will develop and affect Ireland – usually concentrating on a rolling 5 day look ahead with emphasis on the 48 hour outlook. Met Éireann staff compile complex scientific information into regular weather bulletins, keeping the public and public sector decision-makers informed on how the weather will change, and providing multiple forecasts each day.

Met Éireann provides:

- Official Weather Forecasts, Advisories, Alerts and Warnings to help protect life and property;
- Communication of public service forecasts, advice, alerts and warnings;
- Availability of expert Forecaster advice and consultation 24/7/365 to provide detailed tailored weather information support to key agencies in severe weather situations;
- Information, forecasts, advisories, alerts and warnings to the public continually provided via Met Éireann, television and radio broadcasts, digital platforms including the Met Éireann website (met.ie), smartphone apps and social media;
- On-going engagement with the National Directorate for Fire and Emergency Management which exercises the Department of Housing, Planning and Local Government's 'Lead Government Department' role in relation to weather alerts;
- Supports the National Emergency Co-ordination Group, when convened.

3.3 The Met Éireann Weather Warning System

The production and communication of Weather Warnings is a key function of Met Éireann as the National Meteorological Service. The core rationale for issuing Weather Warnings is to protect the lives and livelihoods of all of the nation's citizens, and to mitigate damage to property and disturbance to economic and societal activity in times of severe weather.

A Weather Advisory/ Alert/ Warning system was introduced by Met Éireann in 2013. This aligns fully with the European MeteoAlarm system. Weather Hazards covered by Met Éireann's weather warnings system are:

1. Wind
2. Rain
3. Snow
4. Low Temperatures
5. Fog
6. High Temperatures
7. Thunderstorms
8. Coastal Wind Warnings

The target time for the issuing of a warning is 24 hours before the start of the event, but a warning may be issued up to 48 hours in advance when confidence is high. Conversely, as situations evolve, warnings may be issued or existing warnings altered on the basis of the latest forecasts/ information inside the 24 hour target time for issuing warnings.

Weather Advisories/ Alerts/ Warnings are presented in three categories:

Status Yellow

Weather that does **NOT** pose a threat to the general population but is potentially dangerous on a localised scale.

Be Aware about meteorological conditions and check if you are exposed to danger by the nature of your activity or your specific location. Do not take any avoidable risks.

Status Orange

Infrequent and potentially dangerous weather conditions which may pose a threat to life and property depending on location and activity.

Prepare yourself in an appropriate way depending on location and activity. All people and property in the affected areas may be significantly impacted.

Check your activity/event and delay or cancel as appropriate.

Status Red

Rare and very dangerous weather conditions from intense meteorological phenomena.

Take action to protect yourself and your property. Follow the instructions and advice given by the authorities under **ALL** circumstances and be prepared for exceptional measures.

Multiple weather warnings may be in place at the same time – typically separate wind and rain warnings may issue for the same period and the same locations.

One of the limitations of the current system is that warnings are issued on an all-county basis – with the result that expected extreme weather conditions in one part of a county can lead to the whole county being placed under a warning.

In addition the existence of boundary conditions between the different colour bands may not be adequately understood always. Threshold figures which trigger changes in colour band are part of a continuum, not discrete points on a scale. So depending on factors such as the time of year and the type of weather system involved, a wind storm at the higher end of the ORANGE band may bring conditions very similar to a storm forecasted to be in the lower end of the RED band.

The experience with the weather warning systems in the past five years points to an overall trend which is moving towards weather forecasts which support “impact based” decision-making. This will involve, for example, moving to look at the likely damage that certain wind speeds may cause, rather than solely providing wind speeds with forecast and warnings. A key aspect of this impact-based approach is providing information to key decision-makers to allow them to prepare to mitigate weather risks and hazards with the potential to threaten life and property. The public are the ultimate key decision-makers who receive Met Éireann information, and each individual has to decide to react in their given circumstances.

Modelling systems of natural phenomenon like weather involve a degree of uncertainty. This uncertainty can be a particular feature of some high intensity storms. The degree of uncertainty contributes to the overall risk posed by such systems. A sudden change in the track of a storm from that forecasted, which can occur, may change the risk profile and population affected. Understanding the type and levels of uncertainty within which weather forecasters are operating is an important parameter in making decisions, based on their forecasts and advice. This uncertainty factor also reinforces the need to take a precautionary approach when considering issuing public safety advice, taking account of the possible evolution of weather systems. This is perhaps best achieved (when time permits) by co-ordinating the advice of expert forecasters with experienced public safety staff in national (and local) co-ordination groups.

3.4 Public Safety Advice

Met Éireann’s official weather warnings are just that – meteorological-based information put into the public domain for the purposes set out above. In particular Met Éireann

severe weather warnings are not mandatory edicts requiring or forbidding specific actions, and should not be regarded as such.

However, official Met Éireann warnings are one very important factor considered by a National Emergency Co-ordination Group in deciding if specific additional public safety advice should be issued in any situation. Such advice, for example, in the form of “Get indoors and Stay Indoors” was issued by the National Emergency Coordination Group in relation to both ex-hurricane Ophelia and the blizzard conditions associated with storm Emma.

Met Eireann Head of Forecasting Evelyn Cusack briefing the NECG in advance of ex-Hurricane Ophelia

3.5 Conclusions and Recommendations regarding Met Éireann’s Weather Forecasting

- Ireland’s weather is part of the global weather system and Met Éireann, Ireland’s national weather forecast service, used its international participation in multi-

national weather forecasting systems, to make solid judgements in relation to the two major weather events of this winter in Ireland - ex-Hurricane Ophelia (16 October 2017) and the combination of storm Emma with Siberian cold air mass (1 – 4 March 2018).

- Met Éireann's forecasting services are supported by world leading numerical weather prediction and meteorological observation systems; these are maintained and developed by Met Éireann and the international meteorological community with which Met Éireann actively collaborates. Met Éireann works to best international scientific practice.

- Met Éireann predicted the arrival and path of ex-Hurricane Ophelia with a high degree of accuracy. This was possible because of Ireland's well developed meteorological infrastructure and forecasting systems. Met Éireann issued appropriate weather warnings, using its colour coded warning system (introduced in 2013) to the public, to the vulnerable sectors (such as aviation and marine) and to the response agencies which it supports. As will be seen in later sections, Met Éireann's timely warnings enabled a range of significant mitigation measures to be undertaken, and not just in sectors traditionally vulnerable to storms, like the marine community.

- Met Éireann's public forecasting service enabled highly effective dissemination and reach of the warnings to a national audience through radio and TV broadcasts. These warnings enabled a range of significant mitigation measures to be undertaken down to individual level. In addition to its high profile broadcast dissemination of weather-related information, Met Éireann has developed its web-based and social media capability for weather information, which are now very significant means of providing information to the public.

- Met Éireann provided adequate and timely support and advice to the NECG which was activated in response to the extreme weather events.

- Met Éireann was widely complimented for its performance and the high quality of its decision-making during the storms, which threatened public safety on a scale not seen in living memory. Indeed the extreme weather events served to

demonstrate the significance of Met Éireann's role as Ireland's national meteorological service in supporting national emergency management. However, it remains a challenge to communicate the limitations of the colour-based warnings system to the general public.

- The understanding of Met Éireann's roles, and its standing as Ireland's National Meteorological Service, was significantly enhanced by its performance during these very high profile events.

- Met Éireann closely supports and advises the National Directorate for Fire and Emergency Management in the latter's role of deciding if a NECG should be put in place for managing severe weather events. Met Éireann makes a vital contribution to enabling organisations to take appropriate action in relation to scaling a response and providing public safety advice.

- Met Éireann's current weather advisory, alert and warning system is based on 'threshold' parameters with some impact based considerations taken into account, whereby values for wind-speed, rainfall etc. trigger yellow alert or orange and RED warnings. Met Éireann's recently published 10-year strategy [8] includes developing services in support of impact-based decision-making - representing a shift from 'what the weather will be' to 'what the weather will do'.
- Met Éireann's colour coded advisory, alert and warning system for the public is seen to be effective. However, issuing of multiple warnings (e.g. wind and rain) in relation to the same events can be confusing for the public.

- While the vast majority of people are conscious of the weather and its potential impact, and some sectors are especially so (e.g. fishing, farming, construction and other outdoor activities) the essence of all advisory, alert and warning systems is to ensure that people are conscious of weather conditions in their locality and the possible impacts this may have on them personally, especially on their safety, in whatever activity they plan to undertake. Met Éireann's colour

coded warnings are designed to get attention, and we believe are widely recognised, if not fully understood at times.

- Modelling systems of natural phenomenon like weather involve a degree of uncertainty, and it was only twelve hours before ex-Hurricane Ophelia's arrival that its final path, tracking over Ireland, could be predicted with a high degree of certainty. Understanding the type and levels of uncertainty within which weather forecasters are operating is an important parameter in making decisions, based on their forecasts and advice. This uncertainty factor also reinforces the need to take a precautionary approach when considering issuing public safety advice, taking account of the possible evolutions of weather systems.

- Met Éireann contributed to the briefings at the NECG meetings and the media press conferences in the NECC. In addition, Met Éireann meteorologists broadcasted continuously through the weather events on RTE TV, TV3, as well as on national and local radio stations nationwide. The accurate predictions and warnings by the Aviation forecasters in Met Éireann ensured safety for Air Traffic over Ireland and in particular helped minimise disruption at Airports.

- Recent severe weather events have highlighted the need for organisations as well as individuals to make decisions about what they should do in light of forecasted weather conditions. There has been a welcome move after the recent experiences towards developing protocols as part of business continuity planning. However, we caution against organisations adopting rigid positions based on Met Éireann's advisories, alerts and warnings – the core advice is to be conscious of weather conditions and forecasts, look at what staff's exposure to harm could be and to plan and decide accordingly. For example, we are aware that a number of organisations put in place a blanket automatic position of not putting vehicles on the road in RED warning weather conditions. As Met Éireann move to impact based warning, it is essential that each sector develop its own tailored safety thresholds for their operations that are based on the ability to safely operate in up to a maximum hazard level in severe weather. We recommend this should be based on a risk management approach appropriate for the nature of the operation, considering for example mitigation measures (equipment, training etc) as well as hazards.

- While Ophelia and Emma have demonstrated Met Éireann's appropriate and successful collaborative approach in RED weather warning situations, it is recommended that Met Éireann's developing capacity in severe weather, forecasting and flood forecasting forms the basis for its future role as a core partner of the severe weather warning and emergency management systems in Ireland, for ORANGE level weather warnings, as well as YELLOW level alerts/ advisories. It is recommended this includes a clearly mandated structure for the issuing of weather-related warnings/ advisories/ alerts.

- It is recommended that mechanisms are put in place to ensure that all those who receive the warnings in the many relevant organisations are aware of the parameters and limitations (and updates/changes) and how they are expected to interpret/ respond to these warnings.

4. THREE FLOODING EVENTS

This Chapter looks at three significant flooding events which have occurred over the period covered by this report. The origins/ causes of the flooding events were different in each of the three cases, highlighting the diverse nature of flooding risk in Ireland.

The Chapter begins by reviewing the current status of flood forecasting in Ireland. It then looks at support schemes which have evolved for persons affected by flooding incidents. It then goes on to describe the three flooding incidents:

- Inishowen Pluvial & Fluvial Flooding event – 22 August 2017
- Mountmellick Fluvial Flooding event – 22 November 2017
- Galway City Tidal Flooding event – 2 January 2018

This chapter ends with conclusions and recommendations in relation the flooding scenario.

4.1 Flood Forecasting in Ireland

4.1.1 Background

In September 2004, Government approved a national flood risk policy which assigned OPW the lead role for flood risk management and mitigation. Flood Forecasting and Warning is a flood mitigation measure within OPW's remit.

There are three main flooding threats:

- Fluvial (river)
- Tidal
- Pluvial (rainfall)

OPW have a contract with EFAS (European Flood Awareness System) and they procured the current tidal surge forecast systems.

4.1.2 Development of a National Flood Forecasting and Warning Service

In 2010 OPW commissioned a number of research studies by consultants on options and cost/ benefits for implementing a Flood Forecasting & Warning (FFW) system in Ireland. It was noted in these reports that Met Éireann could be a suitable location for operating the National FFW service, given their scientific/ modelling expertise (albeit meteorological not hydrological), their 24/7/365 operation and public confidence in their forecasting role.

It was decided by Government on 6 January 2016 that a National Flood Forecasting and Warning system should be progressed. While this was a welcome decision in response to a long-recognised need, developing and operating a high-quality and reliable flood forecasting and warning system is a significant, long-term undertaking, involving several organisations. Flood prediction models need to be developed and calibrated to reflect national, regional and local catchments.

It is intended that Met Éireann will operate the new Flood Forecasting and Warning service. With OPW, Met Éireann has established a work programme and has recruited additional expertise to operate the Flood Forecasting and Warning service. As this programme of work is developed, additional resources will be required to research and procure computer models, to build and manage the necessary ICT capability and to collect, process and combine relevant hydrometric and meteorological data.

The existing flood forecasting and warning capacity, combining the new expertise of Met Éireann with existing OPW staff, will be maintained in the interim while the new service is being developed.

4.1.3 OPW's Tidal and Storm Surge Forecasting Service

The OPW currently has arrangements in place with consultants to provide a tidal and storm surge forecasting service for the coast of Ireland. The tidal and storm surge forecasting service provides information via a project website to assist with the early alert of the potential risk of coastal flooding at eighteen locations around the coast of Ireland, and additionally at higher resolution locations comprising Cork Harbour, Wexford Harbour, Dundalk Bay, Galway Bay and Shannon Estuary.

The tidal and storm surge forecasting service is provided twice daily and results are presented via a project website in the form of a surge, astronomical tide and total water level time series prediction approximately 65 hours in advance. Access to the website forecasts is password restricted, and it is accessible to the OPW, coastal local authorities, Irish Coast Guard, Met Éireann, ESB, NDFEM and Irish Water.

These OPW forecasts are updated at approximately 10:00 hours GMT and 22:00 hours GMT each day. They give graphical predictions of surge residual in metres, total combined tide and surge water level in metres to OD Malin and astronomical tide in metres to Chart Datum. Error bands are shown on the graphical plots indicating forecast uncertainty.

The OPW has a generic system for e-mail circulation of High Tide Advisory (HTA) notices. Such notices are issued from time to time by OPW during periods of anticipated high tides that have the potential to cause coastal flooding.

4.2 Support for Persons Affected by Flooding

As well as the development of emergency management arrangements described in Chapter 2, there have been significant improvements in the State's support for persons affected by flooding emergencies in recent years.

While property insurance remains the primary means of dealing with flooding damage, the Department of Employment Affairs and Social Protection has a standing scheme of Emergency Humanitarian Assistance for householders affected by flooding. The scheme is one which was developed during previous flooding events and is designed to assist those affected, dealing first with immediate needs of flood victims. The Humanitarian Assistance Scheme is available to assist people who are not in a position to meet costs for essential needs, household items and in some instances structural repair. The scheme is means tested and assistance is not provided for losses which are covered by insurance or for commercial and business losses. [9]

[9] More information on the Scheme is available at:

http://www.welfare.ie/en/Pages/Humanitarian-Assistance-Scheme.aspx

Financial support under the Humanitarian Assistance Scheme is initially targeted at the immediate needs of those who may have been directly impacted by the flooding (such as clothing, food) with further support available (financial support for household items and structural repair) as the clean-up operations begin.

In the event of flooding incidents, the Department's Community Welfare Services staff engages with local authorities to assess the level of service required and an inter-agency response ensures that supports are provided close to those affected as swiftly as possible.

A humanitarian assistance scheme to support small businesses, community, voluntary and sporting bodies was also developed for those who have been affected by recent severe weather events. The scheme was administered by the Irish Red Cross and is a humanitarian support contribution towards the costs of returning business, sport and community premises to their pre-flood condition including the replacement of flooring, fixtures and fittings and damaged stock where relevant. The scheme does not provide a contribution to loss of earnings or loss of business good-will.

While each activation of this scheme previously required a specific Government decision, it is now proposed to make this into a standing scheme, similar to the Humanitarian Assistance Scheme of the Department of Employment Affairs and Social Protection. Under the proposed arrangements, the Irish Red Cross will operate the scheme, based on the criteria currently used in the one-off schemes, when activated by the Department of Business, Enterprise and Innovation.

4.3 Pluvial/ Fluvial Flooding In Donegal/ Inishowen Peninsula - 22/ 23 August 2017

4.3.1 Introduction

On Tuesday 22 August 2017 an extreme rainfall event occurred in Donegal which caused extensive damage and disruption, particularly to the community in the

Inishowen Peninsula area. The response to the brief period of flooding was led by Donegal County Council and supported by a range of agencies. Although the flooding event ended quickly, considerable efforts were undertaken, again led by Donegal County Council with the support of relevant agencies and Government Departments, to clean up and restore infrastructure and to assist those affected by the floods.

4.3.2 Forecasts

Met Éireann had issued a YELLOW level warning at 17:00 hours Monday, 21 August 2017 indicating the likelihood of some very heavy or thundery downpours at times on Tuesday, mainly in parts of Connacht and Ulster with possible local spot flooding as a result. Met Éireann issued an ORANGE warning for thunderstorms on 22 August 2017 across Ireland.

Typically, rainfall events in Ireland average around 5mm-10mm of rain in total, perhaps up to 20 - 40mm for the heavier events. However, these are usually spread over a period of time, so the rainfall intensity per hour does not cause flooding difficulties.

4.3.3 Rainfall Inishowen 22 August 2017

On Tuesday 22 August 2017 heavy rain began to fall in Donegal circa 14:00 hrs. Rainfall continued over a nine hour period lasting from 14:00 until 23:00 hrs. The rainfall levels recorded at Malin Head (70mm) and Carndonagh (83.4 mm) were exceptional, exceeding RED level on the Met Éireann Meteoalarm classification of severity. This event has been characterised as a one in a 100 year event, meaning that there is a 1% chance of such an event happening in any given year. While Inishowen had the greatest intensity of rainfall, other areas of County Donegal also experienced localised flooding resulting from this event.

4.3.4 Emergency Response

As is frequently the case, the first indication for public authorities of sudden-onset flooding problems came through 999 calls for assistance, which the Fire Services West Region Communications Centre (WRCC) in Castlebar began receiving from 19.00 hours on Tuesday 22 August 2017. Donegal County Council's Fire Service responded to numerous calls seeking assistance for flooding, principally in the Inishowen area between 19:00 hours on 22 August 2017 and 04:00 hours on 23 August 2018.

In light of the severe flooding incidents being reported, Donegal County Council activated its Crisis Management Team at 20:00 hours to manage the response and rescue operations being undertaken by the Donegal Fire Service. The fire service response prioritised rescue and life-saving operations, including rescue of a number of people trapped in stranded vehicles.

Donegal County Council also mobilised its Civil Defence service and road service staff during this operation. Irish Coast Guard units were mobilised also and provided assistance for a number of rescues.

Donegal County Council's Communications Office liaised with the Crisis Management Team during the event and shared information/ warnings on social media platforms and with local media outlets.

The co-ordination of the emergency response was stood down at 07:00 hrs on the morning of 23 August 2017, with Donegal County Council immediately moving into and initiating the clean-up and recovery operation.

The National Ambulance Service (NAS) worked with An Garda Síochána and Donegal County Council to maintain ambulance services in areas where roads were severely damaged, ensuring access to all areas covered by Letterkenny, Buncrana and Carndonagh NAS stations. An extra ambulance was placed in Carndonagh NAS station for a short period to ensure a rapid response was available to all medical emergencies.

Many homes in Donegal lost power supply due to lightning strikes and ESB Networks worked to restore power as quickly as possible in all affected areas.

4.3.5 Extensive and Severe Damage

It became clear at an early stage in the response that the damage to communities across Inishowen was widespread and severe. Households were inundated suddenly and to great depths. The damage to road infrastructure was extensive and many bridges and culverts were badly damaged as streams and rivers were completely overloaded by the deluge. Landslides in some areas caused property damage as well

as damage to farmland. It is understood that a possible contributory factor in some landslides may have been wildland fires earlier in the year that burned away vegetation/ scrub/ gorse and trees on hillsides.

Most people whose houses were affected self-evacuated and went to stay with relatives or friends. A number of persons were assisted to re-locate, and temporary accommodation was arranged by Donegal County Council for a small number of families. The initial estimate was that 200 homes were affected by flooding, including 20 local authority houses, many with what would be characterised as severe damage.

4.3.6 Recovery Phase

In the immediate aftermath of the floods, which receded very quickly, the focus of the public authorities shifted to the welfare of those affected.

An Taoiseach, Leo Varadkar, TD and a number of Ministers with relevant specific areas of responsibility, together with local TDs visited the areas worst affected in the days immediately after the flooding.

4.3.7 Information for the Public

Donegal County Council's Communications Office provided key information to the public via local media outlets and its online platforms including website, Facebook and Twitter during the flooding and recovery period also.

Key information included updates on road conditions, closures and re-openings, housing supports and assistance, financial assistance schemes, clean-up supports and assistance available, HSE supports and contact telephone numbers including out-of-hours numbers.

A press release on the Flood Recovery was issued each day and social media was used to post regularly on each of the items above. The Council also responded to queries from the public via Facebook and Twitter.

An information leaflet with useful contact numbers was also circulated via An Post to each household in the Inishowen Peninsula to facilitate those without access to the internet.

4.3.8 Support for Persons Affected

The Department of Employment Affairs and Social Protection activated its standing scheme for Emergency Humanitarian Assistance on Wednesday morning 23 August 2017. Local officials of the Department began working immediately on the ground with Donegal County Council to identify and make contact with those affected. It is understood that more than 115 requests for assistance were made under the scheme. Financial support under the Humanitarian Assistance Scheme was initially targeted at the immediate needs of households directly impacted by the flooding (provision of funding to replace clothing, food) with further support available (financial support for household items and structural repair) as the clean-up operations continued.

The traumatic nature of this flooding event for many in the community was recognised and the HSE responded with Donegal County Council to work with communities in Inishowen. The HSE offered a range of services to ensure public safety and support for the communities affected. All 'high priority' patients in the community continued to be attended. Psycho-social support services were put in place also by the HSE with the intent of assisting persons impacted as a result of the severe flooding, including setting-up of a confidential telephone helpline.

4.3.9 Housing Assistance

Donegal County Council put extra staff to work on their helplines and on their 'out of office' contact number, including offices being opened and phones being staffed over the weekend after the flooding. The numbers of calls were reported to have been less than might have been expected.

The Council's Housing Service continued to provide support and assistance to those affected by the floods. Fifty families were registered with Donegal County Council as being displaced at 1 Sept 2017 and these families were being supported, with their needs being determined on a case-by-case basis. Twenty of these families were

supported by their own insurance companies and did not require support from the Council.

4.3.10 Farming Assistance

Staff of the Department of Agriculture, Food and the Marine (D/AFM) in Donegal monitored the situation. Teagasc personnel on the ground provided support and advice to farmers who were mainly affected by loss of silage bales and loss of some stock. D/AFM ensured that other agencies were aware of contact details of their helpline support for farmers who needed assistance/ advice and that other agencies were aware of appropriate contact numbers for referrals.

On 6 September 2017, the Department of Agriculture, Food and the Marine announced an initiative to support the small number of farmers who bore the brunt of the severe flooding experienced in the Inishowen area on 22 August 2017. This measure provided financial assistance in approved cases to farmers for the direct costs arising from instances of loss of livestock, the loss of/ damage to conserved fodder (hay or silage) and the clean-up cost of agricultural lands, including repair to fences, damaged by debris washed up by the floods. Losses not covered by insurance were eligible for consideration.

This measure built on the availability of support through the Animal Welfare Helpline and through the advisory assistance made available by Teagasc in the region.

4.3.11 Clean Up and Restoring Access

Infrastructure, including roads and drainage systems are not designed to cope with rainfall of the intensity which occurred on 22nd August 2017 in Inishowen.

In parallel with the support for those directly affected, Donegal County Council continued to co-ordinate and manage:

- Damage assessment of roads, bridges and infrastructure;
- Diversions and temporary road repairs;
- Clean-up of debris and flood damage;

The assessment of the 1500km road network in Inishowen was a major undertaking and work was undertaken to identify the location and nature of issues and to design and cost solutions. Donegal County Council identified over 600 sites with varying degrees of damage to transport infrastructure.

The tasks for Donegal County Council included assessing the full extent of damage throughout the county, making temporary repairs where possible and organising diversions where routes were impassable. Donegal County Council worked directly with the Department of Transport, Tourism and Sport to plan for the repair of the severe damage caused to the road network and bridges in Donegal.

The Council's priority was to get the Regional routes open first and good progress was achieved in the week after the flooding. A number of major roads were re-opened to traffic and the installation by the Defence Forces of a temporary bailey bridge on the R240 at Riverside between Quigley's Point and Carndonagh also helped greatly.

Donegal County Council identified a need to clear debris from river channels on an emergency basis to prevent further damage to bridges in particular. OPW supported the cost of this work.

The Department of Defence mobilised a platoon of 30 Defence Forces personnel to assist Donegal County Council with clean-up and recovery. The soldiers were deployed to provide assistance to people affected by flooding and helped remove damaged furniture and goods quickly. Defence Forces also provided engineering support for the some bridge repairs.

4.3.12 Water Supply Infrastructure

Seventeen significant water network incidents were reported that involved pipes being affected as a result of flood damage to roads, bridges and waterways. Six wastewater treatment plants were affected by the flooding. Irish Water (IW) and Donegal County Council staff carried out temporary repairs in order to restore water supply to customers.

By 31 August 2017, all water supplies were restored and functioning. Further permanent repairs were scheduled to be carried out in due course as part of the road repairs.

Six wastewater treatment plants were affected by flood waters in Donegal. Five (Bridgend, Clonmany, Ballyliffen, Buncrana, Gleneely) were restored quickly to pre-flood operating conditions, but Burnfoot treatment plant had extensive damage to its electrical control panels.

4.3.13 Co-ordination of the Flood Response and Recovery

Co-ordination of the efforts of the multiple organisations who are involved in response to emergency situations is recognised as a key factor in effective operations. This principle extends to the recovery phase also.

4.3.13.1 Local Level Co-ordination

Donegal County Council, as designated Lead Agency for response to flood emergencies**,** led and co-ordinated both the response and the recovery operation in accordance with established protocols and guidance, under the overall umbrella of its Major Emergency Plan.

In keeping with the principle of local management of the emergency response, Senior Management of Donegal County Council met with elected members of Donegal County Council to report on the response effort**.** The Councillors met on Thursday 24 August 2017 to review the response and to plan for the recovery. The area most affected is one of Donegal County Council's five Municipal areas and a separate meeting was held of councillors from that Municipal area. Donegal County Council re-allocated staff from the unaffected areas to assist with damage assessment and the clean-up and recovery work on the ground. The Council met again on 28 August 2017 to consider plans for the recovery phase.

4.3.13.2 National Level Co-ordination

The Department of Housing, Planning and Local Government (D/HPLG) is designated as Lead Government Department for co-ordinating the response at national level to severe weather and flooding situations. The National Directorate for Fire and Emergency Management (NDFEM) within the Department is tasked with receiving and assessing weather warnings and reports on events around the country. The NDFEM assesses each situation in light of available information and makes decisions whether

or not to convene a National Emergency Coordination Group meeting, in line with procedures developed over the years and set out in its Standard Operating Procedure "Activation and Operation of a National Emergency Coordination Group (NECG).

The NDFEM was made aware of the flooding situation during the night and was in contact with Donegal County Council staff from early on the morning of 23 August 2017. In this case, as Lead Government Department for flood response, and based on the situation information from Donegal County Council, the NDFEM view was that pre-arranged emergency response systems had been activated and had operated appropriately and that the worst of the flooding had passed. It was the NDFEM judgement that the Donegal flooding event did not warrant the convening of a NECG during the response phase.

