

ITS SERVICE BOOK

ITS1201 WEATHER WARNING SYSTEM – FIELD DATA

Purpose

Weather Warning Systems may utilize field or patrol data to support road and weather advisories or they may be more localized systems that issue warnings of weather-related conditions to approaching drivers. Since MTO has two separate streams of input sources for Weather Warning Systems, ITS1201 is separated into two (2) Service Books; one focused on patrol data/external data sources and the other on field systems.

This Service Book focuses on field data from devices and systems designed to monitor local conditions that may be prone to the area.

These conditions may include:

- Precipitation (rain, snow, etc.)
- Visibility
- Water levels
- Wind conditions

Warnings associated with the above conditions can be provided to travellers through upstream VMS and traveller information services such as Ontario511.

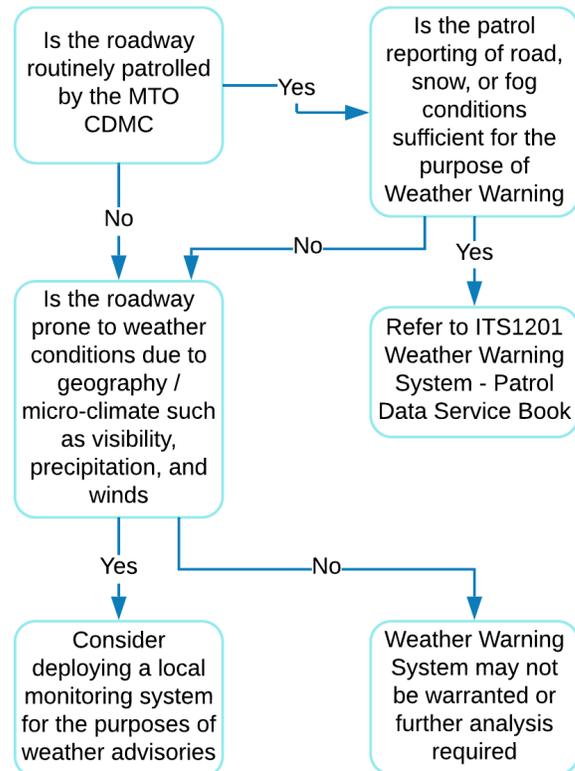
The objectives of a Weather Warning System are to:

- Improve safety through awareness of downstream driving conditions
- Infer a detour to those not used to driving in the conditions
- Reduce weather-related primary and secondary collisions
- Maintain mobility

Considerations for Use

Weather Warning Systems can be considered for all road types but should be given a higher priority to key commuter and commercial vehicle routes prone to unsafe driving conditions due to weather (e.g. micro-climates, bridges and road features such as long grades).

The following decision tree provides a method for determining the need for Weather Warning Systems based on field systems on Ontario roads.



ITS Service Applicability and Limitations of this Service Book

This Service Book may be used in conjunction with other related MTO ITS Services that may have Service Books associated with them.

- ITS1105 – CVAV Road Weather Motorist Alert and Warning
- ITS1202 – Weather Warning System – Patrol Data

Limitations

This Service Book may be used in conjunction with other Service Books that have been developed.

This Service Book will aid in determining the need, components, purpose and general placement for a Weather Warning System. Further analysis, specific to the application, is encouraged.

While technologies and data sources continue to evolve, this Service Book references technologies open to using by MTO.

System Components

The key components of a Weather Warning System are:

- **Detection** – a means to monitor and detect weather conditions
- **Processing** – a means to process/manage the weather data for operations, maintenance, and/or traveller information purposes
- **Traveller Information** – a means to convey to travellers the warning messages associated with the weather conditions

Detection

A variety of sensor technologies are available to measure a weather condition.

Wind Meters

Wind meters are able to record the speed intensity and direction of winds. Areas prone to high winds may include bridges and other roadways with certain geographical and climate characteristics (such as open rural corridors).

The MTO has deployed wind meters on the Burlington Skyway and Garden City Skyway.

These classify wind speeds as follows:

- High wind warning – 40 to 65 km/h
- Severe wind warning – 65 to 100 km/h
- Total closure – >100 km/h

Visibility Sensors

Visibility sensors measure visibility at a localized area and use this information to determine the overall visibility.

The MTO has deployed reduced visibility systems and these trigger on at visibility less than 500 metres and triggers off once visibility is above 750 metres.

Other Sensors

Although not widely deployed by the