4.3.13.3 Supporting the Recovery Effort

As the Lead Agency, Donegal County Council worked with the Principal Response Agencies, the Defence Forces and other organisations, including the Department of Employment Affairs and Social Protection and Irish RED Cross. NDFEM, on behalf of the Lead Government Department, was in contact with Donegal County Council from Wednesday 23 August to maintain an overview of the damage and the impact on communities in Inishowen.

NDFEM undertook to co-ordinate issues relating to the recovery stage at national level. In relation to issues which were identified, NDFEM liaised with:

- Department of an Taoiseach
- Department of Transport, Tourism and Sport
- Department of Defence
- Department of Employment Affairs and Social Protection
- Department of Agriculture, Food & Marine
- Department of Business, Enterprise and Innovation
- Office of Public Works

NDFEM convened an Inter-Departmental Group on Recovery in the Custom House on Friday 25 August 2017 to ensure full support for the recovery operation led by Donegal

County Council and to clarify longer term support arrangements in terms of funding and necessary support schemes.

After this meeting, the commitments already given directly to Donegal County Council of the full support of Government in dealing with this crisis were reaffirmed.

Also, at this meeting, the absence of a support scheme for small businesses and the community/ sporting sector was highlighted and actions were taken subsequently to have a scheme initiated. This was modelled on the one-off scheme operated during the flooding of winter 2015/16 by the Irish Red Cross under the aegis of the Department of Defence.

A further meeting of relevant Departments was convened by the National Directorate on Thursday 31 August 2017 to ensure that all necessary support arrangements were in place and operating and that emergent issues were being dealt with.

4.3.14 Review

As with all emergency response situations, a review process was undertaken to identify areas which operated satisfactorily and issues where improvements could be achieved. The National Directorate for Fire and Emergency Management convened a workshop of relevant senior staff from all local authorities on 26 September 2017 to embed learning points from the Donegal flooding event and to discuss the continued response to severe weather and flooding emergencies over the winter season ahead. This workshop was held less than three weeks before ex-Hurricane Ophelia struck Ireland and proved to be a timely and beneficial review of the “Lead Agency” role of local authorities.

4.4 Fluvial Flooding Event at Mountmellick on 22 November 2017

4.4.1 Introduction

A Met Éireann Yellow Weather Warning for rainfall was issued on 22 November 2017. Heavy rain was expected for Munster and Leinster, moving in from the south coast, affecting areas as far north as Meath clearing later on Wednesday evening. 30-40 mm of rain was expected, with larger amounts possible over higher ground. A further

weather warning was issued at 18.00 hrs stating that further rain was expected for a time on Wednesday evening up to 22.00 hrs with the possibility of flooding in places.

The forecasted rain duly came and gave rise to reports of flooding in various parts of the country particularly, Laois, Kildare and Dublin City. There were reports of blockages to the road network at various points across the country and Transport Infrastructure Ireland (TII) and local authorities worked to address issues.

4.4.2 Flooding in Laois and Dublin

The river Barrow overflowed its banks following the rainfall on 22 November 2017 and some houses in Mountmellick were flooded as a result. Laois County Council activated its fire services, Civil Defence, engineering staff and outdoor crews. It was deemed necessary to arrange for the evacuation of a number of houses in two estates. 35 houses were evacuated, with 20 flooded and a further 15 cut-off due to road flooding. Laois County Council (LCC) provided emergency accommodation for 23 people from those households affected, with the remainder staying with family and friends.

Dublin has a new rainfall telemetry system, with 15 gauges around the city and all recorded between 40-50 mm of rain on 22 November 2017. While only one commercial property was reported as being flooded, a number of roads in the Dublin City area were flooded which caused traffic disruption. The affected roads were re-opened after a short period. Sewage overflows were reported as affecting a number of areas but again these were dealt with, and gardens, not houses, were affected.

4.4.3 Support for those Affected by Flooding

The Department of Employment Affairs and Social Protection (D/EASP) has a vital role to play in assisting households in the immediate aftermath of emergency events through its Humanitarian Assistance Scheme. The purpose of this Scheme is to prevent hardship by providing income-tested financial support to people whose homes are damaged from flooding and severe weather events and who are not in a position to meet costs for essential needs, household items and structural repair. The scheme does not cover risks that are covered by insurance policies or cover business or commercial losses.

Following a severe weather event, Community Welfare staff within D/EASP closely monitors the situation on the ground. They engage with the relevant local authorities and other agencies and may open emergency clinics at locations close to the scene of the flooding and undertake home visits, as required.

D/EASP confirmed that its Humanitarian Assistance Scheme was available to assist those whose homes were affected by this episode of flooding. D/EASP and Laois County Council established a single point of contact for humanitarian assistance at the Community Centre at Wolfetone Court in Mountmellick.

The Department of Defence activated an Emergency Humanitarian Scheme for small businesses, community, voluntary and sporting bodies. The scheme was administered through the Irish Red Cross with full information, modelled on previous schemes including application forms, made available on the Irish Red Cross website.

4.4.4 National Response

The National Directorate for Fire and Emergency Management (NDFEM) was in regular contact with local authorities throughout the day. The NDFEM view was that pre-arranged emergency response systems had been activated and were operating appropriately. It was the NDFEM judgement that the situation in Laois did not warrant the convening of a National Emergency Co-ordination Group. After further contact with a number of local authorities, it was considered that sufficient capacity existed and arrangements were in place at the local-level to deal with issues arising.

The Defence Forces made approximately 30 personnel available to assist where appropriate in Laois.

4.5 Tidal Surge Flooding at Galway City – 2 January 2018

4.5.1 Introduction

The year 2018 opened with a cycle of severe weather events that affected the country, including named storms Dylan and Eleanor. The most severe impact of these events was flooding in Galway City on 2 January 2018, arising from high tidal conditions, allied with storm Eleanor.

4.5.2 Weather Patterns

Weather systems over the north Atlantic were very active from Christmas 2017, with several Atlantic storms tracking close to Ireland. Storm Dylan affected the northwest on 30/31 December 2017, followed by storm Eleanor which had a much more widespread impact on January 2/3 2018.

While Ireland's normal weather pattern is prone to storms at that time of year, there was enhanced storm activity influenced by abnormally cold weather over North America. Extremely cold arctic air had reached as far south as Florida and this affected the Jet Stream, causing enhanced storm formation over the Atlantic and hence over western Europe and Ireland. France and the UK experienced snow with storms/ heavy rain, and Ireland was fortunate to escape the worst of this weather.

4.5.3 Storm Eleanor

A status Orange storm weather warning which named storm Eleanor was issued by Met Éireann on Monday evening, 1 January 2018, 24-hours ahead of the anticipated weather event. Status Yellow wind/ rain/ thunderstorm warnings were also in place. It was forecast that storm Eleanor would move quickly across the country during the evening and night of Tuesday 2 January 2018. The forecast warned of west to southwest winds of mean speeds ranging 65 to 80 km/h, with damaging gusts of 110 to 130 km/h. The forecast also warned of very high seas to be expected along Atlantic coasts, with a risk of coastal flooding.

4.5.4 OPWs High Tide Advisory Notice

The OPW has a generic system for e-mail circulation of High Tide Advisory (HTA) notices. Such notices are issued from time to time by OPW during periods of anticipated high tides that have the potential to cause coastal flooding. Such an HTA notice was issued by OPW on Tuesday morning, 2 January 2018, advising that there would be a period of very high astronomical Spring Tides approaching Highest Astronomical Tide (HAT) in all coastal areas commencing on the afternoon of Tuesday 2 January until Thursday 4 January 2018. Surge levels were predicted to increase in all coastal areas during the 24 hours from noon Tuesday, including as follows for the west Coast:

0.45m at Shannon Estuary
0.60m at Galway Bay
0.40m at Roundstone and Clew Bay
0.50m at Kilalla Bay and Sligo Bay
0.60m at Donegal Bay
0.50m at Lough Swilly

Local authorities were advised to monitor closely surge and sea level forecasts throughout this notice period (from 2 to 4 January 2018) as it was not possible to accurately forecast the surge conditions that would occur more than 24 hours in advance.

4.5.5 Preparations in Advance of the Storm

The severe weather team in the Department of Housing, Planning and Local Government, (part of the NDFEM) monitors forecasts and warning updates from Met Éireann and the OPW regarding severe weather and tidal conditions and were actively engaged in the run up to and during storms Dylan and Eleanor. NDFEM staff liaised with both Met Éireann and the OPW in relation to their warnings and linked with organisations involved in promoting public safety and maintaining critical infrastructure. Relevant agencies were involved in disseminating public safety information messages through advertising, broadcasts and various social media. NDFEM staff also linked with the local authorities most likely to be affected regarding their preparedness and the support available at national level, if required.

The vulnerabilities along the west and south coasts were recognised and local authorities along the western/ Atlantic coast activated their inter-agency Local Coordination Groups and internal Crisis Management Teams to consider the forecasts and updates regarding high tides and storm Eleanor and the potential threats, and to monitor the impact of the severe weather locally.

4.5.6 Impacts - Flooding - Galway City

The most severe impacts resulted from storm Eleanor on the evening of Tuesday, 2 January 2018. Galway City Council received the Orange weather warning issued by Met Éireann on Monday 1st January 2018 for Munster, Leinster and south Galway. The warning was for expected southwest to west winds of mean speeds 65 to 80 km/h, gusting to 110 to 130 km/h and very high seas along Atlantic coasts, with a risk of coastal flooding also.

Galway City Council also assessed the tidal forecast for Galway Bay for 1 - 4 January 2018. This tidal information was downloaded and circulated to senior staff of Galway City Council at 10:25am on Tuesday morning. The combined astronomical tidal level, plus surge, circulated was 5.6m O.D. An OPW high tide advisory notice received by e-mail on Tuesday morning 2 January 2018 informing of increased sea level surge corresponded with that obtained from OPW storm surge web-site.

Galway City Council already had flood protection barriers in place for Lower Salthill and an 'Aquadam' at the Spanish Arch since the previous October. As these flood protection measures were in place, and given the forecast level of 5.6m O.D., significant flooding was not expected.

High tide in Galway on Tuesday 2 January 2018 was at 5.12pm. Weather conditions were closely monitored by Galway City Council and Galway Harbour Master. At 5.05pm the wind speed was 17 knots and was from a south direction. In less than half an hour at 5.32pm, the wind had shifted to the southwest and was reading 59 knots. This change in direction and severe increase in wind speed, combined with the high tide and the storm surge, gave rise to the four conditions which resulted in serious tidal flooding being experienced.

The sea level rapidly ascended above the dock walls and flowed onto Dock Road. The flood waters moved quickly across the road and flooded New Dock Street, Merchants Road, Flood Street and into Quay Street and Spanish Parade. This happened over a very short space of time.

A separate flooding event occurred in the Claddagh/ West End area including Claddagh Quay, Father Griffin Road, Raven Terrace and Dominick Street to Munster Avenue. This was as a result of the surging in the Spanish Arch/ Docks area which caused a back-up in the Eglington Canal. This resulted in over-topping at the Bridge on Dominick St.

The water levels rose rapidly in less than 30 minutes, but descended again very quickly. The flood had substantially receded by 7:30pm.

Initial observation of water level gauges indicated that the sea level in Galway Bay had risen to a level of 700-1000 mm above that forecasted.

4.5.7 Local Response to Flooding

In terms of immediate response, the following actions were taken by Galway City Council:

- Roads crews were sent on site and provided the initial response;
- Senior staff on site called in additional resources from Roads, Environment, Housing and Drainage Departments of the Council;
- Galway City Council co-ordinated the response on the ground with the other response agencies, including the Fire Service and An Garda Síochána;
- An Garda Síochána closed roads on approaches to the Docks area;
- Fire services assisted the public;
- Local media was notified and City Council used social media to advise the public to stay away from the area.

The Galway City Local Co-ordination Group was activated and held a conference call at 7.15pm and met at 9 pm to review the event that had occurred and to plan for the following high tides. Representatives from Galway City Council, An Garda Síochána, Civil Defence, the Fire Service, the Defence Forces and the HSE attended. Critical issues were identified and discussed and preparations planned for the following morning’s high tide.

Galway City Council crews with assistance from the Defence Forces worked through the night. In addition to the sandbags already deployed, a further 3,500 sandbags were filled during the night and deployed for use by residents in Salthill, Grattan Park, Claddagh, Spanish Arch, Dominick Street, Docks and surrounding areas. A further 2,000 sandbags were filled for Wednesday morning and 300 were provided by the OPW and were distributed throughout the day. Ten No. 1 Ton bags were also filled and deployed at Spanish Arch as part of a protective bund.

City Council staff, with assistance from An Garda Síochána, the Fire Service, the Defence Forces and Civil Defence, were on site throughout the rest of the week at morning and evening high tides.

The City Council provided assistance to those affected by flooding including provision of pumps, collection of flood damaged contents and provision of dehumidifiers. Close to 100 properties suffered flooding/ flood damage. A large proportion of these were commercial properties. An Information Sheet on forms of assistance available to those affected by flooding was developed and issued to the public.

4.5.8 National Response

In the aftermath of damage in Galway City on Tuesday evening 2 January 2018 and in light of on-going threats from storms and high tides, a National Emergency Co-ordination Group meeting was convened on Wednesday 3 January 2018. The National Emergency Coordination Group is attended by all Government Departments and relevant agencies and reviewed the severe weather situation from the various perspectives, the key issues at national level, the actions underway and necessary to deal with the impact of storm Eleanor and the on-going threats caused by the combination of wind and tidal conditions.

This meeting was attended by Eoghan Murphy, TD, Minister for Housing, Planning and Local Government and Denis Naughten, TD, Minister for Communications, Climate Action and Environment. The Minister of State with responsibility for the Office of Public Works, Kevin Boxer Moran, TD, travelled to Galway on the morning of 3 January 2018

to see the extent of damage at first hand and liaised with his Ministerial colleagues and the Chair of the National Emergency Co-ordination Group.

4.6 Flooding Specific Conclusions and Recommendations

4.6.1 Introduction

In the previous sections of this chapter, three localised but significant flooding events were described. The floods were across three categories - pluvial, fluvial and tidal in origin. The difficulties with forecasting and recognising the emerging flooding situation, and identifying and warning those potentially affected were highlighted.

Nonetheless, the generic elements of the emergency response system were visible/ evident in all three cases. Also, the support systems for those affected by flooding, which have been developed over the years, are now seen to be activated immediately in the aftermath of flooding events and a collaborative approach is the norm.

Also, post-event learning, which has helped develop the emergency management capability was activated following each of the three flooding events. This section of the Report is an attempt to capture the relevant learning points.

4.6.2 Pluvial Flooding Conclusions

Sudden and extreme pluvial flooding events are seen to pose the greatest threat to life safety in flooding, as well damage to property, outside of catastrophic dam failure. Similar pluvial flooding events have occurred previously, the most significant recently perhaps being the rainfall event in the Dublin area on the night of 24 October 2011, when two persons lost their lives. The reports from Donegal indicate that it was lucky that no fatality or serious injury resulted from the event of 22 August 2017.

Every area of the country, urban and rural, is at risk from this type of rainfall and consequently this type of flood event. Property cannot be protected from pluvial flooding in the same way as it can from more predictable river or tidal flooding.

While the likelihood of severe pluvial events may be anticipated, it is not possible to forecast the locations where a sudden pluvial rainfall event such as occurred in Donegal

on 22 August 2017 might occur. Nor is possible to forecast such events sufficiently in advance to provide a warning for communities who are likely to be affected. Met Éireann's plans to enhance radar coverage over the next number of years will enable better monitoring of rainfall intensity levels as they happen and may provide a sound basis for real-time warning of dangerous rainfall events.

An additional noteworthy dimension of the Donegal event was the bog-slides resulting from the extreme rainfall event. Recent wildland fires, which had removed vegetation from the surface of the bog, was considered to be a contributory factor in the case of landslides and 'bog-bursts'.

4.6.3 Fluvial Flooding

OPW have recently published the Catchment Flood Risk Assessment and Management (CFRAM) studies, together with flood management proposals, for the areas of the country identified as most at risk from fluvial flooding.

As described in section 4.1.2 above, a new national flood forecasting and warning system is being developed and calibrated. Although it will take some years to become fully operational, this is intended to provide early warning for the kind of situation that developed at Mountmellick, where the upper reaches of the River Barrow overtopped its normal channel because of prolonged rain in the Slieve Bloom mountains.

4.6.4 Coastal Flooding

Arising from the Galway experience, the inclusion of the impact of wave set-up in tidal surge models emerged as an issue in relation to local flood forecasts and warnings. It appears also that additional, standardised base-line, range and scenario modelling in each vulnerable area will be required to capture these types of high impact flooding events.

4.6.5 Dams/ Reservoirs

Dams are used to create elevated water levels on rivers which can be used for upstream storage or specific purposes like electricity generation. Water is also stored in reservoirs, generally at elevated levels. The threat of catastrophic flooding arises from dam/ reservoir failure, resulting in uncontrolled discharge of flood waters which would threaten the lives and property downstream of the dam/ reservoir. Such an event is likely to be as a result of a sudden development.

Dams and reservoirs are associated with public utilities and the threat of flooding from them is included under the infrastructure heading in Chapter 8.

4.6.6 Flood Forecasting and Warning

Current flood forecasting and warning arrangements, together with planned developments, were described at the beginning of this Chapter in Section 4.1 above.

- The decision to place the development of the national fluvial flood forecasting service within Met Éireann provides a platform where its output can be integrated with other severe weather warning systems in the years ahead.

- However, as this will take some years to develop and calibrate, in the meantime, current ad-hoc arrangements need to be maintained to provide a level of fluvial flood warning.

- While OPW contracts out the operation of flood forecasting and warning services, it is appropriate that the Oversight Group established by OPW in relation to the new national Flood Forecasting and Warning service retain responsibility for the development, integration and issuing of flood advisories/ alerts and warnings across the range of flooding threats.

- While there has been on-going development of severe weather warning, it is recommended that the scope for enhanced early warning be extended to integrate warning systems for all types of severe weather, where possible.

4.6.7 Locally-Led Response

The description of the immediate local response to the three flooding events highlights a number of important points. Local authorities were assigned the “Lead Agency” role for co-ordinating local response, as they are recognised as being best placed to respond to emergencies in their communities than local authorities. They also deliver a significant portion of the response effort in emergencies of all kinds.

Local authorities have engaged fully with emergency management development programmes since the publication of the Framework for Major Emergency Management. They have participated in learning reviews after each emergency event as a means of consolidating and improving performance. This has resulted in enhanced practice and performance over the years.

The local authority Executive accounts for its performance in the first instance to the elected members of the local authority. Local authority members/ councillors had specific training in emergency management/ severe weather emergencies, arranged and facilitated by the Association of Irish Local Government (AILG) in the latter half of 2017, highlighting the importance they place on this issue. Local elected members also fulfil a valuable role during emergencies in identifying issues within the communities and channelling information to and from the public who are affected.

As will be seen in the next chapters, where local authorities have advance warning, they can take appropriate pre-event actions. In general, as seen in the three events described in this Chapter, local authority staff undertake extraordinary work in crisis situations. However, it needs to be recognised that, with the exception of their fire services, local authority staff are not employed on a 24/7/365 basis. Indeed, one of their importance services, Civil Defence, depends on volunteers who give their time to their communities on a voluntary basis.

With the exception of a number of specific staff who are part of on-call arrangements, the efficacy of local authority response is dependent on pre-warning which enables staff to be alerted and mobilised. Clearly in cases of sudden onset events/ emergencies which occur outside normal working hours, local authority staff may struggle to respond at the levels their communities have come to expect.

4.6.8 National Response to Local Events

The severe weather team in the National Directorate for Fire and Emergency Management (NDFEM) monitors forecasts and warning updates from both Met Éireann and the OPW regarding severe weather. NDFEM staff were actively engaged in the run up to and during two of the flooding situations described in Chapter 4.

As Lead Government Department for flood response, and based on the NDFEM contacts with relevant County Councils, the NDFEM took a view that pre-arranged emergency response systems had been activated and were operating appropriately. It was the NDFEM judgement that none of three flooding events warranted the convening of a National Emergency Co-ordination Group during the response phase, while the principle of local response remained more appropriate.

Over the past year, significant work was done to give visibility to the local co-ordination structures, which the public are not as aware of as that which takes place at national level. The efficacy of local co-ordination remains a key determinant of successful emergency management and, in the next chapters, when dealing with the variations in weather conditions which can arise across the country, we recommend the further development of the Local Co-ordination Group as the locus for monitoring local conditions and issuing of localised public safety advice, based on the available forecasts from Met Eireann and their own monitoring of conditions.

5. EX-HURRICANE OPHELIA – 16 OCTOBER 2017

5.1 Introduction to Ex-Hurricane Ophelia

The US National Hurricane Centre (NHC) issued its first advice on the seventeenth Tropical Depression of the season near the Azores in the eastern Atlantic on Monday 9 October 2017 at 09:00hrs UTC. As the situation evolved, the storm was designated as Hurricane Ophelia (Wednesday 11 October 2017 21:00hrs UTC), using the US hurricane naming convention for the 2017/ 18 hurricane season.

5.2 Forecasting the Storm

On Tuesday 10 October 2017 the first definitive evidence of a possible extreme wind event with respect to Ireland was noted by the forecast team in Met Éireann, using the ECMWF probability predictions, for the following Monday 16 October.

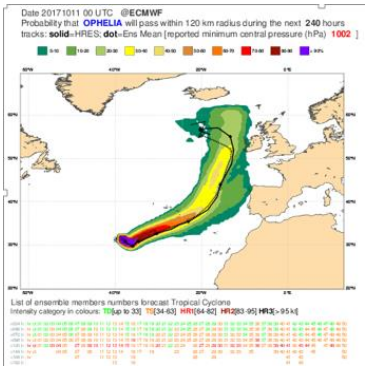
At 09:00hrs on Wednesday, 11 October 2017, the NHC elevated Ophelia to Hurricane Category 1 status as per the *Saffir-Simpson* [10] Hurricane scale. The NHC bulletin at 3 am on Thursday 12 October forecasted further strengthening of the Hurricane and mentioned the possibility of a powerful extra-tropical depression affecting Ireland and the UK for the first time. The first weather chart shown in Figure 5.1 below is from the 00.00hrs Ensemble forecast run on the 11 October 2017. The ECMWF Ensemble Prediction System (EPS) consists of one control forecast starting from the best guess initial conditions, and 50 others starting from slightly perturbed initial conditions.

The dotted track in Chart 5.1 below is the mean position of the centre of Ophelia from the 51 runs of the model. The solid line is the track as predicted by the deterministic High Resolution model. The coloured contours give probabilities of a “hit” at any given location.

The next high resolution deterministic forecast, run at 12.00hrs on 11 October 2017, brought the centre close to the southwest of Ireland on the 16 October 2017 – shown below in Figure 5.2.

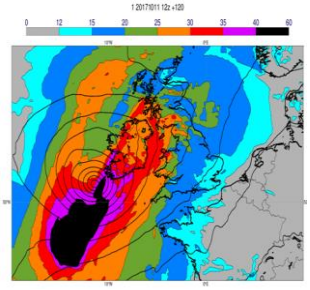
[10] The Saffir-Simpson Hurricane Wind Scale estimates potential property damage. The scale ranges from 1 to 5 based on a hurricane's sustained wind speed.

Figure 5.1



This is the EPS, run from 00:00hrs on Wednesday, 11 October 2017. This brings the strong winds on a northwards track and tracks the storm centre to the northwest of Ireland.

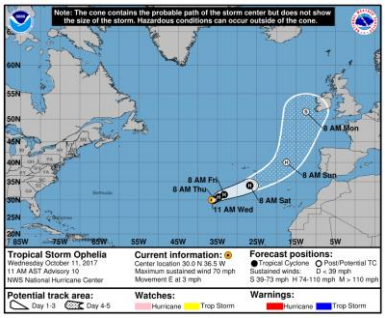
Figure 5.2



The next high resolution deterministic run fom 12:00hrs on 11 October 2017 brought the center close to the southwest of Ireland on the 16 – the time of validity for the image shown here.

At the same time as the ECMWFs were issued on Wednesday, 11 October 2017, the National Hurricane Center (NHC) in Miami put Ireland into the zone of probability in its five-day track of Ophelia, as shown in Figure 5.3, having forecast its transition into a post-tropical storm. The National Hurricane Centre issued updates which continued every 6 hours until 03:00hrs Monday 16 October 2017.

Figure 5.3



Met Éireann began to monitor the development of this tropical storm, working with both the US Hurricane Forecasting Centre, from which it received updates every six hours, and the UK Met Office. Met Éireann continued to run its forecasting models tracking the evolution of the storm. It became clear on Friday 13 October 2017 that this storm was tracking towards Ireland.

Tele-conference briefing was held first between the UK Met Office, the National Hurricane Centre (Miami), the American National Weather Service and Met Éireann on the Thursday afternoon (12 October 2017). Conference briefings followed daily at 09:00hrs (Irish local time) on Friday 13, Saturday 14, Sunday 15 and Monday 16 October 2017. Initiated and hosted by the UK Met Office, this was the first time multilateral conference calls involving partners on the other side of the Atlantic have taken place.

The images below in Figure 5.4 and Figure 5.5 below are the ECMWF deterministic and ensemble forecasts over Thursday 12 October 2017 (on the left) and Friday 13 October 2017 (on the right); guidance at this stage enabled Met Éireann to issue Weather Advisories relating to Ophelia with a good degree of confidence.

Figure 5.4

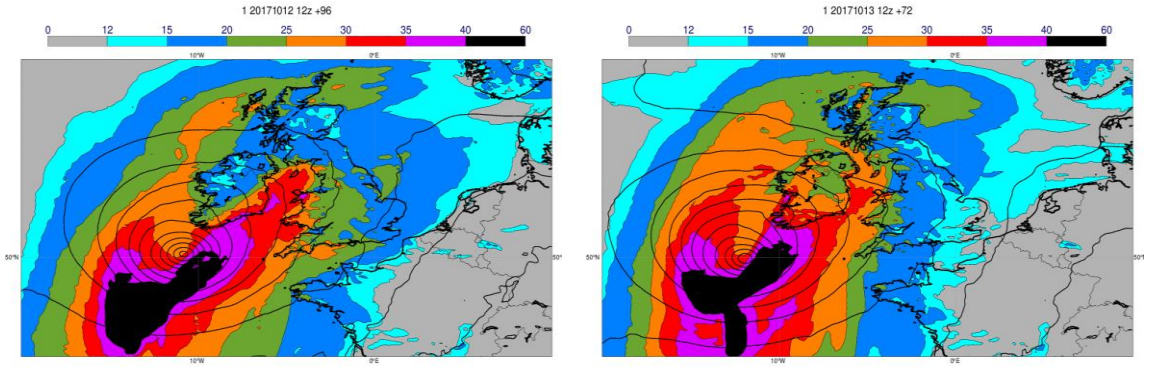
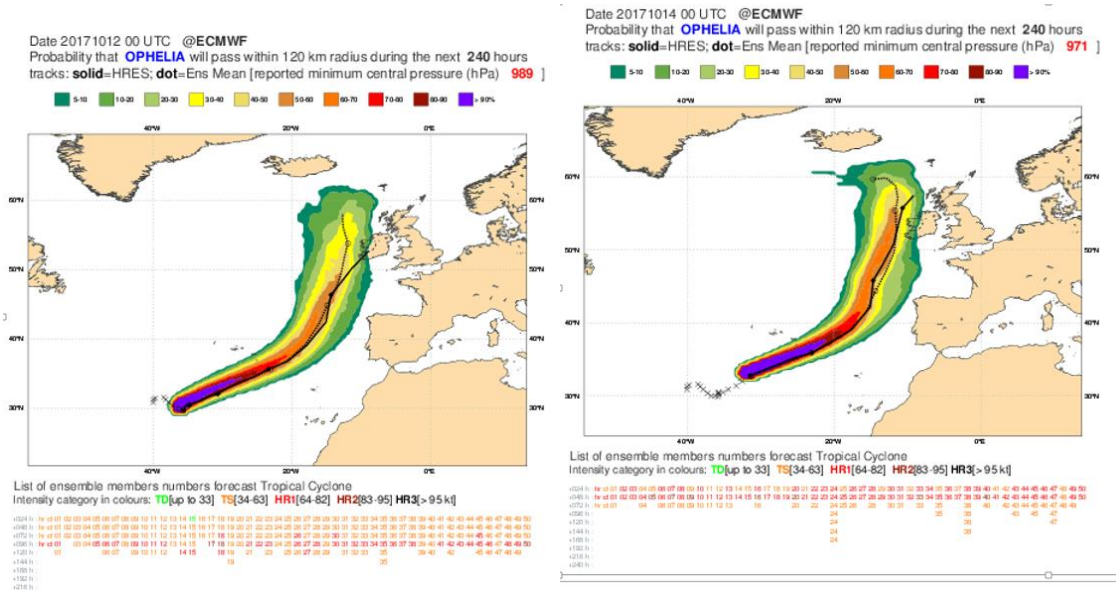


Figure 5.5



5.3 Unusual Features in the Formation of Ex-Hurricane Ophelia

This weather system achieved hurricane status exceptionally early in its path across the eastern Atlantic. In fact, Ophelia is the most easterly Atlantic hurricane on record (records date back to the mid-1800s) and reached category 3 in hurricane strength (Saffir-Simpson scale) making it the strongest hurricane to have been recorded in the eastern Atlantic.

It moved northwards and intensified instead of weakening as would be anticipated usually. The upper air flow was such that it directed Ophelia northwards instead of the usual track westwards.

The sea was abnormally warm in the mid-Atlantic (Azores) - 2 degrees warmer than normal. Such above-normal water temperatures and light upper-level winds helped feed the storm with energy and allowed it to reach such unusual intensity so far north and east in the Atlantic Ocean.

As Ophelia was transitioning from a tropical storm (ex-Hurricane) to an extra-tropical feature, it engaged with the Jet Stream which strengthened it further as it morphed into a “mid-latitude” style of weather system.

5.4 Forecasts and Advisories

On Thursday 12 October 2017, Met Éireann issued an initial advisory which reflected the information available:

> A combination of a vigorous Atlantic weather system and the remnants of Hurricane Ophelia will pass close to Ireland on Monday, and has the potential to be a high-impact event in parts of the country. There is a lot of uncertainty as to the exact evolution and movement of this weather system during the coming four days, but storm-force winds, outbreaks of heavy rain, and very high seas are threatened. Met Éireann will maintain a close watch on the evolution and issue further advisories and warnings as these are warranted.
> **Issued:** Thursday 12 October 2017 14:00hrs
> **Valid:** Thursday 12 October 2017 14:00hrs to Tuesday 17 October 2017 06:00hrs

As well as issuing its advisory through the normal channels to its contact points, Met Éireann contacted the National Directorate for Fire and Emergency Management (NDFEM) on Thursday 12 October 2017 to highlight that there was a possibility that the track of Hurricane Ophelia could move towards the north Atlantic. Typically, hurricanes track west towards the Caribbean; however there were some early indications that Hurricane Ophelia was not moving west but instead was taking a more north-easterly track. News reports were starting to emerge also of Hurricane Ophelia potentially making landfall in Ireland over the weekend or into Monday 16 October. However, there remained a high degree of uncertainty regarding the track and intensity of this hurricane with Met Éireann, the UK Met Office and the NOAA (USA) monitoring this system and co-ordinating information to update forecast models.

The Met Éireann advisory was updated 09:40hrs Friday 13 October 2017:

> On Monday, an Atlantic storm from the remnants of Hurricane Ophelia will move northwards close to Ireland. There is still a high degree of uncertainty regarding the exact track and evolution of the storm. However, storm force winds, heavy

rain and high seas are threatened. Met Éireann will continue to monitor this storm and will issue appropriate warnings as required.

It was unclear at this stage whether or not this weather system would pass directly over Ireland and, if it did, what level of impact it would have across the country.

5.5 RED Level Wind Warnings

However, by Saturday morning Met Éireann's high resolution deterministic model 54 hour forecast for Monday 16 October 2017 was available and it forecast hurricane force winds close to Ireland, as illustrated in Figure 5.6

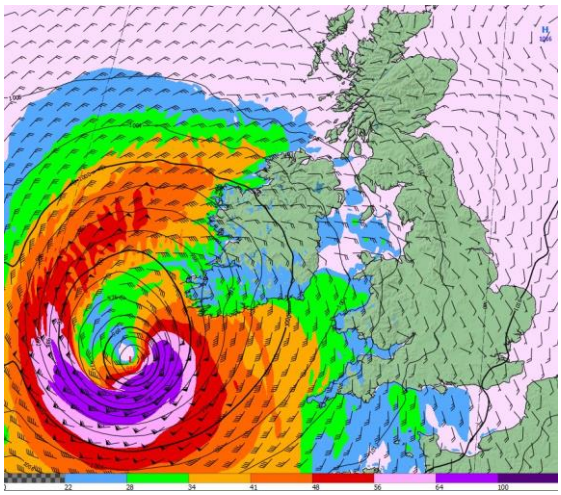
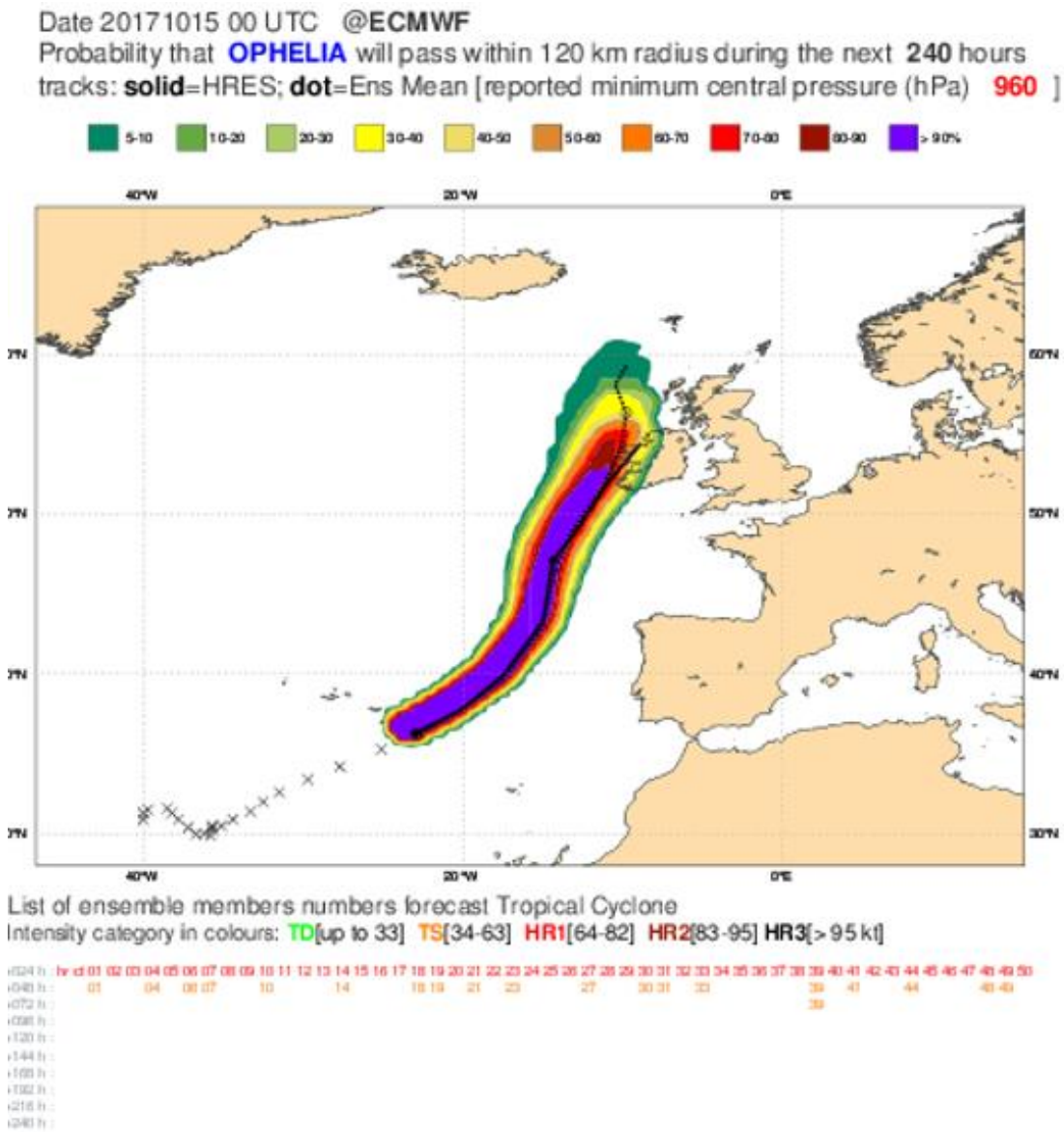


Figure 5.6

Figure 5.7 below represents the updated ensemble-based forecast graphic from ECMWF from the same day.

Figure 5.7



Based on these forecast models, together with an assessment of all the satellite and other observational data, and considering the outcome of the teleconference discussions, Met Éireann issued a status RED wind warning on Saturday 14 October 2017 for counties Galway, Mayo, Clare, Cork and Kerry, with a status Orange warning for the rest of the country in accordance with its colour-coded weather warning system.

> Ex-hurricane Ophelia is expected to bring severe winds and stormy conditions on Monday. Mean wind speeds in excess of 80km/h and gusts in excess of 130km/h are expected, potentially causing structural damage and disruption, with dangerous marine conditions due to high seas and potential flooding.

This was the first time since the introduction of the colour-coded weather warning systems that a Status Red/ Orange warning was issued 48 hours ahead of an expected event.

In response to Met Éireann's warning, the NDFEM decided to convene a NECG for Sunday morning 15 October 2017 (see below) and Met Éireann attended this and provided updates on its forecasts. Met Éireann highlighted that this was an 'unprecedented' situation. Its forecasters used a variety of channels in addition to its normal broadcasts of weather forecasts to highlight the potential risk to life which was posed by this coming storm.

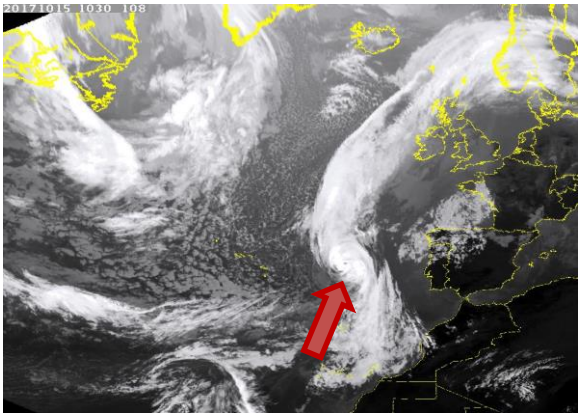
The HARMONIE model is run 4 times a day and the Sunday morning and afternoon updates shifted the track slightly eastwards to bring it in over the landmass of Ireland. This track brought with it the possibility of severe convective cells (thunderstorms and heavy showers) and local wind storms and in the south-west, west and north-west a risk of heavy rain of up to 100mm over the mountains.

By Sunday evening, 15 October 2017, it was evident that the storm would move in over Ireland on Monday but there was still some uncertainty in the precise track and intensity. In view of the evolving forecasts and possible very severe impacts and danger to life, Met Éireann extended the Status RED weather warning to all areas at 8pm:

> Ex-Hurricane Ophelia is forecast to track directly over Ireland during daytime Monday. Violent and destructive gusts are forecast with all areas at risk and in particular the southwest and south in the morning, and eastern counties in the afternoon. Also heavy rain and storm surges along some coasts will result in flooding. There is potential risk to lives.

Figure 5.8 below shows 10.30hrs METEOSAT satellite image on Sunday 15 October 2017, with Ophelia positioned west of Portugal. Here, Ophelia has become embedded within a band of cloud extending up to Scandinavia and it was along this trailing (baroclinic) zone that Ophelia moved pole-ward towards Ireland.

Figure 5.8



As Ophelia got caught up in the jet-stream it accelerated towards Ireland, travelling 1800km in just 24-hours. As it moved northwards across the cooler seas it began to weaken and completed the transition from a hurricane to an extra-tropical cyclone by 03:00hrs Monday 16 October. In other words, Ophelia changed from being a major hurricane fuelled by convection from the warm tropical seas to being a mid-latitude storm whose energy derived from the interaction between polar air and tropical air and was described as Ex-Hurricane Ophelia. The temperature at Valentia was over 19 degrees at 06:00hrs Monday. As Ophelia was no longer a hurricane, the NHC no longer had responsibility for issuing alerts and warnings and did not take part in the conference briefing Monday morning between Met Éireann and the UK Met Office. However the final forecast from the NHC was cautionary:

> 'Despite the expected weakening, the post-tropical cyclone is still likely to bring hurricane-force winds, especially in gusts, to portions of western Ireland on Monday……. This is the last advisory issued by the National Hurricane Centre now that Ophelia has become post-tropical. Local forecasts, warnings, and other communications regarding the post-tropical cyclone that are pertinent to Ireland and the United Kingdom will continue to be available from Met Éireann and the UK Met Office.'

5.6 Preparation for the Arrival of Ex-Hurricane Ophelia

5.6.1 The National Directorate for Fire and Emergency Management

The NDFEM is the section of the Department of Housing, Planning and Local Government, which is designated as "Lead Government Department" for co-ordinating

the response to severe weather events. The NDFEM severe weather team met at 10.00hrs on Friday morning 13 October 2017 to consider the Met Éireann advisory and additional information received from them and the potential impact of this storm on Ireland.

Based on the information provided by Met Éireann, NDFEM took a number of initial actions after this meeting including:

1. Contacting all local authorities and requesting that they activate their Crisis Management Teams (internal local authority) and Local Co-ordination Groups (inter-agency) over the weekend to prepare for a very severe wind and rainfall event on Monday;

2. Verifying with key Departments and other agencies/ sectors that they were aware of the expected arrival of an exceptional storm and advising them of the potential impact of ex-Hurricane Ophelia;

3. Requesting the Office for Emergency Planning (OEP) to notify all Government Departments and relevant agencies that a NECG would likely be convened over the weekend, with a meeting to be held probably on Sunday 15 October 2017 in NECC at 10:30hrs;

4. Notifying the Department's own senior Management Board and the political system of the situation, and the actions being taken to prepare in advance of the storm's arrival.

NDFEM staff worked with the Met Éireann duty forecaster on updates of the predicted track and strength of Ophelia. The severe weather team met a number of times on Friday and after 15.00hrs on Friday afternoon confirmed the convening of a NECG to the OEP.

The NDFEM continued to monitor this emerging severe weather crisis with Met Éireann on Friday evening and into Saturday, as well as liaising with local authorities and preparing for the NECG meeting on Sunday morning. Met Éireann issued its RED level wind warning at 12:00hrs on Saturday for Galway, Mayo, Clare, Cork and Kerry and an ORANGE level warning for the rest of the country.

5.6.2 National Emergency Co-ordination Group (NECG) Meeting

The NECG meeting convened at the request of the Lead Government Department on Sunday morning 15 October 2017 in the National Emergency Co-ordination Centre (NECC) in Agriculture House, Kildare St., Dublin 2.

Seán Hogan, the National Director for Fire and Emergency Management, is mandated by the Secretary-General of Department of Housing, Planning and Local Government to convene and chair National Emergency Co-ordination Group meetings. This first meeting was used to re-introduce the mode of operation of the NECG, and noted the emerging weather situation with a RED level warning in operation for Cork, Kerry, Mayo, Galway and Clare. The severity of wind-speed conditions associated with this warning was emphasised, as well as the potential for very heavy rainfall and flooding.

Met Éireann updated the NECG on the weather forecast models being run at its HQ in Glasnevin and indicated that duty forecasters were considering issuing a RED level warning for other counties in the south and south-east region of the country.

OPW provided information from the RPS model flood forecasting system on the expected high tides over the coming 48 hours.

The meeting identified and discussed key issues. Public safety was established as the key objective for the NECG and it was concluded that, given the severity of the impact expected, warning and informing the public should be the main focus in the period up until the storm's arrival.

The second key focus of NECG was on response capability and ensuring that all organisations with a role to play were using the pre-storm period to hone their arrangements for clean-up and restoration after the storm would pass.

The Department of Housing, Planning and Local Government also activated the severe weather protocol for homeless services, hostels and emergency accommodation centres, to ensure that all homeless people could access safe accommodation for the duration of the storm.

It was clear that travelling conditions would be extremely hazardous throughout the country from early Monday morning. The Department of Transport, Tourism and Sport and Bus Éireann (BE) briefed NECG members on Bus Éireann's decision to withdraw school bus services in all areas affected by RED wind warnings and this decision was communicated to all Bus Éireann staff over the weekend. With school bus services suspended in counties with RED level warning, the Department of Education and Skills advice was that schools management should decide locally if they would open or not.

5.6.3 Safety Advice for the Public

The designation of ex-Hurricane Ophelia as a RED level wind event triggered campaigns of public safety advice from ESB Networks and the Road Safety Authority, and their targeted adverts started to appear on broadcast media from Saturday 14 October 2017.

However, the concern at NECG was to ensure that the public understood that a RED level warning means **"take action to protect yourself"**. [11] In this case, the NECG advice to people was to stay indoors in a safe place and shelter for the duration of the RED warning.

A press conference was convened in the NECC following the meeting of NECG. The key public safety advice messages were summarised to include:

- Advice not to undertake unnecessary travel and not to cycle;
- People were urged to keep in touch with weather forecasts and public safety advice;
- People were asked to prepare by securing loose objects on their property which could become potentially dangerous missiles in the predicted stormy conditions;
- Bus Éireann's schools transport services would not be operate in counties covered by RED level warnings;

[11] The three levels of weather warning may be summarised – YELLOW – BE AWARE; ORANGE – BE PREPARED; RED – TAKE ACTION see section 3.3.

- Due to anticipated disruption of electricity supply people were advised to charge phones and other devices, noting that ESB Networks had activated its plan for rapid restoration of power when working conditions became safe following the storm.

As well as broadcast media and Met Éireann forecasts, web-based and social media systems were used to carry warnings and advice for the public. National warnings were picked up and highlighted by local authorities. This was especially the case in the southern areas, where the RED level warnings had been in place since Saturday. Therefore, public safety messages were disseminated through a wide range of traditional and social media channels, supporting the main key public safety message:

- This event is unprecedented with serious life threatening conditions and all unnecessary travel should be avoided while the storm is passing. "**Do not be outside during this storm"** was the core message**.**
- Don't travel during the height of the storm, and take due care when travelling after the storm as there will be debris including fallen trees on the roads. Listen to local radio and national media broadcasts regarding the current weather situation.
- High seas are predicted, with the potential for localised coast flooding as a result of wave overtopping. You are strongly advised to stay away from coastal areas, piers, walkways etc. near the sea.
- Very strong winds with violent gusts are predicted, making driving conditions extremely hazardous, especially for the more vulnerable road users, e.g. cyclists, pedestrians, motorcyclists and high-sided vehicles. Road users should pay particular attention to the risk posed by fallen trees and flying debris. Given the anticipated extreme weather conditions, today should be a 'no bike' day.
- Members of the public are being asked to report any homeless case or individual that they have concerns about to their Local Authority, and the case will be followed up by outreach teams in each Local Authority area.

- Power outages will occur in certain parts of the country, with contingency planning activated by the ESB. The ESB is highlighting the dangers from fallen live wires and is advising the public to stay away from these fallen cables. ESB Emergency Services can be contacted at 1850 372999.
- Bus Éireann's schools transport services are not operating in counties covered by RED level warnings.
- People are asked to check in on isolated and vulnerable neighbours before the severe weather conditions and again after the worst of the event has passed, preferably by phone or text to avoid leaving your home.
- People are advised to remove patio furniture, rubbish bins and any loose items from around buildings, which can be turned into missiles by the wind.
- Farmers are advised to be conscious of the warnings in place and not to travel alone when checking on livestock, and avoid doing so during the peak of the storm.
- People who have travelled to work should stay inside until after the storm has passed, checking with transport providers to ensure they have a safe means of travelling home.

5.6.4 Closure of Schools

On the afternoon of Sunday 15 October 2017 the Department of Education and Skills instructed all schools and third level colleges to act on the Department's advice and to close on Monday 16 October 2017. It was advised that crèches and Montessori facilities (in private ownership) should also remain closed for Monday.

The closure of schools is anticipated always to cause significant disruption for the parents of the school children, with the knock-on effects on other services and commercial activity.

Given the predicted timing of the arrival of the storm between 08.00 and 09.00hrs at the south coast, which would coincide with peak travel time to work and in light of the schools closures, organisations, families and individuals began to consider the

implications of the public safety advice. A significant number of organisations decided to remain closed on Monday, when the storm was expected to track across the country.

5.6.5 Extension of the RED Level Warning to the Entire Country

Later on the evening of Sunday 15 October 2017, Met Éireann upgraded its severe weather warning to RED level for the entire country. Forecasts at this stage were predicting that the storm would track across Ireland, affecting all areas. The overland track brought with it the possibility of severe convective cells (thunderstorms and heavy showers) and localised extreme wind storms. Met Éireann advised the public to expect violent and destructive wind-speeds on Monday, posing a threat to life.

By the evening of Sunday 15 October 2017 the public safety message was advising people to stay indoors for the duration of the storm, with the exception of the staff supporting emergency response and essential services. This was, in effect, a national shutdown. While many organisations succeeded in assessing the advice, making decisions and implementing it, giving effect to this was problematic for some organisations. Contacting all their employees on a Sunday evening proved to be a difficult task for many organisations.

In the case of public services, achieving a consistent approach across the full panoply of organisations was also difficult. During the NECG meeting on Sunday morning, the issue of travel to and from work had been discussed by Government Departments with offices in areas of the country affected by the RED warning. Several Government Departments, in light of advice provided by the NECG, had taken the decision to close their offices located in counties with Status RED weather warnings. As the Status RED weather warning was extended to the entire country – all public service offices were now subject to the warning. The decision of Government Departments to close offices aligned with the advice being provided by the NECG regarding the need to avoid any unnecessary travel during the period of the storm warning, which covered all of Monday 16 October 2017. Late on Sunday evening, Departments were advised, therefore, to suspend all non-essential activities for the entirety of Monday across all parts of the country. Giving effect to this advice required a lot of ‘first-time’ activity on the Sunday evening.

5.7 Monitoring the Storm's Progress

The storm was predicted to make landfall on the south coast, hitting Cork and Kerry first at about 09.00hrs on Monday 16 October 2017.

NDFEM staff and others assembled in the National Emergency Co-ordination Centre (NECC) from 06.00hrs that morning. The focus for the early part of the day remained on warning the public of the dangers of the coming storm and re-iterating the safety messages.

The following three graphics from left to right show the circulation and winds associated with ex-Hurricane Ophelia as it moved north-eastwards during the day. The centre of the vortex was off Kerry at 10am (Figure 5.9), Clare at 1pm (Figure 5.10) and Donegal at 7pm (Figure 5.11). The dark purple shaded area denotes the hurricane force 12 winds, the lighter mauve Violent Storm Force 11 and the RED Storm Force 10.

Figure 5.9

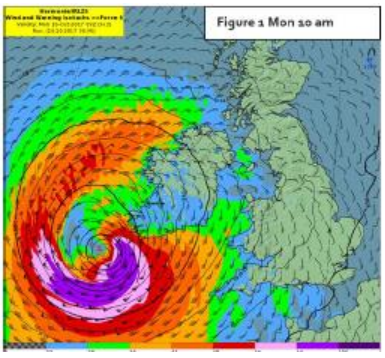


Figure 5.10

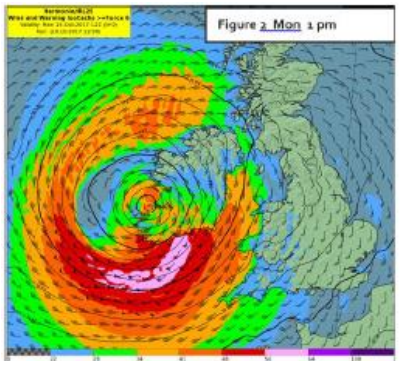
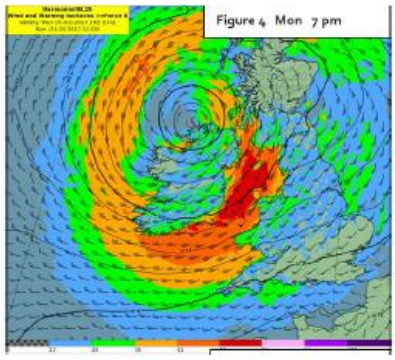


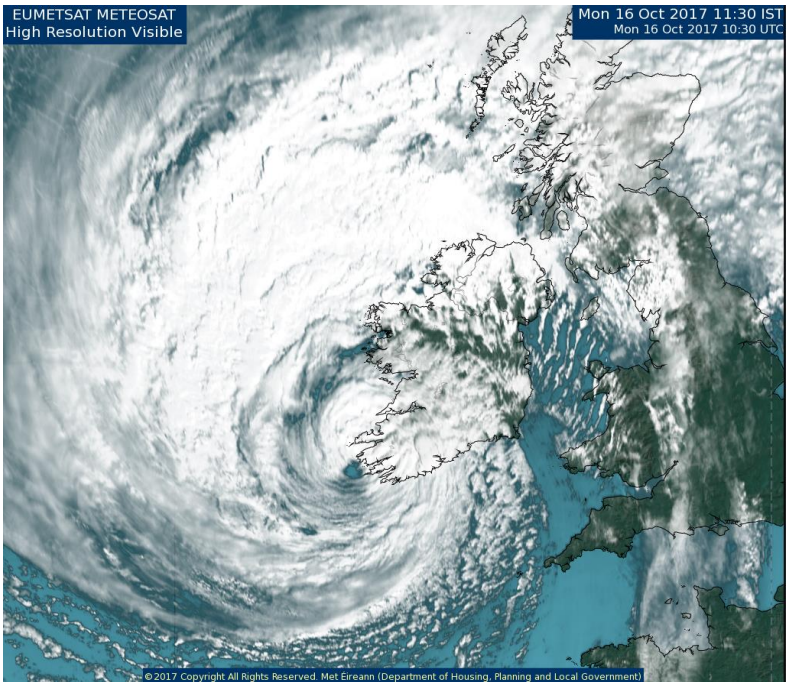
Figure 5.11



The heaviest rain occurs on the north-western side of a hurricane system and because the centre of the storm

Figure 5.12 below is the 11.30am EUMETSAT satellite image over Ireland showing the centre of ex-Hurricane Ophelia just off the Kerry Coast. The lowest mean sea level pressure at a land station during the day was 962.2 hPa recorded at Valentia Observatory, Co Kerry in the hour ending 11am.

Figure 5.12



5.8 Monitoring the Storm Damage

At 10.00hrs, initial reports on the actual conditions in Cork and Kerry were received in the NECC from the local authority co-ordination centres, as these were the first local authorities affected by ex-Hurricane Ophelia. From the earliest stage, extensive numbers of trees were reported to have been knocked and widespread disruption of electricity supply was reported. These conditions were expected to be replicated right up across the country as the storm tracked north.

For the first time, the three Fire Services Regional Communication Centres (RCCs) for 999/112 call-taking were linked with the National Emergency Coordination Centre and provided a real-time information channel into the NECG. The three centres, located in

Limerick, Dublin and Castlebar provide mutual support to each other during spate call periods and each of the three regional communication centres recorded high levels of calls for assistance as the peak of the storm passed over their areas.

Local authorities also had activated their emergency contact phone lines which are in place for receiving calls relating to non-life threatening situations. As well as providing a service for the public, this helped to lessen the load on the 999 system and provided local authorities with a direct channel of communication to people affected by the storm. Local authorities were active on social media, posting reports of damage and blocked roads as they received them.

5.9 Reports of Fatalities

Most regrettably, the reports of the first fatality caused by the storm were received on Monday morning after 11.00hrs. This was the death of Claire O'Neill, who was killed when a branch of a tree fell on her car near her home in Aglish, Co Waterford.

This was followed soon after by reports of the death of Michael Pyke in south Tipperary who was struck by a branch as he went with a chainsaw to clear a tree on the road near his home between Ballylooby and Cahir.

At about 2.45pm, Fintan Goss was killed when his car was struck by a falling tree in Ravensdale, County Louth.

The tragedy of these three lives lost illustrates the real underlying impact of a severe weather event such as Ophelia. It was suggested by one commentator [12] that the tone of media coverage became audibly more sombre after the first death was reported and the reports of fatalities may have impacted significantly on the public's perception of risk and danger.

[12] Heaney Mick – Radio Review, Irish Times, Ticket, p 16, 21 Oct 2017

5.10 Co-ordinated Local Emergency Response

The Framework for Major Emergency Management (2006) designates local authorities as the “Lead Agency” for co-ordinating the response to nine emergency scenarios, including severe weather. They work with the other two Principal Response Agencies – An Garda Síochána and the HSE – and together form the hub around which local response is mobilised, directed and co-ordinated.

Preparations for the local response to the storm by the local authorities, An Garda Síochána, the HSE and a range of other infrastructure and supporting organisations were put in place over the weekend preceding the storm. The local authority severe weather teams had received the Met Éireann weather warnings and other advice on the forthcoming storm on Friday 13 October 2017. They set about scaling their response in line with the expected impact from ex-Hurricane Ophelia. This response started in advance of the arrival of storm with the activation of local authority Crisis Management Teams and inter-agency Local Co-ordination Groups.

Outdoor crews, area engineers, fire services crews and Civil Defence volunteers were put on standby and attended at their work early on Monday morning in the southern half of the country in advance of ex-Hurricane Ophelia making landfall. In some areas, staff were asked to come in on standby prior to the RED warning taking effect. However, the approach to bringing in staff on-standby was not consistent across the emergency and essential services.

Local Coordination Centre in Limerick during storm Ophelia, with local authority, Garda, HSE and Fire Service

Defence Forces staff were put on standby at a number of locations throughout the country in readiness to assist the Principal Response Agencies if required.

5.10.1 Deployment of Emergency Services Personnel

The main objective of local authorities was to ensure public safety during the storm. They joined the national efforts in warning and informing their communities of the impending storm from the early stages.

As ex-Hurricane Ophelia tracked through the country, emergency services personnel were deployed only to undertake what were perceived as life-saving operations during the storm, as the conditions were deemed extremely hazardous for emergency services staff themselves.

One of the issues to emerge during the blanket media coverage of the events of the day were the actions of what might be described as a small number of 'thrill-seekers' – people who went out and, against the specific advice, walked along wind-swept coastlines, with some even getting into the sea for a swim. While individuals bear the consequences of their own actions, the difficulty for emergency services is that they may be called to assist/ rescue such persons and are thereby placed in a dilemma where they have to make decisions about responding, or not.

5.11 Co-ordinating the National Response

The Department of Housing, Planning and Local Government is designated as the Lead Government Department (LGD) for co-ordinating the response to severe weather emergencies. Although local authorities lead the front-line response to severe weather emergencies, when exceptional weather events occur there is an expectation of a 'whole-of-Government' response, co-ordinated by the LGD.

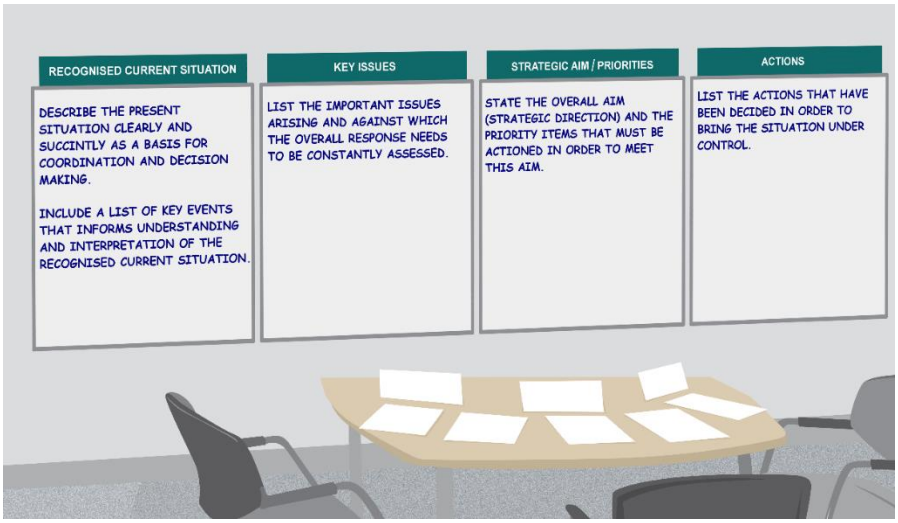
The NDFEM undertake the LGD function on behalf of the Department of Housing, Planning and Local Government. NDFEM staff initiated work on responding to this event on Thursday 12 October 2017 and worked over the weekend to prepare for the national response to Ex-Hurricane Ophelia. The National Emergency Coordination Group was convened on Sunday morning 15 October 2017 and NDFEM staff worked

on Sunday to ensure that all Government Departments and agencies were disseminating public information and warnings and were ready for the storm.

NDFEM staff and staff from other organisations began work in the NECC at 06.00hrs on Monday 16 October 2017. The public safety advice which was issued on Sunday evening was echoed on Monday morning through national radio and social media.

The NECG reconvened again at 09.30hrs on Monday morning and NDFEM used its standard four board crisis management system to update and manage the event, viz:

- Recognised Current Situation
- Key Issues
- Objectives and Priorities
- Actions



Four- Board Crisis Management System used by the Lead Government Department and Local Authorities

Met Éireann relayed real-time analysis of Ex-Hurricane Ophelia's track for the NECG and the wind-speeds being experienced throughout the country. OPW provided on-going assessments on the possibility of river and coastal flooding.

Reports were received throughout the day from Crisis Management Teams and inter-agency Local Co-ordination Groups, detailing the known damage to infrastructure and the roads blocked due to trees falling.

ESB updated the group throughout the day on the status of damage to the electricity supply network.

Two further NECG meetings were convened on Monday 16 October, at 14.00hrs and later at 19.00hrs.

During the second NECG meeting, the Chair established a sub-group led by the Department of Education and Skills to consider if schools should re-open on Tuesday or if the decision for them to stay closed on Monday should be extended. While it was recognised that some schools would not be as badly impacted as others, the information available at mid-afternoon Monday indicated that over 350,000 businesses and homes were already without power, and severe winds continued to cause damage across the country as the storm progressed northwards. Many regional and local roads were closed at that time due to fallen trees. It was also the case that school authorities would in very many cases not have had an opportunity to check their buildings and confirm they were safe, that they had power and water, and that routes to the school were open and safe. The Education sub-group concluded, having heard the initial reports of damage from the south of the country and the extent of power outage, notwithstanding an expectation that school bus services could resume on Tuesday, that schools should remain closed on the Tuesday. It was recognised that the decision to close schools would again have a major impact on families and on the workforce. However, this decision was taken in the interests of safety for children and to provide clarity for everyone concerned in a timely manner.

This decision was noted by the NECG and communicated by Department of Education and Skills to all school Boards of Management and to the public through the NECG press conference. This decision was part of the public information message for the press conference.

5.12 Public Information

From the earliest stage of the day of the storm, the public broadcast media and journalists from other media outlets joined with the efforts of the public authorities to

convey the warnings to the public and to bring updated information on the progress and impact of the storm.

It was clear from early Monday morning that the vast majority of the public had heard and heeded the safety advice arising from the RED level warnings associated with this event and that the country was for the most part, indoors watching the media coverage of the storm and waiting for it to arrive where they were.

In a very significant move, Radio and TV programme schedules were adjusted to facilitate coverage of the evolving situation. Press conferences were held after the 10.00hrs and 14.00hrs NECG meetings and press statements were issued at regular intervals throughout the day. Media staff remained in the NECC for the day, sending out regular reports and broadcasts.

As well as the public information carried by broadcast media, huge numbers accessed information through phones and other devices. A huge shift to social media was reported in the means used by the public to access information. Met Éireann recorded a huge increase in numbers accessing weather information and updates electronically. The ESBN would report a similar shift to social media in the week ahead.

5.13 The Storm begins to Ease

Although there were variations in how the storm seemed to impact, similar patterns of damage were reported by local authorities throughout the day as this storm passed northwards over the country. The south and south-east were undoubtedly hit hardest, but there were reports of very strong and in some cases unusual wind events in different parts of the country.

Wind-speeds had begun to moderate in the southern end of the country by Monday evening, and reports from local authorities in the south and south-east indicated that conditions were allowing for the deployment of outdoor crews to assess the damage and to commence clean-up of debris and removal of trees blocking major roads. When mobilised, local authority staff prioritised clearing national and regional roads. The collection of information on blocked roads over the day enabled crews to be directed to priority sites and their activities to be co-ordinated.

It was clear that there had been very significant damage to the electricity supply network in the south and west of the country. By 19.00 hrs on Monday night ESB Networks had recorded that 360,000 customers were without electricity supply. They deployed crews throughout the country mainly to make situations safe, knowing that the main work would be in the south and south-east regions – this was the start of a seven day effort by ESB Networks to fully restore all 385,000 customers affected.

5.14 Political Participation in NECG

A number of Government Ministers, including An Taoiseach, Leo Varadkar, T.D., attended NECG meetings to monitor the situation and to ensure that the national response was fully supported by their Departments.

Eoghan Murphy, TD, Minister for Housing, Planning and Local Government, was in attendance at the three NECG meetings on Monday 16 October 2017 and the two meetings on Tuesday 17 October 2017. Damien English, T.D., Minister of State at the Department of Housing, Planning and Local Government attended the three NECG meetings on Monday 16 October 2017, the two meetings on Tuesday 17 October 2017 and was in attendance at the final NECG meeting on Wednesday 18 October 2017. Shane Ross, T.D., Minister for Transport, Tourism and Sport, Paul Kehoe, T.D., Minister for Defence and Kevin Boxer Moran, T.D., Minister of State at the OPW attended NECG meetings at different stages.

An Taoiseach, Leo Varadkar, TD attending the NECG with Ministers Paul Kehoe, Eoghan Murphy and Damian English

A “hot debrief” involving An Taoiseach and Ministers was held after the 19.00hrs NECG meeting, as this had been their first opportunity to participate in and observe the emergency management and co-ordination system in action.

NDFEM drafted a Memo for Government which was brought by Minister Eoghan Murphy to update Cabinet on Tuesday morning 17 October 2017.

5.15 The Immediate Aftermath of the Storm

It had been apparent from the reports on Monday 16 October 2017 that the south and south-east of the country were worst impacted by the storm. Many roads were blocked by fallen trees. National and Regional roads were affected with a number closed, sometimes at multiple locations, including the N25, N71, N72 and N73. The M8 had closed at the Blackwater viaduct due to the severe winds. Cork County Council reported hundreds of local roads were affected/ blocked by fallen trees.

Local authority outdoor staff and area engineers were fully deployed from first light on Tuesday, clearing trees and debris. As well as their own staff, the local authorities engaged specialist tree surgeon contractors for this work. Reports from the southern half of the country indicated that crews had made very good progress re-opening national and regional roads on Monday evening and by mid-day on Tuesday the bulk of this work had been completed.

Opening roads generally involves putting a cut in the tree and using a JCB or similar machine to push the parts of the tree to the sides of the road and clearing sufficient space to enable traffic to pass. Crews return later then to cut up and fully remove the tree. Motorway operators across the network had patrols in place to deal with debris. Repair crews, including chain-saw crews and electrical crews, were on standby at motorway maintenance depots.

Many communities removed trees blocking their local roads themselves using their own resources.

In some situations, because of presence of electric cables, road clearance had to be deferred until ESB Networks had made the situation safe.

5.15.1 The Transport Sector

Transport services were severely impacted on the day by ex-Hurricane Ophelia. All transport providers have severe weather protocols in place and the Department of Transport, Tourism and Sport was in contact with each of its agencies in the lead up to ex-Hurricane Ophelia. The Road Safety Authority had put a public safety campaign on national and local radio in place, warnings of the dangers associated with driving in high winds and flooding.

The unprecedented nature of Ophelia meant that many transport services could not safely operate and were cancelled as a result. All decisions had been announced on Sunday 15 October 2017 in advance of the storm. Bus Éireann cancelled all its services for Monday 16 October 2017; Dublin Bus operated its normal schedule in the early peak period and then suspended services for the remainder of the day; Irish Rail likewise operated a range of services initially with some restrictions in early morning

and began suspending its services, with the last services leaving Connolly Station in Dublin around 2.00 p.m.

Flight cancellations were widespread across all airports with over 160 flights being cancelled in Dublin alone.

Irish Coast Guard had been broadcasting marine safety information to shipping on its radio network in the run-up to the storm and vessels in the Irish Search and Rescue Region were in port or sheltering. Ferry sailings on the Irish Sea were cancelled.

Fishing vessels heeded warnings and went to harbour in advance of the storm. However, maximum wave heights recorded on wave buoys on the south coast reached almost 18 metres and there were reports of damage to some harbour infrastructure along the south and south-west coasts, including damage to vessels in Dunmore East harbour.

However, with the exception of the Luas light rail system in Dublin where the roof of a control building was damaged by the storm, transport infrastructure was not impacted severely by the storm and most services were able to resume on Tuesday 17 October 2017.

5.16 A Summary of the Storm's Impact

The following sub-sections set out a short summary of damage and impact across a range of sectors.

a) Trees

The impact of the storm was most visible in the number of trees knocked or broken. Species of trees which still had leaves on were reported to have broken, or had branches off, rather than being uprooted. These impacted in turn on the road, ESB and communications networks.

An aspect of particular note was the reports of a number of communities being isolated as trees blocked routes, where there was only one road in or out.

b) Buildings

Some damage was caused to buildings by the storm. However, given the record wind speeds recorded and the sustained winds, the building stock held up remarkably well to the conditions. Design standards and construction methods in common use may be seen to have performed well.

The experience of this storm provides a benchmark for expected levels of building damage in future storms.

c) Building Sites

Building sites, with temporary structures, cranes, hoardings and loose materials are regarded as particularly vulnerable in storms. However, the advance warning of the storm had enable sites to be secured and little damage was reported from this sector.

d) ESB Networks

At 19.00hrs on the evening of 16 October, supply had been lost to 360,000 or approximately 17% of ESB Networks customers. Like local authority staff, ESB crews had been on standby and started working on Monday evening where conditions allowed, initially working to make sites safe where wires were down.

All ESB Network crews were deployed from early Tuesday morning. While the central control system identified areas with power outage, the first task facing ESB Networks was to locate and assess damage sites. On the Tuesday, they also began working with HSE in relation to health care facilities that had lost power and with Irish Water and communications infrastructure providers to prioritise work to restore supply to essential services and critical infrastructure.

As well as the efforts of crews on the ground, on the day after the storm ESB Networks put a very significant effort into establishing Expected Restoration Times (ERTs) and communicating these to the public affected.

e) Irish Water

Irish Water reported significant outages of water treatment plants and waste water facilities, primarily due to the disruption of power supplies. On Tuesday, 17 October 2017 Irish Water prioritised the deployment of available generators to its affected schemes and worked together with ESB Networks to ensure that affected water treatment plants and group water schemes could be restored as quickly as possible.

f) Communications Infrastructure

The telecoms service providers reported that the areas worst impacted included Counties Cork, Kerry, Waterford, Tipperary, Wexford, Laois and Kilkenny. While hilltop masts survived the storm well, mobile phone services were impacted by the loss of power to hilltop sites. Power was restored in some cases using generators, but access to many sites was restricted due to blocked roads. The fixed line network was impacted

also in the worst affected areas. Engineer crews worked for the next number of days to deal with major issues and their full storm response plans were activated for restoration of services.

g) The TETRA Emergency Services Communications Network

The Office of Government Chief Information Officer **(**OGCIO) acts as the contract manager for the TETRA National Digital Radio Service (NDRS). This network is used by the emergency services (An Garda Síochána and HSE; local authority fire services are currently in the process of transitioning to TETRA) along with key utility company personnel. The resilient design of the network ensured a high level of service was maintained. A number of sites went down, resulting in minor coverage issues in a limited number of locations in County Cork. The coverage level in the southern area at 19:00 on the 16 of October stood at 97.75% - the coverage level at full capacity is 98.12%. TETRA Coverage in the western and eastern regions was not impacted. Like other communication networks TETRA high sites were reliant on battery power in a number of locations; these typically provide back-up service for 24 hours. TETRA Ireland engaged also with the ESB Networks to prioritise their sites for restoration of power, in order to ensure continuity of communications network service for the emergency services.

5.17 National Co-ordination of the Recovery Effort

At national level, the NECG was reconvened on Tuesday morning 17 October 2017, and the various sectors provided situation updates for the NECG as reported below.

The Chief Executive of Laois County Council attends NECG to represent the local authority sector, together with the Local Government Management Association (LGMA) and he provided a summary update on behalf all local authorities detailing the damage and disruption caused by ex-Hurricane Ophelia and the recovery efforts underway.

Met Éireann provided an overview of how ex-Hurricane Ophelia had developed and noted that record breaking wind-speeds were reported in a number of locations. While heavy rain was reported in a number of locations also, it was noted that the bulk of the

rainfall normally associated with such a tropical storm had passed to the west of Ireland. The anticipated flooding which could have arisen from 100mm of rainfall had not happened. The following table from Met Éireann provides summary information and statistics from ex-Hurricane Ophelia:

Station details	Elevation (m)	Highest 10-minute mean wind speed	Direction	Hour end (UTC)	Wind Gusts	Direction	Time (UTC)
Roche's Point (Cork)	40	Violent storm (115km/h)	S	11	156km/h	SSE	10:59
Sherkin Island (Cork)	21	Violent storm (106km/h)	S	11	137km/h	SSE	09:45
Cork Airport (Cork)	155	Strong gale force (87km/h)	SSE	11	131km/h	S	11:09
Shannon Airport (Clare)	15	Strong gale force (87km/h)	SE	12	122km/h	ESE	11:42
Casement Aerodrome (Dublin)	91	Strong gale force (85km/h)	S	15	117km/h	S	14:38
Malin Head* (Donegal)	20	Strong gale force (78km/h)	SSW	19	106km/h	SSW	19:30
Oak Park (Carlow)	62	Strong gale force (76km/h)	S	13	111km/h	SSE	12:26
Gurteen (Tipperary)	75	Gale force (72km/h)	SE	12	102km/h	SE	12:30
Johnstown Castle (Wexford)	62	Gale force (70km/h)	S	12	115km/h	S	12:35
Moore Park (Cork)	46	Gale force (67km/h)	SE	11	115km/h	SE	11:17
Finner (Donegal)	33	Gale force (67km/)	SSW	17	100km/h	S	16:06
Dunsany (Meath)	83	Near gale force (57km/h)	SSE	13	106km/h	SSE	13:16
Dublin Airport (Dublin)	71	Gale force (70km/h)	WSW	24	104km/h	SSE	13:25
Mace Head (Galway)	21	Gale force (70km/h)	ENE	7	94km/h	ENE	06:53
Valentia Observatory (Kerry)	24	Gale force (63km/h)	WSW	17	98km/h	ESE	09:22
Knock Airport (Mayo)	201	Gale force (63km/h)	S	15	93km/h	S	14:48
Mount Dillon (Roscommon)	39	Gale force (63km/h)	SE	13	93km/h	SE	13:27
Athenry (Galway)	40	Near gale force (57km/h)	S	14	93km/h	S	13:58
Mullingar (Westmeath)	101	Near gale force (57km/h)	SE	13	91km/h	SSE	13:03
Belmullet (Mayo)	9	Near gale force (56km/h)	ENE	9	87km/h	ENE	07:03
Claremorris (Mayo)	68	Near gale force (54km/h)	S	14	81km/h	E	12:37
Ballyhaise (Cavan)	78	Near gale force (52km/h)	S	15	93km/h	SE	13:37
Newport (Mayo)	22	Strong breeze (50km/h)	N	6	80km/h	NNE	

Traffic on Met Éireann's' digital platforms, www.met.ie, the mobile website m.met.ie and the two mobile apps (iOS and Android) were the highest ever recorded by Met Éireann. The number of page views for www.met.ie was 1.87 Million, and the number of unique users was 0.41 Million. For the m.met.ie and mobile apps the number of page views was 2.45 Million and the number of unique users was 0.30 Million. There were a total of 4.32 Million Page views on the 16 October 2017, or 180,000/hour or 3,000/ minute. The peak was approximately 6,500 page views in one minute on 16 October 2017. Over the two days, the 15 and 16 October 2017, Met Éireann's tweets were viewed 12.5 million times. In addition the Met Éireann Facebook profile was viewed 55k times.

The NECG met again at 14.00hrs on Tuesday 17 October 2017 in the afternoon to review progress with the restoration effort. All national routes were cleared on Tuesday morning and regional routes were fully cleared by Tuesday evening.

While the local authorities, An Garda Síochána and the HSE are the Principal Response Agencies (PRAs) charged by Government with planning for and leading the

response to emergencies of all kinds, the Permanent Defence Forces (PDF) are the reserve - the support which can be mobilised to assist when required by the PRAs. In light of the progress made by the local authorities, it was decided that it was not necessary to mobilise Defence Forces personnel for road clearing tasks.

However, the Defence Forces were tasked to provide support to ESB Networks in their work of restoring power in the south of the country. The Air Corps used their helicopters to fly ESB Network staff along the lines on damage reconnaissance missions on Thursday. This support supplemented the private helicopter resources that had been deployed over the first two days of the storm response. The Defence Forces also assisted significantly in the electricity restoration effort by providing resources to deliver materials and clear fallen trees and debris that had impacted the network.

An army barracks in north County Cork was used to provide temporary accommodation for the influx of external contracted staff from other regions of the country and overseas who were working as part of ESB Network's restoration effort.

The NECG was convened again on Wednesday, 18 October 2017 to oversee co-ordination of the recovery. Work continued on Wednesday to clear trees from local roads in many areas. However, from Wednesday onwards the key issue was the restoration of power in the south and south-east of the country, prioritising Irish Water treatment plants in so far as was possible.

At its meeting at 14.00hrs on Wednesday 18 October 2017 to review the on-going clean up, service restoration and recovery operations, in light of the very considerable progress already made in clearing roads at that stage and the local authorities' capacity to manage the situation at local level, the decision was taken to stand down the NECG as a formal national level co-ordination mechanism. However, the NDFEM continued to liaise with national infrastructure providers and local authorities and took actions that were deemed necessary to co-ordinate and support the efforts.

On Thursday 19 October 2017, a new weather event (named storm Brian) was strengthening and notification was given by Met Éireann about the potential for its impact. Storm Brian was forecast to hit the south of the country on Saturday, 21

October 2017 and, while it was regarded as a ‘normal’ winter storm, there were concerns that the incoming storm might hamper the on-going electrical supply restoration efforts. However, ESBN committed to continue the restoration efforts until all customers were restored.

5.18 Conclusions and Recommendations in Relation to Storm Events

5.18.1 Introduction to Storm-Specific Issues

Ex-Hurricane Ophelia was a dangerous and disruptive severe weather event, impacting on the functioning of society and posing significant safety risks to individuals.

Emergency Management literature distinguishes between ‘generic’ and ‘agent’ or scenario specific aspects of an emergency, the latter which derive from the particular emergency type. Scenario-generated needs vary considerably depending upon the impact and the specific nature of the scenario - in the case of Ophelia, wind-speeds which were expected to cause widespread damage – in the case of Emma, blizzard conditions with driven snow which could cause disorientation and lead to people getting lost in extreme conditions.

Conversely, generic response-generated demands are common to all emergencies because they are produced by the efforts of responding organisations to manage such crises; they include co-ordination, information management and public communication – all are generic functions that are required in any crises.

5.18.2 Weather Forecasting & Public Warning

The communication of Met Éireann’s weather advisories, forecasts and warnings, through an array of ‘traditional’ and ‘social’ media, played a pivotal role in helping to prevent greater loss and injury during this event. The fact that ex-Hurricane Ophelia had been preceded a few weeks previously by the widely reported Hurricane Maria, which had battered the Caribbean area and in particular, Puerto Rico, causing high profile large-scale destruction and loss of life, may have contributed to the widespread understanding of the situation in Ireland.

Met Éireann's forecasts provide the basis for the public safety warnings issued by the NECG, which are generally perceived to have been appropriate and proportionate, even though the impacts of the storm, as would be expected, varied across the country. Unfortunately, the three deaths described in Section 5.9 underscored the reality of the dangers of different severe weather scenarios, and again the media reports of these events may have impacted significantly on the public consciousness of risk.

The unscheduled work undertaken by the mainstream media in carrying warnings before the event and providing up-to-date information during it was perhaps one of the most significant contributing factors to what was perceived as the relatively successful reaction of the public to the conditions created by the storm as it passed over Ireland.

The early detection and accurate forecasting of the ex-Hurricane described in above was a key factor in the general perception of public and media that the management of this high impact event was successful.

5.18.3 Trees

The most widespread and potentially dangerous consequence of high wind is the risk of trees breaking/ falling, posing a danger to motorists and pedestrians in the vicinity. This was the case with ex-Hurricane Ophelia, where trees down were reported in all areas across the country, with especially high numbers of roads blocked in the south and south-east regions.

The three fatalities which occurred during ex-Hurricane Ophelia were associated with falling trees and breaking branches. These three tragic fatalities underlined the perceived public safety risk of this storm event. Countless numbers of trees were knocked or broken during the storm and, although it is impossible to say for definite, it seems probable that more people would have died had the country attempted to carry on with a 'business as usual' approach on 16 October 2017.

Trees are an integral part of our world, and mitigation of the public safety risk associated with them is a difficult task. Identifying and trimming or removing trees which

pose a significant public safety hazard in public areas and along roadsides is a specialist and increasingly expensive task.

Local authorities are responsible for trees in public areas. Trees on private lands, including lands adjoining public roads are the legal responsibility of the land owner. Section 70 of the Roads Act, 1993 is the relevant legislation setting out responsibilities, and is summarised below.

- 70(2)(a) - Owner must take reasonable steps to ensure that a tree is not a public road hazard;
- 70(2)(b) - Where a tree is considered to be a hazard, the Roads Authority may serve a notice requiring remedial action;
- 70(3)(a) - The owner may appeal the notice to the District Courts;
- 70(7) - An Owner who fails to comply with a notice shall be guilty of an offence;
- 70(8) - Where Owner fails to comply with a notice, the Roads Authority may take the action specified;
- 70(9) - Roads Authority may take immediate action to remove a tree considered to be an immediate and serious hazard;
- 70(10) - Roads Authority may recover costs associated with any action under subsections (8) and (9).

From a risk management perspective, an assessment process should be used to identify trees which, because of their species, age, condition and location, coupled with the level of traffic on roads, would merit action by being trimmed or, in extreme cases, be removed. While the legislation is clear in terms of assigning responsibility, it is recommended that a good practice/ guidance document on tree safety assessment should be prepared by an inter-agency group under the aegis of Department of Agriculture, Food and the Marine, Forestry Section. This should involve relevant stakeholders and would address all the safety issues associated with trees in public areas and on roadsides, while understanding that risk cannot be eliminated entirely. This could be adopted as the basis for individual land-owners and local authorities to address tree safety issues in a balanced and consistent manner. The preparation and

launch of such guidance could provide a focus for a concerted campaign of appropriate action, perhaps in the form of a “tree safety week”.

Another public safety issue relates to the ownership and use of chainsaws. The widespread availability of chainsaws and people using them was undoubtedly a factor in the rapid clearing of roads across the country. Community self-reliance needs to be encouraged, but with a focus on chainsaw operator safety, such as in tree clearing/ felling following storm damage. Reviewing and updating current Health and Safety Authority Guidance on forestry operations (Guide to safe working with timber and chainsaws and Code of Practice for Managing Safety and Health in Forestry Operations) and disseminating these widely could be linked with the “tree safety week” concept.

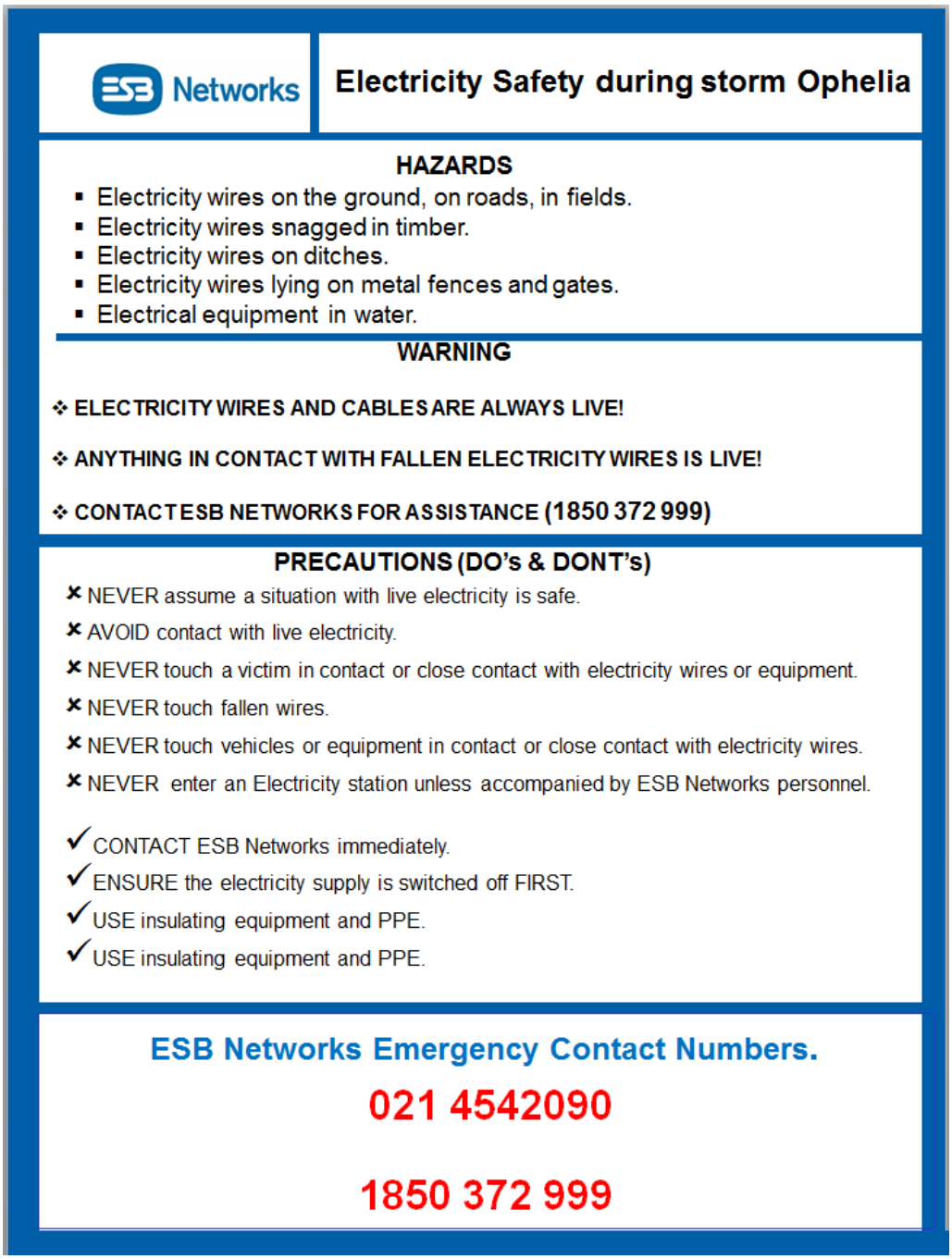
Another issue arises for those whose property is threatened by trees on adjacent land in private ownership. While the legislation quoted above relates only to public roads, it is recommended that in such cases the issue is brought to the attention of the tree owner in the first instance and, if the hazards remains, to the local authority.

5.18.4 Fallen Electricity Lines

Storms and strong winds are associated with damage to the electricity distribution network, directly and through falling trees. One of the most pervasive threats to public safety is the hazard posed by live electricity lines lying on the ground or across fallen trees/ debris and this continues to be a key public safety concern during storms.

ESB Networks have developed a very effective specific public safety campaign to make the public aware of this hazard and how the public can report such situations to them.

ESB Networks also reissued the hazard warning sheet below for emergency services so that all staff could be reminded of how to recognise and manage this hazard safely.



5.18.5 Flying Debris and Missiles

The hazard posed by flying debris from damaged buildings poses a significant threat of injury. The advice for people to remain indoors is intended to mitigate this risk. Very limited damage to buildings was reported following ex-Hurricane Ophelia.

The early warnings provided time so that buildings, building sites, structures and outdoor furniture could be secured and made safe.

5.18.6 The Importance of Timing

The time of day, the day of week and the season in which a storm occurs has a bearing on the potential impact of that storm. As Met Éireann moves towards impact-based forecasting, these factors will help in calibrating the warning system, and the Principal Response Agencies will continue to take account of such factors when issuing advice to the public and scaling their response.

6. SNOW STORM EMMA 1 – 4 MARCH 2018

6.1 Weather Development

On Thursday, 22 February 2018, Met Éireann informed the Severe Weather Team in the Department of Housing, Planning and Local Government that an unusual cold weather event, with polar air emanating from Siberia, was tracking westwards across continental Europe towards Ireland. Unseasonal low temperatures with significant snowfall were forecast.

Met Éireann was in contact with its European counterparts on the potential track and impacts of this weather event and these discussions assisted with predicting its timing and potential severity.

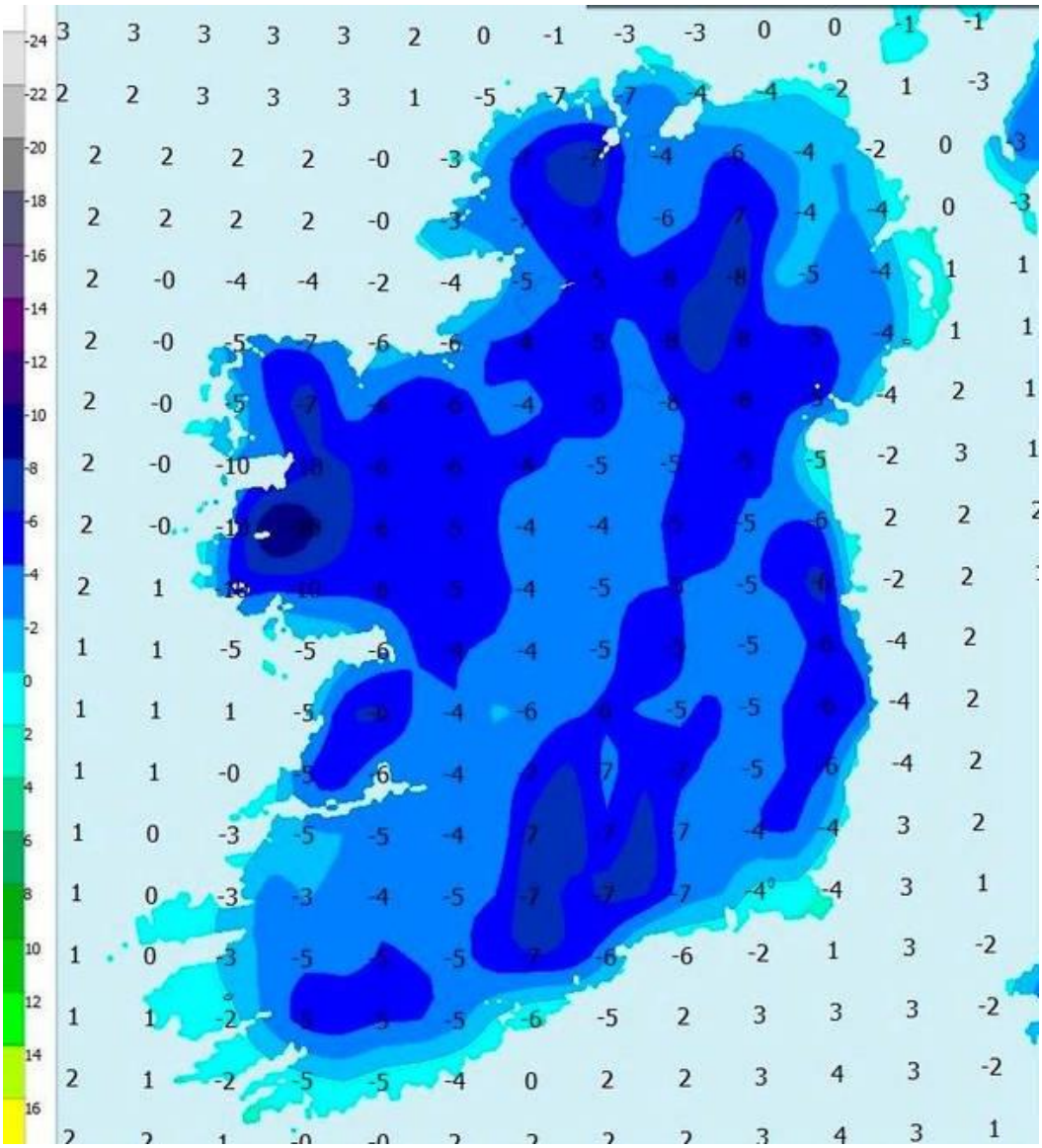
The Department's Severe Weather Team liaised with Met Éireann and a decision was taken on Friday 23 February, 2018 to convene a NECG on the following Monday.

Over the weekend of 24/25 February 2018, Met Éireann noted a further potential complication. A weather system was moving northwest from the Bay of Biscay and, combined with the polar air mass moving in from the east, this system had the potential to exacerbate the levels of snowfall forecast. It was highlighted that this convergence of weather events, due to the high winds associated with what became known as storm Emma, could likely cause blizzard conditions across the whole country and had the potential to produce conditions of severity similar to those experienced in 1982.

This event, combining heavy snow and strong winds, as well as being disruptive, was considered to have the potential to cause life safety concerns. Already, as the first weather event tracked across continental Europe it was being reported as causing significant disruption, indicating the potential impacts likely to be experienced in Ireland.

The Siberian weather system developed and tracked as predicted, at first affecting the east and south-east coastal areas, bringing unseasonably low temperatures and heavy snowfall on Tuesday and Wednesday, 27 and 28 February 2018, particularly in eastern

areas of the country. With the convergence of the two systems, the extent and geographical location of the regions affected became more widespread.



On Thursday evening, 1 March 2018, with some of the country already having experienced significant snowfall, storm Emma with winds from the southeast, began to affect south-eastern coastal counties. These gale force winds were accompanied by heavy snowfall, initially affecting Wexford and Waterford but overnight moving quickly across the entire country. This latest snowfall exacerbated conditions in the east and south-east regions which had already received significant falls of snow.

Storm Emma was accompanied by storm surges and strong easterly onshore winds which, combined with High Astronomical Tides, to give rise to a threat of coastal/ tidal flooding for a period beginning on 1 March through to 5 March 2018.

Although the storm force winds abated Friday morning, snow continued to fall throughout Friday in Leinster and Munster.

The warmer air from the south eventually displaced the cold Siberian air mass and on Saturday 3 March 2018 the country began to experience a gradual thaw. Met Éireann had indicated that the rate of thaw would not be excessively fast, and would take place at different rates in different regions, subject to local temperature increases. The thaw had the potential to cause localised flooding too, due to the volumes of snow which had accumulated.

6.2 Warning Phase and Preparations

On Friday 23 February 2018, the Department's Severe Weather Team circulated its conclusions about the developing weather situation to key sectors, including transport and energy and informed all local authority Chief Executives, requesting them to activate their crisis management teams and their local coordination centres. The Department followed up with telephone conversations with local authorities in the regions identified by Met Éireann as being most at risk.

The Department also informed all Government Departments and Agencies of the initial information it had received from Met Éireann and requested that the full array of media sources be utilised in disseminating key public safety information regarding preparation for the incoming severe weather system.

The Lead Government Department's Severe Weather Team continued to communicate with Met Éireann, trying to develop scenarios including likely timings of the impacts of the storm.

6.3 National and Local Coordination of the Response

Preparatory work had continued in all sectors over the weekend, and the NECG met on Monday morning, 26 February 2018, bringing together the full range of Government Departments and Agencies, to review national and local preparedness for the anticipated weather event, to respond to the developing situation and to deal with predicted and emerging issues.

The main focus of co-ordination activity of the Lead Government Department was moved from the Custom House to the NECC in Agriculture House, Kildare Street from Monday 26 February 2018. NECG meetings were held daily thereafter with morning and afternoon meetings being held from Wednesday 28 February through to Sunday 4 March 2018.

As Minister of the Lead Government Department, Eoghan Murphy, T.D., attended the NECG daily meetings from Monday 26 February to Sunday 4 March 2018. An Taoiseach, Leo Varadkar, T.D., attended meetings from Thursday 1 March through to Sunday 4 March 2018. Ministers Shane Ross, T.D. and Paul Kehoe, T.D. attended meetings on 1 to 5 March 2018 or joined by conference call. Minister Simon Harris, T.D. joined meetings by conference call from Tuesday 27 February 2018 and attended on Sunday 5 March 2018. Minister Simon Coveney, T.D., joined the meeting by conference call on Friday 2 March 2018. Minister Denis Naughten, T.D., joined the meeting by conference call on Saturday 3 March 2018. Minister of State Damien English, T.D., attended meetings on 27 and 28 February 2018 and joined by conference call thereafter until he was able to attend again on Saturday 3 March 2018. Minister of State John Paul Phelan, T.D., attended on Sunday 4 March 2018. Minister of State Kevin ‘Boxer’ Moran, T.D., attended meetings from 2 March to 5 March 2018 inclusive or joined by conference call.

After the first NECG meeting on Monday 26 February 2018, the process began of alerting the general public to the predicted conditions and advising of the actions to take to prepare for this event and to assist vulnerable members of their communities.

As the week progressed, based on updated forecasts from Met Éireann, it became clear that blizzard conditions would arise and these were predicted to impact the country on Thursday night, 1 March, into Friday morning, 2 March 2018. The likely

conditions were regarded as not merely disruptive, but potentially extremely dangerous for any person out in the blizzard conditions.

On Tuesday, 27 February 2018, the weather picture was still developing, with events beginning to unfold as predicted by Met Éireann. Based on forecasts available at this time, it was expected that a RED Level weather warning would be issued by Met Éireann in the next 24 hours or so. In light of this, the NECG issued a statement, urging employers to spend the day planning with their employees to make the necessary arrangements, taking into account the forecasted weather and anticipated travel conditions on Thursday evening into Friday.

At the early stage, the NECG's objective was to keep the country open for as long as possible; however, people were strongly advised to have returned home before the RED Level warning came into effect at 16.00hrs on Thursday, 1 March 2018, and to remain there until the blizzard conditions had passed.

The NECG also considered the issue of schools, colleges and childcare facilities remaining open. School closures are generally matters for local boards of management, emphasising safety, and taking local conditions into consideration. At this time, it was anticipated that these institutions would likely be subject to a general requirement to close on Friday if severe weather conditions transpired as predicted.

6.4 Snowfalls

Overnight on Tuesday and into Wednesday, significant snowfall was experienced in many parts of the country, particularly the eastern and southern regions, with accumulations of 5cm to 30cm being reported.

At 05:00hrs on Wednesday, 28 February 2018, Met Éireann issued a RED Level warning, initially for the south and east regions, signalling wind speeds of up to 110km/hr allied with further heavy snowfall in addition to that which had already accumulated in regions across the country. This was the blizzard conditions which had been anticipated. The warning was scheduled to come into effect from 18.00hrs Thursday and to remain in place until 06.00hrs Friday.

Reports from around the country on Wednesday morning described the significant impact of the overnight snow, with amounts higher than had been initially anticipated. Transport networks in many regions were impacted and conditions on roads were described as being very difficult.

A full winter maintenance programme was being implemented by the motorway operators and the local authorities, with salting of priority routes enabling traffic to continue to flow with care on these routes. The public transport services were impacted to varying degrees, with school transport, inter-city and the regional local link bus services affected in the areas with the worst snowfalls. Flights from Dublin Airport were also being diverted. With snowfall accumulations significantly impacting school transport, many schools made the decision locally to close that day.

Later on Wednesday, Met Éireann extended the RED Level warning to cover the entire country, and extended it to be effective until 09:00hrs Friday. Having considered the forecasts, and the possible public safety impacts of blizzard conditions, the NECG made a decision to issue a “Stay Indoors” advisory, with effect from Thursday at 16.00hrs until the blizzard had passed on Friday morning. This was reversing the previous objective of keeping the country open in so far as possible. People were advised to be home by 16:00hrs on Thursday afternoon, and to remain indoors until such time as the RED Level warning had been lifted in their area. In the early hours of Thursday morning a RED Level warning for Snow-Ice was issued for all counties by Met Éireann from 23.00hrs Thursday, extending to Friday at 15.00hrs.

Local authorities worked with Non-Government Organisations to ensure that the most vulnerable in such conditions, such as rough sleepers, had shelter available. Outreach teams worked through the night to ensure all rough sleepers had the option of coming indoors. Wednesday night saw 106 people avail of the additional temporary accommodation provided by the Dublin Regional Homelessness Executive.

The OPW indicated that a storm surge would accompany storm Emma and that this, allied with high astronomical spring tides, would bring the danger of coastal flooding on southern and eastern coasts, with Cork City particularly at risk.

On Thursday morning, 1 March 2018, the NECG received further reports of heavy snow showers throughout Wednesday night and Thursday morning in all areas, bringing accumulations of significant levels of snow, accompanied by strong gale force north-east winds, resulting in extremely treacherous driving conditions, with many roads impassable.

With public safety remaining the key concern, the NECG repeated its advice that people should arrange to be home by 16:00hrs on Thursday and informed the public that the closure of schools and public offices had been extended nationwide.

Transport networks and services were severely disrupted on Thursday with widespread delays and cancellations impacting most of the country. Local authorities worked with key stakeholders, including Transport Infrastructure Ireland (TII), to ensure that the priority road networks continued to be open for traffic.

6.5 Snow Storm Emma

The anticipated snow and wind associated with storm Emma arrived on Thursday night. On Friday morning, 2 March 2018 Met Éireann advised that, although snow would continue, the wind storm giving rise to the blizzard conditions had passed. The public safety advice issued by the NECG to shelter indoors was withdrawn at 07.30hrs on Friday morning. However, Met Éireann's RED Level snow warning remained in place on Friday morning for Munster, Leinster and County Galway. An Orange Level warning was in place in the rest of the country.

Roads in many areas of the east of the country were impacted by the blizzard conditions and became impassable

Heavy snow continued to fall, particularly in eastern counties over the course of Friday. Although the “Stay Indoors” advisory was withdrawn because the blizzard conditions had passed, the public were urged not to travel because road conditions were very difficult and dangerous. While public transport remained non-operational throughout Friday, local authorities and Transport Infrastructure Ireland worked at the task of keeping priority routes clear. However, as snow was falling heavily, this required a continuously repeated ploughing and gritting process on the same roads. Over a 24 hour period, local authorities worked to full capacity and gritted over 24,000km of roads and spread 6,000 tonnes of salt. Notwithstanding these efforts, it was highlighted that local roads would take significantly longer to clear. Transport operators monitored progress with the intention of restoring as many services as possible on Saturday.

Irish Water continued to monitor the evolving situation with some incidents of disruption beginning to emerge.

Local authorities continued to work with homeless NGOs and volunteers to keep as many rough sleepers as possible indoors in shelter. In addition, teams worked with the HSE on the streets and in the extra accommodation to ensure that individuals were engaged with and their medical needs assessed. On Friday, it was reported that all rough sleepers in Dublin, other than nine individuals who chose not to avail of accommodation, were being catered for. Those staying outdoors were provided with extra facilities and were monitored on an hourly basis by the outreach teams.

On Friday afternoon, Met Éireann revised its RED Level snow warning, restricting it to cover Meath, Kildare, Dublin, Wexford and Wicklow only. Yellow and Orange Level weather warnings remained in place for the rest of the country.

By Saturday morning, 3 March 2018, the very heavy snowfalls which storm Emma had brought since Thursday began to diminish. While some further snow showers were expected during the course of the day, Met Éireann advised that storm Emma was ending and that it had displaced the Siberian air which had held the country in a frozen grip since the beginning of the week.
With conditions remaining very difficult in many parts due to heavy snow accumulations and drifting, the public were advised to exercise high levels of caution for their own safety, and that people who intended to undertake essential journeys needed to take account of circumstances locally before deciding to undertake those journeys.

The priorities for the emergency management services at this time were:

- to ensure that emergency services could respond in areas where conditions were most severe,
- to facilitate the utilities and essential services,
- to open the priority road networks, and
- to get public transport operational again.

Reports from the utilities, including ESB Networks and Irish Water, indicated a number of issues countrywide and they were endeavouring to resolve these on a prioritised basis, with assistance from local authorities and Defence Forces. By Saturday evening, ESB Networks reported that 14,000 premises were without power, primarily in the

Wexford area. Irish Water reported that there were 13,000 customers without supply, again primarily in the Wexford area. Restricted supplies and boil water notices were in place with the public requested to conserve water and not to leave taps running.

6.6 The Thaw

With the passing of storm Emma followed by a gradual rise in temperatures, the situation on the road network began to improve in many areas. Local authorities continued to work to progress the clearance of badly blocked roads and hired in all available contractors to assist. They also appealed to communities to clear footpaths and to people with tractors and machinery to begin the arduous task of digging out the high drifts of snow which were blocking many roads.

There was some concern initially relating to the thaw and the potential for localised flooding from meltwater, especially within steep and high catchment areas. People in urban areas were advised to be vigilant regarding blocked gullies and drains leading to increased risk of flooding due to meltwater.

6.7 Getting Back to Normal

With the thaw progressing on Sunday, 4 March 2018, the NECG continued to co-ordinate efforts at the national level to get as much as possible of the country back to normal, although Monday's commute was expected to be a difficult undertaking for many. The public were advised to use public transport where appropriate. All agencies continued to work flat-out on Sunday to restore services. Schools checked their premises on Sunday, as well as linking with school bus operators, to make a decision about opening on Monday. From reports received, it was considered likely that many schools would reopen, but those in worst affected areas of Wexford, west Wicklow and north Kildare would remain closed on Monday.

While the motorway and national primary road network was maintained open, all available machinery was pressed into clearing snow drifts on regional and local roads

While the general intention was that Government Departments, Offices and Agencies were to open on Monday, some decisions to open would be appropriately based on local conditions. Employers and employees were requested to consider staggering opening and start times to reduce peak volumes of commuter traffic as well as to consider the option of working from home. Acknowledging that some employees would not be able to travel due to local conditions, the NECG asked for flexibility and understanding from employers in this regard.

As Sunday progressed, public transport services resumed with most services getting back to normal over the course of the day, although services in the southeast continued to be restricted. The motorway network was fully operational with some difficulties on a short stretch of the M7 between junctions 9 and 10 being addressed during that evening and night to ensure that the carriageway was fully operational on Monday morning.

Utilities were working also to restore all services. ESB restored power to 6,000 customers in the Wexford area, with assistance from the local authorities. Irish Water reported around 18,000 premises without water, of which over 11,000 were in the Wexford area, and another 66,000 people had restrictions to supply. Irish Water's main

concern at this stage was the increase in demand across the country which was putting severe pressure on water treatment plants, with the Greater Dublin area seeing an increase in demand of over 10% from Friday to Sunday, partly driven by increased leakage. Similar issues were occurring elsewhere with the potential of needing night-time restrictions as a counter-measure.

In relation to Health services, the National Ambulance Service (NAS) received over 1,000 ambulance calls over the period and responded to all. All outpatient and day surgeries were expected to resume on Monday, apart from some in areas still experiencing travel difficulties. All non-elective surgeries were cancelled for Monday. Demands on Emergency Departments increased significantly due to an increase in injuries arising from slips and falls.

6.8 Restoration of Normal Activity in Worst Affected Areas

Most parts of country returned to normal as the thaw removed snow, particularly in urban areas. On the roads network, all motorways and national routes were cleared of snow, with efforts then switching to secondary routes and commuter routes into urban centres.

In the areas worst affected, many local and rural roads remained inaccessible for the remainder of the week following the snowfalls, notwithstanding on-going efforts to restore all routes by local authorities and the significant work of local communities themselves. For instance, as of Monday, 5 March 2018, approximately 50% of local and rural roads in Wexford remained blocked with high drifts of snow. 3,300 local authority staff worked on the clean-up and clearance effort, supported by up to 350 Civil Defence volunteers on a daily basis. 2,637 Defence Forces personnel, together with 789 vehicles were also deployed on 618 tasks to assist local authorities principally in west Wicklow and Wexford. Local authorities directed spare capacity to worst affected counties in order to assist with the response in these areas and the restoration of essential services.

In the south-east and parts of Kildare, schools and colleges remained closed for most of the week after the snow as roads were cleared.

6.9 Impacts of Heavy Snow across the Sectors

6.9.1 Local Authorities

Local Authority public offices were closed by the severe weather events. However, critical services were maintained. Local authorities also hosted and operated the Local Co-ordination Centres where the Principal Response Agencies and others managed the local response to ensure the impact in each area was reported and actioned appropriately. As well as local coordination, they also maintained 'vertical co-ordination' through communication with the National Emergency Coordination Group.

Providing situation updates and information for the public was of primary importance and local authorities were proactive on both local and on social media, with advice being provided on conditions as well as information on transport and road disruption and restoration.

6.9.2 Other Principal Response Agencies

The normal operations of An Garda Síochána and the Health Service Executive were also impacted by the storms. However, they participated with local authorities in Local Coordination and Response Management structures.

The severe weather events had a huge impact on all HSE services. Nonetheless, essential services were maintained throughout. Ambulance services and access to priority patients continued to be provided, albeit with great difficulty in some cases. Response times were extended in many cases, and in some cases required the assistance of the Defence Forces and other services. HSE Community services were severely disrupted also.

The issue of emergency and essential services staff welfare is discussed later in Section 9.8.

6.9.3 Transport

Severe disruption was caused to the transport sector by wind and snow with road, rail, sea and air services all impacted. However, preparation for the two events and the

response of all the transport agencies was managed proactively by the Department of Transport, Tourism and Sport. The Department worked with key stakeholders, including Transport Infrastructure Ireland, the National Transport Authority and public and private transport service operators to ensure that all available resources were deployed in maintaining joined up services and getting Ireland moving again as the weather events passed.

Communication on the availability of services to users was prioritised and was managed through national, local and social media. The Department of Transport, Tourism and Sport worked with the business sector, the HSE and local authorities regarding the prioritisation of key emergency routes and supply nodes.

The transport sector engaged external contractors and other Government agencies in order to facilitate the mitigation of problems as they arose during this difficult period. Motorways and National routes were prioritised with additional resources deployed to enable key artery roads to remain open. On the motorways, 24/7 operations were undertaken in extremely difficult conditions throughout the period 27 February 2018 – 3 March 2018 which ensured that no motorways were closed. To achieve this, the number of winter fleet drivers used on the motorway network was increased from a normal level of 81 to 236 for the duration of the storm. Furthermore, adequate supplies of salt were in situ in advance of the storm as a result of the salt procurement and management measures implemented by Transport Infrastructure Ireland following the severe winters of 2010. These resilience measures meant that the availability of salt was not an issue for the duration of the storm.

There were no significant restrictions on the motorway network for the duration of storm Emma. The motorway network was operational throughout and following the storm event. While some sections were reduced to one lane during the most severe snowfall, the capacity at all times well exceeded traffic demand. Some issues that did occur on the motorway network arose from vehicles becoming stranded, because they couldn't exit the motorway junctions onto the connecting roads. In relation to the M7 between Naas north and Naas south (between junctions 9 and 10), roadworks at this location meant that there was no hard shoulder available and ploughed snow was stacked

immediately adjacent to the road edge. A problem arose overnight on Saturday 3 March 2018 and into Sunday morning caused by melting/ collapsing high snow banks impinging on the verge-side lane in the north-bound direction, resulting in single lane running for a period at this location. The single lane was more than adequate for the limited traffic demand on Sunday morning. Potential problems at this location were identified as a risk item in advance of the storm and two excavators were on standby to clear the snow from the verge if necessary. The length in question was less than 500m and the problem was resolved with Garda assistance early on Sunday afternoon by reverse ploughing this section into the median and it was not necessary to use the excavators.

Airports were significantly impacted by storm Emma. While Dublin Airport Authority had snow-clearing vehicles and salt stocks in place, the intensity of snowfall from Wednesday 28 February 2018 through to Friday 2 March 2018 led to large-scale diversions and cancellations of flights. By Saturday 3 March 2018 most flights had resumed. Other airports experienced similar impacts.

After the snow, Saturday 3 March 2018 saw many of the affected transport services starting to resume, with curtailments confined to areas which were particularly adversely affected by heavy snowfall. Communication of information to the public on the availability of services was again prioritised. By Sunday, 4 March 2018, many services were back in operation and, on Monday, the vast majority of transport services were operational. Dublin Bus operated a full service, albeit with some local curtailments off the main routes. Customers were advised to allow extra time for all journeys. Bus Éireann operated the majority of services with some curtailments, principally in the south-east. Airports and Ferry Services were operating as normal.

In relation to public transport services, it is important that there is an understanding of lead-in times which need to be factored into the timing of decisions to withdraw or to restart services. The safety implications and time required for drivers and other staff of public transport organisations to get to and from their depots needs to be considered.

6.9.4 Education Sector

Schools, third level institutions and childcare facilities were severely impacted. During the snow, they began to close across the country from Wednesday, 28 February 2018, following significant levels of snowfall on Tuesday night.

Bus Éireann schools transport also ceased to operate during this period and this had a major impact on schools. A decision was made by Department of Education and Skills on Wednesday, that in line with the weather forecasts, and given the ground conditions following snowfall on Tuesday and Wednesday, that all schools in areas affected by the RED Level warning would remain closed on Thursday 1 and Friday 2 March 2018.

On Sunday 4 March 2018, as an Orange Level weather warning was in place and as the thaw continued, decisions regarding the opening of schools on Monday 5 March 2018 reverted from the Department to Principals and Boards of Management operating on local assessment of conditions.

6.9.5 Business Sector

Based on weather forecasts received from Met Éireann, employers were advised via Department of Business, Enterprise and Innovation on Tuesday 27 February 2018 to start planning with employees to make alternative working arrangements, taking account of the travel conditions anticipated for later in the week, including the possibility of working from home where possible. The intent at this time was not to close down the country and people were advised to attend work before any, as yet unconfirmed, RED Level warning came into effect. People were also advised as an alternative to wait to travel to work until after any RED Level warning had been lifted or local conditions had cleared and it was judged that the journey to work could be undertaken safely.

However, as the week progressed and the extent and likely impact on public safety of the approaching severe weather became clearer, the NECG issued a statement on Wednesday 28 February 2018 advising that, given the serious and potentially life threatening conditions expected to be posed by blizzard conditions, all persons in areas where the RED Level warning was in place should be indoors from 16:00hrs Thursday,

1 March 2018, and remain indoors until the RED Level warning was lifted on Friday. People were advised not to go to work over this period, with only key emergency personnel and essential services like food delivery personnel asked to work. With the exception of the blue light services, staff were deployed on a case-by-case basis following risk assessments of local weather conditions.

6.9.6 The Agriculture Sector

Farmers, because most of their work is outdoors, are particularly vulnerable to severe weather conditions. Farmers were advised not to work on securing buildings or shed roofs during storm conditions or to go outside to tend to animals during blizzards. Unfortunately two farm fatalities were recorded in the aftermath and repair phase after Ophelia in 2017. On 21 October 2017 a farmer in Wicklow fell from a ladder while securing a shed roof damaged during the storm and sustained fatal injuries. On 22 October 2017 a farmer in Cork fell from the bucket of a loader while attempting to secure roofing sheets damaged by the storm.

6.9.7 Homelessness

Those sleeping rough are particularly vulnerable during severe cold weather events. Early, proactive intervention by state and NGO services on foot of weather warnings saw the provision of additional emergency beds from early in the week beginning 26 February 2018.

Local authorities in the main urban centres of Dublin, Cork, Galway, Limerick and Waterford maintained all cold weather initiatives for rough sleepers in place and additional capacity was put in place to ensure that there were additional bed spaces available for rough sleepers who would not normally avail of homeless services.

7. HOT WEATHER AND DROUGHT CONDITIONS – JUNE - AUG 2018

7.1 Weather

The summer season of 2018 was unusually dry and warm. Settled weather developed in the middle of May and continued through June and for much of July as an exceptionally dry Scandinavian air mass dominated most of Europe.

Very high temperatures (for Ireland) were recorded in late June and early July (described as heat-wave conditions). A heat-wave is defined as 5 days with temperatures over 25 degrees and drought is defined as a period of 15 or more consecutive days, on which no significant rain fell.

Temperatures peaked during the week ending 29 June 2018 with temperatures reaching 32° Celsius at Shannon Airport. During July temperatures were less extreme ranging in the low to high twenty degrees Celsius. Throughout the summer period night-time temperatures remained within normal ranges, which lessened the potential for impacts on public health.

Drought conditions were recorded across the country from late June onwards. Despite the temperatures having fallen back in July, rainfall amounts remained well below average for the summer season in midland Southern and Eastern regions. This meant that there was little or no alleviation in the drought conditions in these areas.

Soil moisture deficit is a measure of how much rainfall would be required to restore moisture levels in the soil to field capacity. The soil moisture deficit remained very high in those parts of the country where drought persisted, typically in the range of 70 to 100 mm, with the highest deficits recorded in the east and southeast regions.

These drought conditions were reflected by reduced flows and falling water levels in rivers, lakes and groundwater, with many rivers reaching their lowest levels on record. Sustained rainfall is necessary during autumn and winter to restore both lake and groundwater levels and river flows to near normal conditions.

The 2018 weather event is comparable to the summers of 1995 and 1976. The features in common include low rainfall from late spring/ early summer and high temperatures from late May - early June onwards.

Water temperatures in rivers and lakes were significantly higher than normal during June and July, adversely affecting fish and aquatic life at some locations.

7.2 Impacts of High Temperatures/ Prolonged Drought

From an emergency management perspective the main feature of this weather was the absence of rain, resulting in a prolonged period of drought – particularly in the east of the country. D/HPLG recognised that a level of national co-ordination was necessary in mid-June. While the threat posed by this crisis did not meet the threshold necessary to warrant National Emergency Co-ordination Group response, the NDFEM opted to activate weekly situation review group/ coordination meetings to ensure that all relevant sectors were engaged and working together and to anticipate any potential escalation in the crisis.

Initially, links were made with Irish Water and the Department of Agriculture, Food and the Marine (DAFM). The co-ordination was formalised on 4 July 2018 when the Department convened a situation review meeting at which it established two sub-groups to deal with 1) water supply/ wastewater and 2) Environmental Air Quality (as a consequence of wildland fires). At the first situation review meeting of Departments and relevant agencies convened on 4 July 2018 in NECC, D/HPLG established the following objectives:

- Maintaining water supplies;
- Preventing wildland fires and supporting fire service response;
- Monitoring environmental impacts / water quality;
- Managing the effects on watercourse and inland fisheries; and
- Anticipating the effects in the agriculture sector (crops yields, grass growth and fodder supply).

Staff in the National Directorate for Fire and Emergency Management (NDFEM) also met with local authority Chief Executives on 3 July 2018 to engage on public safety issues relating to drought and heat-wave, including:

- wildland fires being responded to by local authority fire services;
- water safety via provision of life-guard service, lifebuoys, promotion etc.;
- caring for homeless persons; and
- water supply in conjunction with Irish Water.

Extensive smoke from wildland fires can impact very significantly on air quality of urban populations, in particular endangering those who are susceptible to chest conditions

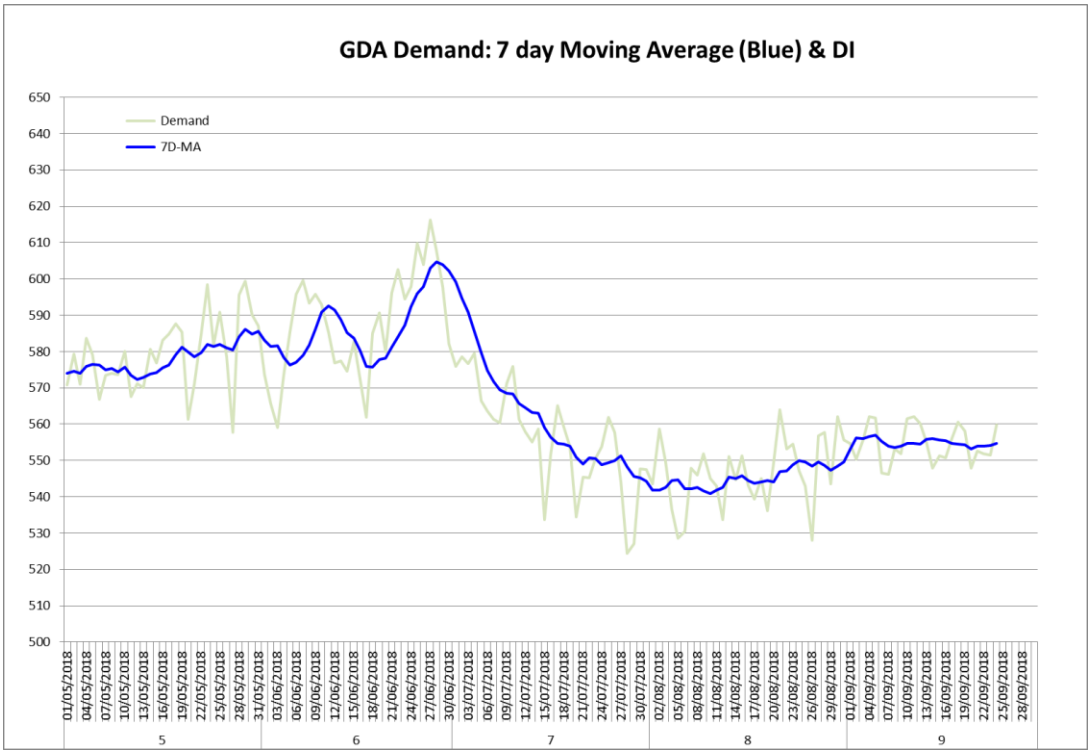
7.3 Water Supply

It was clear from the start of the drought that the single biggest challenge arising from these conditions was maintaining drinking water supply across the country. Irish Water activated its internal crisis management system from early June 2018, to manage an increasingly difficult and evolving situation.

The Irish Water Crisis Management Team began work as soon as this warm weather came into view in June, monitoring both demand and water supply production capacity

around the country. Countermeasures were activated where supplies were at risk. Initially, demand for water increased across the country. Irish water introduced water restrictions on supplies at risk and intensified a public campaign urging that customers conserve water. Irish Water introduced a Water conservation order (ban on the use of hose pipes in domestic settings) with effect from midnight on 5 July 2018, urging people everywhere to conserve water - section 56 (16) of the Water Services Act 2007. Water pressure was reduced in many areas at night to further conserve water supply.

The public responded well to the request for conservation and daily demand levels were reduced significantly. Consumption dropped from a peak level of 600ML per day to 545 ML in the Greater Dublin Area over July and demand remained at this level through August 2018. This demonstrated the effectiveness of Irish Water's focussed management of the crisis, in combination with a very positive public response. The conservation orders remained in place on a National basis until 31 August 2018 and in specific regions until 30 September 2018.



ESB worked closely with Irish Water throughout the summer to monitor flow levels and ensure that priority was given to maintaining levels for water abstraction, while ensuring compensation flows were maintained. Where the question of reducing compensation flows below levels set out in legislation for the Liffey, Shannon and Lee river system

was raised it was not necessary to modify compensation flows to maintain public water supplies during this crisis. However, the work completed in modelling the requirement to alter compensation flows and the data gathered will be helpful should a similar shortfall in raw water occur along these catchments in the future.

Local authority staff were deployed to identify and fix leaks, and Irish Water mobilised additional crews at critical locations to support local authority efforts.

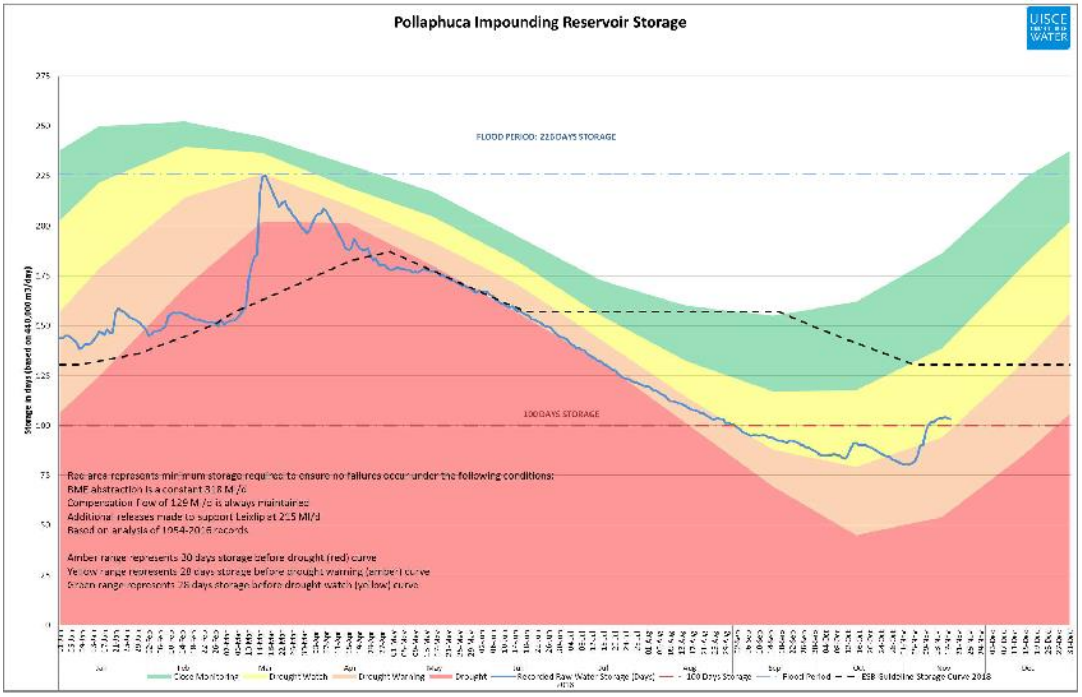
It was necessary for Irish Water to put alternative water supply and distribution arrangements in place for schemes that could not meet demand due to the severe drought conditions. Irish Water implemented their Drinking Water Incident response plans to provide supplies of water to customers in schemes affected by drought conditions.

The agriculture community and those with their own wells were also affected, as groundwater levels in aquifers declined. The National Federation of Group Water Schemes issued advice on conservation measures, working to support its members on the ground.

7.4 Poulaphouca Reservoir

Poulaphuca reservoir provides 50% of the drinking water supply for the Grater Dublin Area. It is managed by ESB as a Hydro-electric generating station and is a key component of water supply infrastructure for Irish Water.

The water level in Poulaphouca reservoir was recorded as being status Red from 10 July (meeting of water subgroup). This indicated that, based on seasonal patterns, the threshold of less than 100 days water supply would be reached if significant rainfall did not occur in the upper Liffey catchment. This continued to be the case, as the graph of the water level at Poulaphouca continued to follow the Red line level. The water level at Poulaphouca continued to fall into mid-September although the rate at which it was falling slowed from mid-August. ESB and Irish Water continued to monitor the water levels at Poulaphouca. While seasonal rainfall is expected to replenish the reservoir level in late autumn and into winter, it can take several months for the water level to return to normal.



7.5 Wildland Fires

The lack of rainfall and high temperatures led to very dry conditions in forest and wildland areas across the country from May onwards. These conditions increased the risk of fires and the potential for rapid fire spread due to the availability of highly combustible dry vegetation and peat and grass. On Tuesday 26 June 2018, the Department of Agriculture, Food and the Marine issued a national condition RED Wildland Fire Danger Notice in response to the drought resulting from the warm weather event; this was extended repeatedly as drought conditions persisted.

Fires on Bray head in Wicklow (above) and below fire services working with the Air Corps helicopter to contain the fires

Local authority fire services were responding to over 160 wildland fire incidents every day at the peak of the hot spell. This level of activity was twice the number of incidents fire services would normally respond to every day. This put severe pressure on fire services, particularly retained (part-time) services. Fighting wildland fire is hazardous and leads to high stress and fatigue of fire crews due to working conditions and the duration of these fires. Incident Commanders exercised a high degree of vigilance and risk assessment to ensure the safety of crews tackling these fires. Life risk and public safety were prioritised. It many instances where there was no immediate threat to buildings or public safety a defensive approach was adopted in managing the incidents.

Local authority fire services liaised closely with Coillte, National Parks and Wildlife and with communities themselves in managing wildland fires, assessing threats and co-ordinating response efforts.

The sustained assistance of the Air Corps enabled many fires to be brought under control quickly and safely

The assistance of the Department of Defence, who provided Air Corps helicopters to assist with wildland fire-fighting, enabled many wildland fires to be controlled and extinguished much more rapidly than would otherwise be the case. Many Incident Commanders noted that, even when Air Corps were only available to attend for a brief

period, the fire suppression was very significant and this was greatly appreciated by the fire services.

The experience of Summer 2018 strongly supports the development of aerial fire-fighting capability. Subject to exigencies and availability, the Air Corps may provide a helicopter fire-fighting service at the request of local authority Chief Fire Officer. The current procedure between the local authorities and NDFEM on one side and Department of Defence and Air Corps on the other for activating, mobilising and prioritising deployment of the Air Corps worked smoothly over the extended period. The Air Corps were also deployed to Northern Ireland on a number of occasions to support Northern Ireland Fire and Rescue Service with wildland fire-fighting. This was managed by the Department of Defence with input from, D/FAT, D/HPLG and the Aeronautical Rescue Co-ordination Centre, UK.

A review undertaken under the aegis of the Department of Agriculture, Food and the Marine indicated that the experience of Air Corps involvement and its contribution in wildland fire fighting was viewed very positively by all involved. While recognising that the service provided by the Air Corps is on a 'good-will' basis and may not be available at all times, this positive experience provides a basis for recommending that an assured capability for aerial wildland fire-fighting should be developed further. Coillte have an arrangement in place with a private helicopter fire-fighting contractor. Further consideration needs to be given to the options, subject to understanding the roles and capability of the Air Corps. The other major source of helicopter assets in Ireland is the contractor to the Irish Coast Guard which operates a fleet of heavy lift helicopters. However, it may not to be appropriate to use dedicated search and rescue assets for wildland fire-fighting. However the possibility of these assets being tasked to rescue persons trapped by wildland fires is one that needs exploration.

The experience of the recent wildland fire seasons is that preventing wildland fires from starting is an essential strategy, requiring a cross-sectoral approach. Controlled burning is banned during high risk periods. The provision of guidance through the news media and social media highlighting the threat posed by wildland fire is key to reducing risk. People enjoying recreational activity in the countryside need to be reminded of their responsibility not to light fires and to behave in manner that is safe. Fire services and NPWS staff observed some examples of careless behaviour throughout the summer season (discarding of matches and cigarette ends, outdoor fires and BBQs in wooded areas etc.).

Preventing wildland fires from starting, such as through careless discarding of smoking materials became a key focus

Farmers suspended controlled burning and also provided assistance to fire services, tankering water for fire service operations and using slurry tankers to moisten dry areas of vegetation along defence lines where wildland fires were being stopped. Wildland fires are not just a problem in remote rural areas. Fires can occur in urban areas and smoke from fires can impact on urban populations also. EPA, Fire Services, HSE, D/Health, D/HPLG and D/CCA&E worked actively to anticipate issues that might arise for persons affected by air pollution from plumes of smoke generated by wildland fires. A number of areas of high population were at risk during the drought with the potential for an increase in the levels of people presenting to GPs and A&E with symptoms of respiratory illness. Any medical condition that affects a person's breathing can be potentially life threatening. The group developed an agreed approach to sharing information on monitoring and response, building on the individual work underway in each agency. HSE and EPA worked to ensure that GPs and public health medical staff were made aware at the earliest stage possible of any deterioration in air quality in their area.

The Fire Services Ctrí mobilisation and communications project was tasked to develop a real-time national fire reporting system and this was brought on line to provide detailed information/ national intelligence on the patterns of wildland fires for NDFEM and the review co-ordination group. This information provided a clear picture of wildland

fire activity and fire services response operations. Ctrí also co-ordinated the suspension of controlled burning in all regions during the RED warning period with the D/AFM.

Overall, the level of collaboration between local authority fire services and National Parks and Wildlife Service, Coillte, Civil Defence and the Defence Forces during the wildland fire season was another illustration of the embedding of effective co-ordination among agencies involved in emergency response.

The aftermath of wildland fires (above)

A burned-out vehicle which went off the road in thick smoke, illustrating the life safety dangers which wildland fires pose

7.6 Water Safety

Water Safety Ireland (WSI) were active from the beginning of the drought and continued a proactive campaign of water safety awareness over the summer period.

WSI data indicates that risk of drowning increases when warm weather occurs early in the summer. The water temperature is still relatively cold in early summer and the risk of succumbing to “cold water immersion” is increased. There is a tendency for people used to swimming in a swimming pool to overestimate their swimming ability and skills in open water and to underestimate the risk to their own safety.

WSI attended the situation review meetings convened by D/HPLG. At the first meeting WSI briefed the group and outlined how the public information campaign would be extended to deal with the level of risk and this was supported strongly by the co-ordination group.

Campaigns ranged across radio, social media and billboards nationwide, targeting those most at risk. WSI are strongly of the view that the extended public safety campaign and the co-ordinated response had a significantly positive effect on water

safety over the summer period. The strong public awareness campaign allied with an earlier than normal deployment of the Lifeguards improved water safety over the summer. All the drowning fatalities recoded in summer 2018 occurred in non-designated bathing areas. WSI undertook a campaign of radio and TV Interviews during the bathing season, and also engaged with print and social media journalists. This work also contributed to raising public awareness in terms of preventing drownings.

Table

Drownings in month of July 2013 - 2018

Year	2013	2014	2015	2016	2017	2018
Drownings in July	15	7	8	5	9	5

Following the meeting on the 4 July 2018, Met Éireann worked with WSI to arrange a direct link from www.met.ie to www.watersafety.ie assisting with the promotion of water safety and drowning prevention.

Lifeguards working at designated bathing areas had a very busy season with many positive interventions as can be seen in the figures given in the table below – It is estimated that up to 241 lives were saved through Lifeguard intervention during the bathing season.

Activity	**Number**
Rescue	241
First Aid	3,462
Lost Children	304
Other Incidents	8,438

7.7 Environmental Issues

The drought conditions led to record low flows being recorded in river systems across the country. As the flow in rivers reduced, the potential environmental impacts increased. The OPW and EPA used the estimated 95 Percentile water level and flow statistic as a monitoring threshold. The estimated 95 Percentile flow in particular is an important low flow figure, as the assimilative capacity assessments for wastewater and other discharge licences are derived from this figure i.e. discharges take account of the estimated 95 Percentile flow when considering the available dilution. Therefore, the risk of impact on the receiving river ecology is greater when flows fall below the estimated 95 Percentile threshold. Similarly, if water is abstracted from a river when the flow is below the estimated 95 Percentile then the assimilative capacity reduces and therefore the risk of impact on the river ecology is greater. The maintenance of compensation flows on the Liffey, Lee and Shannon prevented this from becoming an issue for those river systems.

At the peak of the drought 61% of relevant river gauging stations recorded flows below the estimated 95 Percentile threshold. This reduced from late July onwards with a reduction to 22% of relevant river gauging stations recording below this flow by late

August. During the drought period the EPA, OPW, Irish Water and the ESB worked closely to monitor river levels, exchanging information and identifying high risk catchments through the water quality co-ordination sub-group. Lake water levels and groundwater levels started high because of the wet spring, and to a degree this buffered the impact of the drought, although water levels continued to fall towards their natural seasonal low point in early October. The 22% of rivers below the estimated 95 Percentile flow in late August was a notable improvement for the season, which demonstrates the importance of having ongoing monitoring of river flows and water levels.

7.8 Fisheries

During the period of the drought water temperatures exceeded 20°C, which is a critical level for native salmonid fish (salmon and trout). There were a total of 8 recorded fish kills from all across the country – the worst of which was on the Ollatrim river near Nenagh where approximately 15,000 fish were killed including over 10,000 lamprey – which are a listed species. Unauthorised abstractions for agricultural purpose (market gardens and grass crops) caused significant additional pressures on already depleted water courses. Fish passage was not possible on many rivers due to impounded weirs and low flows. Filamentous algal build-up also caused problems in many rivers especially for freshwater pearl mussels. With very low flow, licensed discharges were being released into rivers where the assimilative capacity was already compromised in a number of cases.

7.9 Conclusions

- The summer of 2018 recorded some of the highest temperatures in June and July and the period of drought was comparable to 1995 and 1976.
- The impact of the high temperatures on public health was not very significant due to the low humidity. The warm blocking high pressure circulated dry air from the western Atlantic. Night-time temperatures did not exceed 18°C. Met Éireann noted that if the warm weather had originated in the Iberian plateau/ North Africa (Spanish Plume effect) the high temperature would likely have been intensified by high humidity, which would have had a greater impact on public health.

- The prolonged period of drought threatened water supply in many parts of the country with the south and east being worst affected. The impact correlates with the recorded soil moisture deficits. The early activation of Irish Water's crisis management system and its sustained operation over an extended period, the LGD co-ordination structures, together with the implementation of the hose pipe ban and the response of the general public were essential to managing water supply over the summer season.

- The management of wastewater discharge became an increasingly difficult issue as river flows fell below the estimated 95 Percentile levels. Such flows were recorded for 62% of representative river gauging stations at the peak of the drought. IW, EPA, ESB and OPW coordinated and exchanged data on river flows and levels throughout the crisis. Water quality was monitored continuously by the EPA and Inland Fisheries Ireland (IFI). Where possible, action was taken to prevent harmful discharges, and enforcement activity was taken by EPA and IFI, as necessary. While there was some impact on water quality, particularly on rivers that fell below the estimated 95 Percentile flow, water quality was maintained within seasonal norms throughout the country despite the difficult conditions. Some fish kills were reported but given the conditions the incidence of fish kills were low and IFI adopted a proactive approach, prioritising vulnerable species at key locations. It will take some time to assess the longer term impacts of the drought on the aquatic environment.

- The Fire service experienced one the longest wildland fire seasons with an increase of 62% on call rates and corresponding activity. This was managed within the existing resources of the fire services with the assistance of the Defence Forces for aerial fire-fighting. Farmers helped also in remote rural areas by using slurry tankers to assist fire service operations. Fire services adopted a practical and risk based approach to wildland fire-fighting, prioritising life safety and allocating resources accordingly. Preventing controlled burning and fire breaking out as a result of irresponsible behaviour was a key part of the strategy in tackling the threat of wildland fires.

- A co-ordinated approach was developed at an early stage to air quality monitoring and dealing with the potential health effects of smoke pollution due to

wildland fires. Wildland fires threatened urban areas throughout the drought period. However, at no stage did air quality diminish to an extent that the Principal Response Agencies were required to consider shelter-in-place or evacuation advice for large urban centres.

- Water safety campaigns were extended throughout the heat-wave period. This campaign was seen to be successful in preventing drowning accidents, notwithstanding that there were a number of drowning's in the early stages of the heat-wave. Many local authorities appointed life-guards earlier in the season and extended cover at beaches to address the risk to public safety and this is to be commended.

8. CRITICAL INFRASTRUCTURE AND ESSENTIAL SERVICES

8.1 Critical Infrastructure

The loss of electricity and water supply was one most difficult impacts of the severe weather episodes for many of those affected. The task of maintaining power supply and water and telecommunications services, what are termed 'critical infrastructure' on which society depends, falls to the critical infrastructure operators – ESB Networks in the case of electricity and Irish Water. However, critical infrastructure extends beyond these two and transport infrastructure in all its forms – road, rail, marine and air – is also critical to the normal functioning of society. Given the proliferation of mobile phones and wifi, communications infrastructure is seen as vital to societal functioning also.

As well as consequential disruption and difficulties for many households, businesses and farms from loss of electricity supply, essential services and inter-connected critical infrastructure are also impacted. This can create what is essentially a 'domino' effect of cascading failure. Some facilities which house essential services are supported by generators and battery backup power supplies, however, such systems, especially battery back-ups, are not designed to operate for long periods.

Protection and restoration of Critical Infrastructure is a key objective of emergency management, and the Critical Infrastructure operators are core partners in the emergency management sphere and attend the National Emergency Co-ordination Group along with their respective parent Departments. Their assessment of threat, as well as their situation reports on damage and prioritisation and coordination of restoration efforts, are key issues in successful coordination of responses.

It was clear from the warning stages that ex-Hurricane Ophelia in particular would cause severe disruption to the electricity supply network. Blizzard and snow conditions associated with storm Emma also were expected to damage the network and to pose additional restoration challenges. But lesser events can also impact, and Orange level events, such as storms Brian and Dylan are also seen to have impacted, but on a lesser scale.

In the immediate aftermath of the storms, ESB Networks worked with a range of agencies including the HSE and Irish Water to ensure that vulnerable people were prioritised. ESBN worked very closely with Irish Water in the recovery phase following

ex-Hurricane Ophelia to restore power to water treatment plants and group water schemes.

Notwithstanding the difficulties caused by loss of power supply, the co-ordinated efforts of these organisations is viewed as one of the key successes of the response to the severe weather.

8.2 Electricity Supplies and ESB Networks after ex-Hurricane Ophelia

The extensive disruption which was experienced within the ESB network due to the severe weather conditions associated with ex-Hurricane Ophelia is an example of Critical Infrastructure at the extreme end of the challenges faced.

ESB Networks have invested heavily in creating a resilient and readily managed electricity supply network and also evolved robust response plans for dealing with widespread power failures. They have had some experience of implementing these plans such as in the aftermath of storm Darwin in February 2014. These plans enable a systematic response to ensure that maximum number of customers can be reconnected in the shortest period possible.

In the first full day after Ophelia, efforts were initially focussed in the affected areas on patrolling the damaged network to make it safe. The process of damage assessment and repair planning is undertaken initially. ESB Networks prioritised their post-storm work on the following basis:

- Dangerous situations
- Customers with known medical needs
- Key infrastructure such as water installations, communications installations, hospitals, schools and Garda/ security installations

ESB Networks had mobilised their Storm Emergency Management Team as soon as the initial warnings of Ophelia were received. In the aftermath, detailed resource plans were developed by the Storm Emergency Management Team to ensure that the materials and skills were correctly assigned for each repair job. Staff in unaffected areas were relocated to affected regions. Over the course of the extended event, repair teams travelled in units from the northern part of the country to more damaged areas in

the south of the country. The deployed units were self-contained units that were equipped with skills and approvals to allow operation and repair of the network, with local controller permission.

ESB Networks (ESBN) had also established contact with the NEWSAC organizations and, once it was clear that the weather event would not impact other territories in the UK, those organizations committed to deploying staff to Ireland to aid the restoration effort. In total, 359 such staff were deployed to assist ESBN between 17 October and 25 October 2017.

At the NECG press briefing on Tuesday, 17 October 2017, ESBN committed to providing Estimated Restoration Times (ERTs) for all outages on the following morning (Wednesday 18 October). These ERTs were communicated through several methods including the ESB website and the Powercheck app. The initial ERT lists were published at 09:00hrs on Wednesday, October 18. In addition, a town-by-town report for the whole country was published and updated regularly. The public were requested—via traditional and social media—to contact ESBN and report any outage that was not logged on the Powercheck app. This dynamic process aided the restoration effort and helped to narrow the focus of resource allocation.

In the initial days, the response was planned to prioritize restoration for health service facilities, telecommunications sites, and water treatment facilities; ESBN assigned specific staff to manage the interaction and information exchange with these stakeholders.

A dedicated email address was established prior to the storm to allow all public representatives to lodge queries with ESBN for immediate response.
By the end of Wednesday 18 October 2017, 218,000 customers had been restored but 142,000 remained without power.

While the restoration effort was proceeding apace and supply being restored, operator and worker safety continued to be of paramount importance. Staff fatigue became a matter of particular concern due to working long hours in challenging conditions; this

issue had to be monitored and managed by the ESB's divisional managers and the SEMT.

An influx of external contracted staff from other regions of the country and overseas created a need for more accommodation. An army barracks in County Cork was made available and used for temporary accommodation. All visiting staff were inducted at the ESBN National Training Centre before being deployed to specific depots in the southern half of the country. This induction provided instruction on specific aspects of the ESBN system. On arrival at the assigned depot, a local network induction was then carried out.

The Army and Air Corps were engaged on Thursday 19 October 2018 to provide additional assistance for ESB in County Cork. Air Corps helicopters assisted by patrolling overhead networks damaged during the storm. This support supplemented the private helicopter resources that had been deployed over the first two days of the storm response. The Defence Forces also significantly assisted in the restoration effort by providing resources to deliver materials and clear fallen trees and debris that had impacted the network.

By the end of Thursday 19 October 2017, 113,000 customers remained without power. At this stage the affected areas narrowed primarily to the south of the country.

The communications effort for customers that were still without supply shifted from the national to local media sources. By the end of Friday 20 October 2017, 65,000 customers had been without power for five days and a program was initiated to attempt to communicate with the most vulnerable and isolated rural customers to ensure they were safe, had basic resources and were aware of the continuing restoration efforts and their ERT.

On Saturday, 21 October 2017 Met Éireann issued an orange weather warning in advance of storm Brian making landfall on the south coast. However, while there had been concern that it would make conditions too difficult to continue restoration work; this storm had only a limited impact on the distribution system and on ESBN's restoration efforts. An additional 7,000 customers lost power due to storm Brian. At this

point, all medium voltage (MV) network faults had been restored by crews and only low-voltage (LV) faults remained to be tackled.

However, though each of the thousands of remaining LV faults affected a small number of customers, they required significant resources, since the majority of LV faults were caused by trees falling on overhead lines. Staff fatigue and exhaustion continued to be an issue; the daily mandatory pre-work safety briefing concentrated on the dangers of working while fatigued. At various stages during the restoration effort, mandatory stand-down and work commencement times were enforced to manage the exposure of teams to long working days.

By the end of Saturday 21 October 2017, five days after the storm, 35,000 customers remained without power.

On Sunday 22 October 2017, approximately 5% of the remaining customers were still without supply. Forced rest periods were mandated for staff and work ceased at 19:30 in the evening. At the end of 22 October 2017, 3,000 customers remained without power. On Monday 23 October 2017, all reconnections were largely completed, and efforts continued to make permanent repairs to connections where supply had been restored on a temporary basis.

At this stage, roles and functions were normalized across ESB Networks. A limited series of post-storm network patrols on portions of the network where no outages had been recorded commenced to assess the likelihood of any unreported network damage. The overseas mutual aid teams completed their tasks and began to return home. A rest day for staff was mandated following their return to their base.

ESBN estimated that approximately €2 million worth of stock was used in the restoration effort including 2,000 poles, 350 km of conductor, and 250 medium or low voltage transformers.

A detailed communication plan was developed before and during the storm by the information management section of the SEMT. Before and during the storm, ESB Networks communicated important public safety messages. After the storm, the safety

messages were repeated continuously, as well as updates on the restoration effort through a variety of media including: television, radio, online video, partnerships with online news resources, search advertising, the ESBN website and blog, Twitter, Facebook, and other social media. ESBN estimated a total reach of approximately 30 million impressions during the storm and restoration period.

The news media were present in ESB Network's NDCC for the day of the storm (Monday 16 October 2017) and they were continually briefed on the storm's impact, restoration efforts, and public safety messages. As customers were restored and the affected areas were narrowed to the south of Ireland, local media were engaged for more localized messaging. It was essential to keep messaging focused and consistent across all media and the discussion topics were prioritized.

The Government were briefed on this aspect via the NECG and continuous information was also exchanged with key stakeholders, such as the relevant local authorities, health service providers, Defence Forces and other utilities via this forum.

While it is difficult in the extreme for any customer who is without power supply for up to a week, the situation assessment and methodical planning and preparation, the assembly and dispatch of resources, the development and dissemination of expected restoration times, the focus on public safety, the collaborative effort across organisations points to a highly effective post-storm electricity restoration campaign. Although nowhere near the scale of Ophelia in terms of damage to the electricity distribution network, this would have to be repeated, in even more difficult circumstances, after storm Emma. Access to the faults identified was problematic in the snow, and the assistance of local authorities and Defence Forces were required. The peak of disruption from storm Emma was on Friday 2 March 2018 when approximately 30,000 customers were without power. By the Sunday evening, most issues had been resolved with the exception of Wexford where 5,000 customers remained without supply. By Monday, supply had been restored to all.

The experience of loss of electricity highlights the need for resilience in other infrastructure providers as well as in households, farms and businesses.

8.3 Irish Water

Irish Water is the new national water infrastructure provider, taking over the water supply and waste water treatment plants and distribution networks previously operated by the local authorities.

The utility is at an early stage of its development but, like the ESB, its Crisis Management Team was mobilised in advance of the storms and oversaw the process of collating information on the impact of the storms on water supply and wastewater treatment facilities from their new National Operations Centre in Dublin, along with the Operations teams in each of its three regions.

The principal impacts on water and waste water treatment were caused by loss of power supply to treatment plants and pumping stations, highlighting the 'domino' effect. Pipeline bursts which couldn't be repaired until conditions were safe for crews and some direct damage to plant/ facilities occurred also.

Initial reports after Ophelia indicated that 137 schemes were affected by power outages, serving an estimated population of 331,500. Irish Water reported that this was made up of:

- 45 supplies serving 21,500 population with no supply (this rose temporarily to 50,000 but reverted as schemes come back on line);
- 92 supplies serving 310,000 population where storage was being depleted and which were in danger of losing supply entirely unless power could be restored by around midday Tuesday.

Counties worst affected by the outages and 'at risk' schemes were in Cork, Kerry, Wexford, Waterford, Kilkenny, Galway, Leitrim and parts of Westmeath and Cavan.

Irish Water and ESB Networks worked very closely to prioritise schemes for power restoration. In schemes where the ERT was further away, mainly in the south, the stock of available generators were deployed by Irish Water to provide a temporary power supply pending full restoration of mains service. However, in a number of areas, for example, Bandon, Innishannon, and Bennettsbridge, water supplies were exhausted. In counties Waterford and Cork in particular, a significant number of small borehole schemes were identified as likely to take longer to resolve.

A number of wastewater treatment plants and a significant number of sewage pumping stations were affected also by power outages, resulting in discharge of untreated or partially treated wastewater to receiving waters. As with drinking water, the number of installations affected was reduced as power supplies were restored. Towards the end of the week, six treatment plants were without power, with a further three relying on generators.

The Irish Water Crisis Management Team was maintained in operation until these issues were fully addressed. Their focus was on working with ESB Networks to prioritise schemes for power restoration, looking at options for supplies which might continue to be affected and making emergency supplies available with tankers where necessary.

Like ESB Networks, Irish Water worked to provide information and situation updates to communities affected and contacted vulnerable customers who needed support.

Water conservation messages were communicated throughout the severe weather events. Restricted supplies and boil notices were in place with the public requested to conserve water and not to leave taps running.

As is predicted at the end of severe cold spells, demand increases as extensive leaking outstrips supply capacity. Irish Water introduced restrictions (including pressure reduction at night) in the greater Dublin area as work to repair leaks continued for several weeks. As of Monday evening, 5 March 2018, 33,500 people remained without water supply, 48,000 were on restricted service and 3,000 were on boil water notices.

8.4 Impact of Storms Dylan and Eleanor on Critical Infrastructure

8.4.1 ESB Networks

Over the course of the early days of 2018, ESB Networks escalated to Orange Preparedness levels based on weather alerts received from Met Éireann for storm Dylan and storm Eleanor.

Storm Dylan had very limited impact on electricity networks, and normal preparedness and staffing levels for the holiday period were quickly resumed.

Storm Eleanor had a significant, but manageable, impact on electricity networks in the North West and across the north Midlands over the evening of 2 January 2018. Overall 150,000 homes, farms and businesses suffered a loss in electricity supply as a result of storm Eleanor on Tuesday 2 January 2018, predominantly in counties Mayo, Leitrim, Sligo, Galway, Cavan and Monaghan.

By midday on 3 January, most had their power supply restored but 16,000 customers remained without power as a result of the storm. An Orange weather warning for flooding and wind continued until 14:00hrs on 3 January 2018 and conditions resulted in further power outages at locations around the country. There were also impacts on the electricity network from lightning strikes in the mid-west and north-west throughout the day.

ESB Networks teams were deployed at 21:00hrs on Tuesday 2 January 2018 from less impacted areas of the country to help their colleagues in the worst affected areas. ESB Networks worked to restore all customers who lost power as a result of storm Eleanor by late on 3 January 2018 and by 23:00hrs that night, just 300 homes and businesses remained without electricity as a result of storm Eleanor.

ESB Networks were active also in reminding the public about safety issues associated with fallen wires and damage to the electricity network. Real time information on power outages and expected restoration times was made available on the PowerCheck App and on www.esbpowercheck.ie. Estimated Restoration Times for all electricity outages were available through this service. These were updated on an ongoing basis as more information became available.

The impacts from Dylan and Eleanor on the electricity network were in line with normal winter storm levels. The ESB Network's escalation for storm Eleanor commenced 24 hours in advance of the storm (19:00hrs 1 January 2018) and lasted for 48 hours with the resumption of 'Business as Usual' by 19:00hrs on 3 January 2018.

8.4.2 Irish Water

Irish Water reported that 12 of their water treatment plants had been affected by interruptions to power supply with 800 - 900 properties initially affected. Irish Water, working with ESB Networks, restored all sites on 3 January 2018.

8.4.3 Transport

Minor transport disruption was reported to road, rail and air travel with spot flooding, fallen trees and debris posing difficulty on some roads. Flooding on the Limerick to Ennis rail line and at Waterford railway station caused cancellation of train services for a short period, with alternative bus transfers in place. A number of ferry crossings on the Irish Sea were cancelled on both Tuesday 2 January 2018 and again on Wednesday 3 January 2018 due to the storms.

8.4.4 Communications

There were some telecommunications outages as a result of storm Eleanor on 2 January, mainly as a result of power outages. *Eir* had approximately 50 sites affected, mostly in Mayo, Leitrim, Cavan and Monaghan, but also some small scale outages in the Munster region. *Three* had approximately 71 sites affected, the worst affected counties being Mayo (19 sites) and Monaghan (18 sites). *Vodafone* had some localised service degradation with approximately 30 sites mainly across Monaghan, Leitrim, Cavan and Mayo losing power, although these sites were covered by backup power. As ESB restored power to these areas, the telecommunications issues were also resolved.

8.5 The Need for Critical Infrastructure Protection

The inter-dependence of critical infrastructure systems on each other as well as society's and individual business, farms and household's dependence on them is self-evident from the situations described in the preceding Chapters.

Within individual utilities, work has been undertaken to varying degrees to build resilient systems. Companies have also advanced significantly in developing crisis management systems, which enable them to anticipate and respond appropriately to evolving situations. The current levels of resilience of the networks and the developed competence of the crisis management systems was to be seen in each of the weather events described in this Report.

However, outside of development which has been undertaken within individual utilities, little work has been done to analyse the levels of interdependence or the threats posed by cascading failure of critical infrastructure. Nor is it just severe weather which poses a threat to our infrastructure – cyber threats also exist, as do broader fluctuations in international energy supplies.

There is a requirement to establish a national framework which establishes both a requirement for and a consistent risk management approach to be implemented by critical infrastructure operators, whether publicly or privately owned. This framework should extend also to the providers of essential services on which society relies. The kind of approach envisaged would include a combination of measures that balance protection of infrastructure, strengthened resilience and crisis management capability – enabling critical infrastructure operators and essential services to withstand and recover from adversity.

The issue of dams and associated threat of catastrophic flooding referred to in Chapter 4 is one that should be addressed under critical infrastructure

From an emergency management perspective, it is seen as vital that guidance developed in this area addresses:

- Definitions of Critical National Infrastructure and Essential Services;
- Provides consistent criteria to measure criticality;
- Maps Inter-dependency;
- Uses a systemic risk management approach to identify and mitigate threats;
- Links to National Risk Assessment and Risk Management;
- Provides for periodic reporting on the state of CIP in Ireland.

In early 2018, the GTF agreed to establish a subgroup on Critical Infrastructure Resilience (CIR) to be chaired by the OEP. This Subgroup was convened by OEP in February 2018. Membership of subgroup included representatives from all Departments who have responsibility for National Infrastructure.

The Terms of References and PID were developed by the subgroup and adopted by GTF. A Guidance document was drafted by staff from OEP and several iterations were circulated to the CIR subgroup to enable the methodology to be refined.

This Guideline adopts a risk based approach that is focused on the impact of the loss of services to Irish society. The Guideline's scope includes critical infrastructure assets owned and operated by the State, and of those operated by the semi-state and private sectors, usually under the regulation of an independent regulatory authority.

The Guideline aims to support LGDs, agencies and CIP operators on how best to identify and protect CI. The development of this guideline included research and engaging with international organisations. This helped shape the methodology to include resilience, and broad evaluation criteria that can be adapted to fit a wide range of sectors.

SEM Guideline 3 on Critical Infrastructure Resilience was approved by GTF on 20 February 2019. It was agreed that there would be a review of the Guideline in March 2020 with relevant LGDs, Agencies and other key stakeholders.

8.6 Identifying "Essential Services"

The effective closing down of the country for both ex-Hurricane Ophelia and storm Emma highlighted a number of issues for the first time. Non-essential public services closed for the days of the storms, but were fully operational again (unless directly impacted) immediately afterwards. The majority of commercial, office, business, and manufacturing also closed down following the public safety messages that were broadcast advising people in non-essential services not to travel to work during the period while RED warning was in place.

But what about essential services on which society also depends? What are our 'Essential Services'?

These include the institutions (hospitals, nursing homes, prisons, care homes) - operating on a 24/7 basis and caring for or detaining persons. However, essential services also include our food production and distributions services, as well as energy production and distribution, among others.

Ex-Hurricane Ophelia and storm Emma threatened to cause severe disruption to essential services, as these services depend on staff being able to travel to work. Many public sector organisations appear to have made individual arrangements for essential staff to attend work prior to the storms affecting their location.

The Strategic Emergency Management Guidelines 3 on Critical Infrastructure Resilience, developed and endorsed by the GTF in February 2019, sets out essential definitions and terminology on Table 1, including the definition of essential services as being defined as “those day to day services which are essential for the maintenance of vital societal functions, health, safety, security, economic or social wellbeing of the people.” However, other than in relevant Business Continuity Plans, it not completely clear how staff in such services can/ should be facilitated to attend work and what additional supports are needed when extraordinary circumstances disrupt normal working arrangements.

It is recommended that all self-evident essential services should codify their arrangements for the kind of circumstances which can arise with extreme weather events, including the staffing issues.

For public services, it is recommended that each Government Department should develop guidance relevant to its own sector which ensures that its essential services are identified from a Business Continuity Management perspective so that essential services can be maintained during periods of severe weather. Relevant issues which need to be addressed such as payments / time in lieu arrangements which may be necessary, to facilitate public service provision should also be developed and agreed within such Business Continuity Plans and may need to be further considered by Government centrally under the aegis of Department of Public Expenditure and Reform.

The aim should be to ensure an optimal outcome in terms of maintaining essential services, while retaining consciousness of staffing needs and public safety during severe weather events.

8.7 Food Supply

Snow-storm Emma brought forth issues related to food supply security for the first time in a generation. The fragility of food availability was demonstrated as people attempted to stock up before the snow event and tried to replenish their stocks in the aftermath. Availability of bread in shops was a particular high profile issue.

The Department of Business, Enterprise and Innovation liaised with the food distribution sector to manage issues arising from essential supplies of bread and milk. Information

on key food processing and distribution nodes were relayed to the relevant local authorities for inclusion in priority clearing of roads/ access.

The need to identify those working in both food production and distribution as essential services became clear in the aftermath of storm Emma.

8.8 Conclusions and Recommendations

The ‘domino’ effect, whereby loss of electrical power impacts on a range of other infrastructures was seen in both ex-Hurricane Ophelia and storm Emma. However, as noted previously, Ophelia was not a worst case scenario as it was not accompanied by the kind of flooding that could happen with this kind of storm and which would have generated a set of different problems which might have delayed restoration of critical infrastructure.

Nonetheless the operators of critical infrastructure worked very effectively, both individually and collectively, to restore services and maintain operations following ex-hurricane Ophelia and storm Emma. This was attributed to very strong pre-event preparations and planning for the response effort by operators. The co-ordination of efforts by utilities at the response stage was seen to very effective.

In terms of critical infrastructure, ESB Networks and Irish Water demonstrated both flexibility and resilience, working together to recover from the adversity which saw large

parts of their networks, and the persons relying on these, without service. The utilities undertook a range of measures to deal with the specific problems that arose across the country. The cooperation between ESB Networks, Irish Water, local authorities (and others) at both national and local level has been recognised as an example of the benefits of effective co-ordination.

The commitment of staff in the utilities and those of the local authorities who worked to restore services and to address the issues arising from the storms as quickly as possible was more than evident.

ESB Networks response to both ex-Hurricane Ophelia and storm Emma was a highly structured and well organised operation. The strength which its Storm Emergency Management Team brought to bear may be seen to have developed from previous severe weather exercises and storm events, including storm Darwin (Feb 2014). Its internal management of the response, its collaboration with a range of partner organisations and its coordination with other infrastructure providers, and working with public safety as paramount, is probably as close to an ideal as will be seen.

Both ESB Networks (ESBN) and Irish Water also put very considerable efforts into communicating with their customers and those left without service by the weather. Likewise, the multimedia approach to information provision and public awareness was exemplary. ESBN's approach encompassed traditional media as well as online and social media. The focus on public safety and how to report faults, as well as the production and dissemination of its Expected Restoration Times (ERTs) was first class. This work helped sustain the patience and forbearance of customers as they waited for restoration of service.

As a utility, Irish Water will be understood to be at a younger stage of its development than ESBN. Nonetheless, its Crisis Management Team demonstrated the same essential situation appraisal and resource management skills, with the objective of minimising impact on customers and the environment. Future investment in water treatment and waste water facilities and putting in place the kind of National Distribution Control Centre which ESBN has will enhance future resilience of the distributed water and waste water systems.

9. SOCIETAL RESILIENCE AND EMERGENCY SERVICES

9.1 Introduction

It has been a particular feature of all severe weather episodes in Ireland over the past decade that communities have shown a willingness to help themselves and their more vulnerable neighbours and to engage with responders to restore normality as quickly as possible. The approach of the Principal Response Agencies has been to work with communities to assist vulnerable and isolated people also. This 'self-help' attitude is regarded in emergency management literature as a very positive feature. Communities which are themselves involved in response and recovery efforts are seen to recover faster and more fully from adversity than in situations where there is an excessive reliance on external actors.

Nonetheless, the two main storms described in this Report illustrate just how powerful the forces of nature can be and how society, institutions of all kinds as well as households and individuals are vulnerable. The loss of electricity impacted on the basic essentials – heat, light, cooking, food storage and communications.

Even with ESB Networks strong electricity distribution network and a highly developed emergency management culture, it can be anticipated that power outages due to severe windstorms will continue to be a feature of life in Ireland. ESB plans for severe power outages caused by storms, where full restoration will take up to 10 days with their full resources diverted to emergency restoration and with support from UK and other EU power companies.

For many households, farms, schools and business of all kinds, ex-Hurricane Ophelia and snow storm Emma provided a reminder about resilience where there is loss of electrical power. Households with private wells were doubly impacted by the storms, because where they were without power, the pumps for their water supply did not work either. Those who still had power supplies were reminded of their vulnerability. While some households had to live without power for up to seven days, this was not a worst case scenario. Roads were opened quickly after Ophelia and people could travel to

avail of facilities with relations, friends or in nearby towns where power was restored. Mobile phones could be charged in cars or additional battery packs could be sourced, so communications were maintained. If the anticipated flooding had to happen, or people remained isolated for long periods, as well as being without power, their circumstances could have been much worse.

9.2 Developing Societal Resilience

While the strong community support is viewed as a very positive feature of Irish society, there are indications that specific preparedness at household and business level does not match the threat posed by storms, flooding and severe weather. It is clear that a balanced level of individual preparedness is required. Work is underway to develop guidance on how all sectors should enhance their individual resilience, as well as harnessing community strengths during severe weather emergencies. This requires multi-level co-ordination with a focus on developing:

a. Household Resilience
b. Organisational Resilience
c. Community Resilience

The Office for Emergency Planning, through the Government Task Force on Emergency Planning, runs a whole-of-Government national “Be Winter Ready” campaign annually, highlighting actions that households, motorists, business and the agriculture sector can take to prepare for winter conditions. The current annual “Winter Ready” platform provides a central point to assist in further co-ordination of these messages. However, further work needs to take place at a local and regional level to enhance the work and development of Community Resilience Groups with the potential for existing Public Participation Networks to assist in enhancing more resilient community networks, especially during the response and recovery phase of severe weather events..

The various elements of society will never be as receptive to the message of resilience or more likely to take action as they will be in the aftermath of an event like Ophelia. In retrospect, it might have been effective to have mounted a societal resilience campaign

in the weeks after the storm and it is recommended that this should be considered in the aftermath of future events and during the “Be Winter Ready” campaigns.

9.3 Understanding the Approach to Managing Weather Crises in Ireland

The approach underlying the system for managing weather related crises in Ireland involves the public authorities (in the form of the NECG currently, working closely with Met Éireann) providing advice, which decision-makers (i.e. the public at large) use as the basis for action. This concept may not be as widely understood in Ireland as we would wish, and may be confused by terminology from other jurisdictions, such as “Code Red” and “lock-down”.. The Met Éireann weather coded warning system will be the subject of a further information campaign as part of the 2019/2020 “Be Winter Ready” public information campaign.

Conveying and reinforcing the warnings to the public and ensuring that appropriate safety messages were disseminated was the key focus of the emergency management community in the run-up to the storms. The broadcast and print media gave prominence to the forecasted storms and the public safety messaging and, allied with social media, it is clear that the most people were aware of the potential severity of the coming storms. The manner in which the vast majority of the public reacted was to accept and heed the advice and warnings.

Success of this “advice-based” approach is predicated on the public having a high degree of trust and belief in what they are being told. Their perception of what they are experiencing/ expecting to experience has to match what is being offered as advice from the authorities. It is clear that, in the intervening period that has passed, there was a significant harmony between the weather that was forecast, the nature of the advice offered, the appropriateness of both of the forecasts and the advice and the public and media’s acceptance of this. It is apparent that a far greater proportion of the population understands and accepts the current approach at the end of the period under review than would have been aware at the beginning.

This core reliance on advice rather than any form of compulsion by the state, allied with voluntary decision-making by individuals and organisations is seen as being appropriate for circumstances and our culture in Ireland. The alternative of an authoritarian,

centralised decision-making model, with associated ‘compulsory’ directions for action could well be counter-productive. The apparent degree of public acceptance of the current approach reflects the general perception of the appropriateness of the judgements made and advice offered by the public authorities, as well as appreciation of the effective work done to manage recent severe weather emergencies.

While the process may work for individuals, families and organisations in their roles as decision-makers, it is more problematic where different conclusions/ actions are decided within the same geographical areas, or within related sectors. The decisions taken on the Sunday evening before Ophelia, which effectively resulted in the closing of most public and private enterprises in the country, was not a smooth process in all cases. This experience highlights the need for communication protocols to be developed within organisations and sectors, which will provide a common basis for action when confronted with the types of advice being issued by the Severe Weather National Emergency Co-ordination Group in future. Indeed, there may be improvements which can be made in the format of advice to facilitate sectors to react more rationally and cohesively.

Given the variations in weather conditions that were seen to occur in different areas of the country during such severe weather events, we consider that the role of the Local Co-ordination Group (comprising senior local authority, Garda and HSE staff and others as appropriate) should be expanded to be used as the source of authoritative advice on local conditions for the public. At the moment, Local Co-ordination Groups tend to reinforce public information messaging from the National Emergency Co-ordination Group. However, a need is recognised for developing a more localised and nuanced advice for the public at the local level.

This local information role could build on the current use of social media as well as more traditional local radio roles by local authorities and other agencies to provide advice/ warnings and information for their communities.

It could be modelled to a large extent on current functioning of the National Emergency Co-ordination Group, with local authority fire services staff providing the core support for LCG functioning in the manner that NDFEM does at national level. The fire services 218 fire stations (with other suitable staffed and equipped locations) could be developed

further to serve as bases for monitoring and reporting local conditions which would feed into the local advice to the public.

We also recommend that Local Coordination Centres should be linked with the national level, to enable ready exchange of information/ forecasts, advice and updates between national and local levels. This would enable LCG to access the expert information such as that provided by Met Éireann and OPW which the NECG has access to in its work.

9.4 Advice for Employers

Ex-hurricane Ophelia was a one-day event. Given the short duration of the disruption, employers, self-employed and employees alike seemed to accept the public safety messages as being appropriate for the situation. However, the issues associated with disruption of employment by weather (or other crisis situations) would benefit from some consideration.

The advice about avoiding non-essential travel may have caused confusion for some employers and employees, while others reported they found it clear and helpful. The notification of advice to take this type of protective action nationally was unprecedented in Ireland. The fact that it was necessary to issue two such advisories within four and a half months of each other make it exceptional.

Questions were also raised about employment legislation and payment to employees who decided not to attend work on foot of the public safety warnings. Responsibility for legislation on employment rights rests with the Department of Employment Affairs and Social Protection, whereas employment regulation rests with the Department of Business, Enterprise and Innovation. The latter is mainly carried out through the Workplace Relations Commission (WRC) and by the Health & Safety Authority (HSA).

In general, it is understood that employment legislation does not impose any obligation on employers as regards the issue of payment of wages for workers who are unable to attend work due to a severe weather warning or safety advice. The WRC has developed some general guidance for employers and employees in the context generally of inability to attend work due to unforeseen circumstances and these are,

following ex-Hurricane Ophelia, in the course of being reviewed and updated. The current text of the advice is available at:

https://www.workplacerelations.ie/en/news-media/workplace_relations_notices/absence_during_extreme_weather_events.html

The Department of Business, Enterprise and Innovation considers that the issue of providing additional advice for employers would be best dealt with on the basis of determining what represents best practice in the workplace between employers and employees - taking account of the wide variety of circumstances which might apply to different employment situations (e.g. essential and emergency services will be different to other employments) and to different emergencies.

It would be good practice for businesses to have a document, which is agreed between employee representatives and employers, setting out procedures for dealing with severe weather warnings to include contact arrangements, arrangements for working from home or other arrangements for minimising disruption to business while having regard to employee welfare. Such guidance would need to take account of the different types of work undertaken in both the public and private sectors. The situation of office workers will be different to those working outdoors as well personnel in the emergency services or those working in aspects of healthcare or responsible for the maintenance and operation of vital infrastructure and essential services.

The former Department of Jobs, Enterprise and Innovation developed and published in November 2011 specific advice to business and employers on 'Business Continuity Planning in Severe Weather – Advice to Businesses on Preparing for Severe Weather', which is currently available at www.emergencyplanning.ie/publications.

The Department of Business, Enterprise and Innovation supports and recommends reviewing and redrafting such guidelines on good practice for employers in the event of severe weather. Given the universal application of the issue to all sectors and the broad implications of the issues involved, the D/BEI recommends that this task be approached under the aegis of the Government Task Force (GTF) on Emergency Planning. In this context, the D/BEI should be best placed take the lead on this review by developing

revised guidelines for consideration by the GTF based upon those it developed previously.

9.5 Safety of Staff at Work during Severe Weather

The primary legislation relating to occupational safety and health is the Safety, Health and Welfare at Work Act 2005. Under this legislation employers, including the self-employed, have a statutory obligation to provide for the safety of their employees while at work, including during severe weather. This statutory responsibility includes employees that are required to drive as part of their work. In this regard the HSA has focussed on Driving for Work and has had a programme in place in conjunction with the Road Safety Authority and An Garda Síochána. Extensive guidance material on this subject is available to employers and employees from the HSA website (www.hsa.ie).

While the NECG have issued explicit public safety warnings for the two severe weather events described in this Report, the use of Met Éireann weather warning systems as the sole basis for employers decisions in relation to use of vehicle fleets is seen as inappropriate. The Met Éireann warning system is related to meteorological thresholds and categorises expected weather conditions on a county/ region basis. Current forecasting models are not scaled to provide detailed information regarding weather conditions at the level of a local community in real-time. Therefore, employers should make decisions based on their own workplace risk assessment, their knowledge of forecasted conditions for their area, their perception of conditions in the locality/ relevant area at the time, bringing their experience and judgement to bear as part of the decision-making process.

It should be noted that commuting to and from an employee's normal assigned place of work, in the employee's own private vehicle or using other modes of transport, is considered to be outside the scope of the Health, Safety and Welfare at Work legislation. The Department of Business, Enterprise and Innovation, having consulted with the HSA, conclude there is nothing to suggest that a revision of the legislation to include normal commuting by workers is required. To do so would be outside the statutory remit of the Health and Safety Authority as it is a matter of broader public safety as opposed to being restricted to workplace safety. In this regard the voluntary

closure by employers of their businesses during ex-Hurricane Ophelia most likely contributed positively to a higher level of safety for the general public at that time.

9.6 Business Continuity Management

It is clear that where electricity supply and/ or water supply is disrupted that SME/ commercial operations and farming are severely affected. The experience from ex-Hurricane Ophelia indicates that significant development is required across the range of public sector organisations, commercial and business and agriculture, as well as households and individual citizens.

Where single points of failure exist, it is essential that people be aware of the risk posed, and where possible this type of vulnerability should be addressed from the level of major critical infrastructure through to households, holding with a practical approach that is both feasible and cost-effective. This is a cross-cutting and multi-level issue requiring analysis, investment, education and training across many sectors.

While some advice is available through 'Winter Ready' and individual organisations and sectors demonstrated remarkable preparedness and improvisations, additional guidance needs to be developed to enable sectors, including farms and businesses, to cope with situations where their staff may be unable to attend work or they may be without electricity or water supplies for extended periods.

Allied to this requirement is the necessity to develop Business Continuity Management (BCM) within the public and private sector. The episodes of severe weather covered in this Report showed how:

- Non-availability of staff
- Loss of facility and
- Loss of supply/ distribution networks

can be expected to occur and to disrupt normal business.

All organisations should have well-developed BCM concepts in place that are based on scenario assessment, potential impact analysis and that includes a generic crisis management procedure, supported with relevant scenario-specific planning. The level

and complexity of BCM planning should be proportionate to the size and scale of operations, clearly defining the maximum tolerable period of disruption to critical tasks.

Business Continuity Management should be prioritised in all sectors, including Agriculture, SME, large commercial/ industrial and the public sector. Atlantic storms are a predictable aspect of Irish weather that will regularly disrupt electricity and water supply. When the impact is widespread (as was the case following ex-Hurricane Ophelia and storm Emma) critical infrastructure, essential services and vulnerable customers are prioritised. Commercial operations should put in place the necessary back-up systems for operating on reduced staff availability and alternative staff attendance arrangements, working from home where possible, as well as a minimum supply of power and water for critical business operations.

It is recommended that guidance should be developed under the aegis of the Department of Business, Enterprise and Innovation to assist employers, to outline steps on how to prepare for such situations and how to communicate alternative working arrangement rapidly to employees.

9.7 Maintaining Emergency Services

The provision of emergency services to those in need during the emergencies described in this report was a source of positive public comment and a source of pride for the staff and services involved. Nonetheless, emergency services response times were impacted and extended by the realities of the conditions. Heroic efforts, frequently as part of an inter-agency approach and with local community involvement, were made to reach isolated people in need of medical and other services. Emergency service managements had good advance notice of the impending arrival of the two major storms described in this Report and had made appropriate plans accordingly which enabled the emergency services to be maintained in the face of major challenges.

Specific actions were taken within the different sectors. Emergency services are delivered by their staff, and arrangements were made by services to have staff available and catered for to maintain emergency services during the storms.

There is now a need to move beyond the ‘heroic’ and for each emergency service to codify its arrangements for the kind of circumstances which can arise with extreme weather events. Learning from experience, services can anticipate difficulties and pre-plan for typical situations and difficulties, including preparing vehicles for snow and for responding to isolated/ difficult locations. Emergency services also need to consider the staffing issues such as stand-by, on-call and call-back arrangements which may be appropriate to ensure appropriate staffing levels are available for emergencies. Compensation/ payments / time in lieu arrangements which may be necessary should be developed and agreed centrally under the aegis of Department of Public Expenditure and Reform.

9.8 Safety of Emergency Services Personnel

In debriefs, two organisations reported that their staff had “near misses” while responding to incidents during the storms. Trees are a major hazard to responding personnel of Principal Response Agencies and utility providers. High wind-speeds make emergency operations during storm conditions hazardous and in an ideal world staff would be withdrawn when very hazardous conditions prevail. Where life-saving operations are necessary, emergency services perform a dynamic risk assessment, based on their observations of local conditions allied with forecasts and decide if and how to respond.

However, many organisations, including local authorities are moving towards an increasingly defensive approach to decisions about deployment of personnel including, but not only, emergency services staff. One of the impacts of the colour coded weather warnings is that some organisations report that RED level weather warnings trigger automatic suspension of services, including a complete withdrawal of public and emergency services when RED level warnings are in place.

Health and safety considerations should not be an automatic barrier to undertaking life-saving operations or to making roads and other areas safe following severe weather and flooding. A balance needs to be found, where senior managers can deploy frontline workers to undertake their statutory functions, while ensuring those same workers are appropriately protected and they are complying with the statutory responsibilities imposed by health and safety legislation. It was noted above that staff of two

emergency services reported near misses during ex-Hurricane Ophelia. We believe that in both these cases, the organisations are highly cogniscent of their responsibilities under Safety, Health and Welfare at Work legislation and comply with statutory requirements in relation to safety statements, risk assessments, provision of specialist equipment, training and instructions for staff etc. Nonetheless, it was a matter of good fortune that their staff were not injured or worse.

We need to understand the factors which are pushing emergency services towards deciding not to respond to emergency incidents, and the gap that is emerging between public expectations for response and the risk assessments that are being made. While all public services strive to comply with health and safety legislation and wish to keep their staff safe, it is expected that the trend towards defensiveness will expand across many sectors.

In our view, the primary driver of this trend is the threat of personal criminal liability placed on senior decision-makers in public services. It seems highly unlikely that the officers and managers in either of the reported near miss situations went out with a criminal intent on the morning of the storms. We contend that front-line decision-makers need support for the difficult situations they face – not an automatic threat of criminal investigations.

We recommend that the relevant national organisation, the HSA, should work with the emergency services and others required to operate in difficult conditions and prepare over-arching guidance for essential and emergency services. This would advise on most appropriate working arrangements to be used during severe weather conditions and the type of risk management measures which are appropriate to enable the employers to meet the dual statutory requirement to perform their emergency functions at non-specific locations, while at the same time complying with the necessary health and safety requirements.

In our view, all serious workplace accidents should be investigated to establish the facts, circumstances and learning points of the situation, in the manner that transportation accidents are investigated and reported on currently. We recognise and support the mandate of the HSA to investigate accidents which result in severe injuries

or death at work under the Safety, Health and Welfare at Work Act, 2005. However, we recommend that the HSA adopt and articulate a clear national policy that provides for it to undertake investigations into incidents at emergency responses to establish facts and learning points. Transport investigations within the air, rail and marine sectors are carried out independently of criminal investigations and without apportioning blame or liability. The fundamental purpose of such investigations is to determine the circumstances and causes of these events with a view to the avoidance of similar occurrences in the future. This approach to accident investigation has contributed to the continuous improvement in safety standards and practices of transport services over time.

Further on the issue of investigations, responses to emergencies are conducted on an inter-agency basis. Another perceived threat to the established and positive working relationships across the Principal Response Agencies is the possibility that a colleague who has been working alongside other services in an emergency response could move into an investigative role in relation to an adverse outcome from that same response. It is entirely appropriate that, consistent with their statutory responsibilities, An Garda Síochána carry out investigations into fatalities, including for the purposes of Coroners' inquests and the HSA carry out workplace accident investigations, usually in tandem with An Garda Síochána. Where an investigation is looking at potential criminal conduct involving other emergency services, it must be ensured that it can be carried out in a manner that is above question, and protects against any conflict of interest and, where possible, avoids undue damage to the established and necessary positive working relationships. In this context, insofar as it may be possible and subject to the requirements of any given investigation, a 'best practice' would be for such incidents to be investigated by Garda Members who are independent of involvement in the events of the emergency response that have given rise to the investigation.

The issue relating to Health and Safety of emergency responders are complex and may be best addressed in the context of a specific subgroup under the GTF.

It is recommended also that current programmes to familiarise emergency services personnel with hazards associated with utilities like electricity networks and fuel and

gas storage and distribution are reviewed and re-vitalised to ensure a high degree of awareness of hazards. We recommend that this work should be co-ordinated and overseen by the CIP Group discussed in Chapter 8.

9.9 Public Safety and the Impact of Severe Weather on Sporting and Crowd Events

Sporting and other organisations routinely have to make decisions about whether events go ahead in particular weather conditions. However, their concerns are usually the playability of the pitch, and public safety may not be the highest factor in consideration. With advance warning, it would normally be possible to cancel sporting and other large crowd events that were scheduled to take place at a time coinciding with a forecasted adverse weather event.

A storm coinciding with a large crowd event (weekend music festival or large sporting event) could pose very significant and difficult issues for the event organisers and introduce the possibility of conflict with the Principal Response Agencies. It is not clear how such a crisis would be dealt with and resolved currently.

Sporting and event organisers would generally be expected to take a responsible and common sense approach in the run up to a forecasted weather event such as ex-Hurricane Ophelia. However, while it is understood that some events may be insured against weather risk, a decision to cancel an event could be compromised if there were significant financial exposures.

In theory, when licencing events, public authorities could include a condition relating to weather impact for licensed events and also for particular attention be paid to compliance with workplace health and safety legislation. However, the great bulk of public events are not licenced and there is no obvious mechanism, other than workplace health and safety legislation, that could be used to require an event organiser to cancel an event due to anticipated severe weather conditions.

In the current model, the public authorities may be advising against an event, but the decision to proceed or cancel rests with the event organiser. These types of situations

may be complex in that, for large scale events, public authorities, including transport operators, will generally be involved directly in getting people to and from events or managing transport issues.

There has been a significant and appropriate shift over the past two decades towards a risk management approach to event planning. It is recommended that, where not already the case, the responsibilities of the event organiser to consider weather impacts is included in such risk assessments.

It is recommended that consideration be given to the current approach of the Principal Response Agencies to dealing with sporting and crowd events, which involves a high degree of collaboration, and the case for that approach to be underpinned with legislation to empower public authorities to direct event organisers to follow specific directions when faced with severe weather threats, without incurring potential liability for financial costs.

We recommend that the draft Code of Practice for Large Scale Events prepared under the aegis of the National Steering Group on Major Emergency Management be revisited and, when revised, adopted as best practice. We also recommend that Local Coordination Groups should use nationally advised thresholds (such as wind-speeds of 80km/hour) at which point they would advise event organisers which are based on temporary structures of all kinds (including funfair equipment) that the events should be stopped/ cancelled.

This issue, while considered here in the context of an extreme weather event, highlights a broader concern which was raised at debriefs about public safety at events in Ireland. It appears that there is a need for a body to co-ordinate the many dimensions of public safety, without necessarily taking ‘sole ownership’ of the issue.

9.10 Self-Endangering Behaviour

During the severe weather events, there have been a small number of reports of situations where persons ignored safety warnings and engaged in reckless behaviour. Self-endangerment is, in theory, a matter for each individual. However, such behaviour

also potentially puts emergency services personnel in danger, if emergency calls are made as a consequence of such behaviour.

While the instinct may be to call for a form of enforcement of public safety advice, in reality there may always be a very small number of persons who choose to ignore the public safety warning. However, such behaviour places a burden on emergency services providers, who have to decide on an appropriate response.

There is no legislative basis, other than workplace health and safety laws, to impose or direct action on an individual (or organisations) during episodes of severe weather. As the great majority of people heed the advice given by recognised public authorities and act on it, we do not recommend developing any such legislation at this time. Indeed, in our view, it is likely that legislation to underpin such responsibility would be complex, difficult to enforce and run counter to the spirit of community resilience which is such a positive feature of emergency management in Ireland.

It is noted that there was almost universal condemnation of such behaviour, highlighting the irresponsibility of those who behaved in this way. Notwithstanding the practical difficulties, we recommend that all emergency services continue with policies which provide for a risk assessment prior to responding to emergency calls during stormy or other severe weather conditions which are as dangerous for emergency services as for everyone else. Services should avoid decisions about “deserving” and “non-deserving” calls, despite the perceptions of reckless self-endangerment.

Normally, incident commanders carry out a dynamic risk assessment as part of their safety procedure in all rescues operations. We recommend that all emergency services operate within standard operational guidance and generally should not risk their own lives, where a life cannot be saved.

9.11 Funding of Emergency Response and Recovery

Since 2009, the Department of Housing, Planning and Local Government has made financial support available to assist local authorities in meeting their costs of clean-up and necessary immediate works associated with significant severe weather emergency

events. This is in recognition of the exceptional nature of activities carried out by local authorities in responding to these types of emergencies and the fact that the costs of these un-programmed activities cannot be met from within existing resources. This assistance has been provided on an ad-hoc basis from savings identified elsewhere in the Department's budget. Costs arising from ex-Hurricane Ophelia were recouped in December 2017 and the Department extended this support to cover the period of severe weather in March 2018 and worked with local authorities to recoup the costs incurred by each local authority.

The provision of emergency funding for local authorities is now well established following many national severe weather emergencies. There is a requirement therefore to develop an appropriate funding arrangement to address the response and recovery phases of severe weather events to ensure that the Principal Response Agencies are in a position to deploy an optimal response and to ensure that local authorities and other Principal Response Agencies are not unduly constrained by resources considerations in delivering responses to exceptional events.

The Table below sets out the amounts recouped to local authorities in each year since 2009 on response to severe weather events and subsequent clean-up activities.

TABLE

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Carlow CC	123,060	349,400				215,000	21,886	291,686	59,829	593,731
Cavan CC	130,000	170,428	97,000			65,021	41,526	91,128	22,051	179,438
Clare CC	1,145,000	681,198				1,388,053	900,000		70,310	186,818
Cork City	3,110,206	349,483		150,000		285,625		136,500	1,986,474	200,600
Cork CC	5,770,219	935,765		550,000		1,388,700	135,226	1,672,528	1,492,829	301,562
Donegal CC		1,005,854				150,000	763,301	200,000	1,784,298	141,532
Dublin City		1,263,389				57,802				285,046
Dlr/Rathdown		366,000								200,069
Fingal CC		410,000						6,800	152,790	347,805
Galway City		33,746				220,698	39,387		115,004	50,565
Galway CC	3,252,123	368,920				478,000	980,418	2,147,180	216,092	151,534
Kerry CC		571,525				486,975	244,447	290,779	161,816	217,373
Kildare CC	226,000	810,000					30,453	28,619	104,086	510,019
Kilkenny CC		173,939				329,411		407,500	317,245	384,389
Laois CC		175,000				351,000		145,936	378,640	200,441
Leitrim CC	525,000	107,465				80,650		772,480	15,991	50,877
Limerick CC	261,382	292,146				794,500	328,840	554,339	391,041	99,850
Longford CC	137,506	143,567				15,000	85,513	360,758	23,736	60,019
Louth CC		277,440				69,731	37,889	146,328	9,385	85,087
Mayo CC		615,000				509,000	980,000	413,000	5,714	
Meath CC		850,448				113,121		79,755	48,105	769,542
Monaghan CC		191,029					45,500	96,232	11,990	111,169
Offaly CC	50,003	229,885				28,500		427,067	226,160	282,913
Roscommon CC	1,015,000	498,843				20,810	285,000	601,343	30,489	74,263
Sligo CC		413,515				174,290	297,000	146,181	53,655	72,019
Sth Dublin CC		543,420							41,505	486,301
Tipperary CC	388,948	793,577				45,503	52,000	729,857	416,513	598,042
Waterford CC		256,000				352,000	253,400	403,558	507,450	626,915
Westmeath CC	353,810	386,444	2,000			134,762	241,309	981,465	123,702	225,617
Wexford CC		309,200				33,500		217,000	184,740	1,226,336
Wicklow CC		763,457	275,938			71,727		499,000	50,527	677,830
Total:	16,488,257	14,336,083	374,938	700,000	-	7,859,379	5,763,094	11,847,019	9,002,166	9,397,701

Amounts recouped to Local Authorities
for Severe Weather Response and Clean-up Activities

Funding for repair of public infrastructure is undertaken by the relevant Departments in line with sectoral responsibilities. Capital costs associated with infrastructural damage, for example damage to the roads network, are not included under the funding arrangements referred to above and are considered separately. Based on the scale of infrastructural damage caused by many recent severe weather events, the capacity to fund recovery may be beyond individual Departments. It is recommended that Departments engage with D/PER to develop a common approach to funding repair to public infrastructure following damage caused by severe weather emergencies.

9.12 Assessing the Costs of Severe Weather

One of the tasks of the Lead Government Department is to collate costs associated with emergency events such as episodes of severe weather. In relation to quantifying costs arising from these periods of severe weather, each Department was requested to quantify, in so far as this is possible, the estimates for economic loss, costs and damage incurred within their sector

There is a requirement for a national model to define a cost estimation methodology so that data can be assembled which is underpinned by financial expertise and can be validated.

9.13 EU Solidarity Funding

The issue of Ireland making application for EU Solidarity Funds has been raised following previous severe weather events and was raised again following ex-Hurricane Ophelia. The damage threshold for application for Solidarity funding is 0.6% of GNI. This amount consists of total damage costs and not just those costs which are eligible for support from the Solidarity Fund. Regional applications can be made in exceptional circumstances, provided that the region affected is a single contiguous geographic boundary and the population directly affected in the region exceeds 50.1% of total national population.

The fund is intended for very severe disasters/ catastrophic events and in effect, the threshold levels mean that only an overwhelming disaster would be eligible. A model to quantify the total damage resulting from a severe weather event has not yet been developed for Ireland. It is not clear how insured damage would be estimated and collated and who would perform this task. Therefore it is not possible to provide an accurate estimate which would form the basis for making a decision to make an application to the EU Solidarity fund – estimates of cost and damage to public infrastructure would not be sufficient. From experience to date, it seems clear that any application based solely on damage identified by local authorities and information on repair costs from the transport sector would be unlikely to come anywhere near the thresholds for receiving grant-aid from the fund.

9.14 Transitioning from Recovery to Normal Mode

Long term recovery for communities and society from the impacts of severe weather is a complex task requiring on-going co-ordination and leadership. The objective is usually to restore the situation to the state prior to the severe weather event occurring. However, there are long term issues that require management and co-ordination for significant periods following emergencies and crises. These include psychosocial support for persons impacted, restoring damaged infrastructure and recovering time lost and dealing with economic losses and environmental impacts.

Many of these issues are beyond the scope of any single LGD and are managed within the relevant/ appropriate sector. We are not aware if any analysis has been carried out on the funding of repairs in terms of building more robust infrastructure or simply replacing existing infrastructure on a like-for-like like basis. This is likely to become a significant issue as the cost of recovery rises together with the increase in frequency of severe weather events.

Appendix A

LIST OF ABBREVIATIONS/ ACRONYMS USED IN REPORT

AILG	Association of Irish Local Government
BCM	Business Continuity Management
CBRN	Chemical, Biological, Radiological and Nuclear
CFRAM	Catchment Flood Risk Assessment & Management
CIP	Critical Infrastructure Protection
DAFM	Department of Agriculture, Food and the Marine
DBEI	Department Business Enterprise and Innovation
DCCAE	Department of Communication Climate Action and the Environment
DEASP	Department of Employment Affairs and Social Protection
DH	Department of Health
DHPLG	Department of Housing Planning and Local Government
DJE	Department of Justice and Equality
DTTS	Department of Transport Tourism and Sport
DPER	Department of Public Expenditure and Reform
ECMWF	European Centre for Medium-Range Weather Forecasts
EMS	Emergency Management Service
ESBN	Electricity Supply Board Networks
EFAS	European Flood Awareness System
EOC	Emergency Operations Centre
EPA	Environmental Protection Agency
EPS	Ensemble Prediction System
ERT	Estimated Restoration Time
FFW	Flood Forecasting & Warning
GTF	Government Task Force on Emergency Planning
GNI	Gross National Income

HARMONIE	HiRLAM Aladin Regional Mesoscale Operational NWP In Europe
HiRLAM	High Resolution Local Area Modelling
HSA	Health & Safety Authority
HSE	Health Service Executive
HAT	Highest Astronomical Tide
HTA	High Tide Advisory
IFI	Inland Fisheries Ireland
IRCG	Irish Coast Guard
IRRS	Irish Radiation Research Society
IW	Irish Water
LGD	Lead Government Department
LGMA	Local Government Management Association
MEM	Major Emergency Management
NAS	National Ambulance Service
NDCC	National Distribution Control Centre (ESB)
NDFEM	National Directorate for Fire and Emergency Management
NDRS	National Digital Radio Service
NECC	National Emergency Coordination Centre
NECG	National Emergency Coordination Group
NGO	Non-governmental Organisation
NHC	National Hurricane Centre (US)
NOAA	National Oceanic and Atmospheric Administration (US)
NSG	National Steering Group
NPWS	National Parks and Wildlife Services
NWP	Numerical Weather Prediction
OGCIO	Office of Government Chief Information Officer
OEP	Office of Emergency Planning

OPW	Office of Public Works
PES	Principal Emergency Service
PRA	Principal Response Agency
SEM	Strategic Emergency Management National Structures and Framework
SEMT	Storm Emergency Management Team
TII	Transport Infrastructure Ireland
WMO	World Meteorological Organisation
WRC	Workplace Relations Commission
WSI	Water Safety Ireland

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Department of Housing, Planning and Local Government

Rialtas na hÉireann
Government of Ireland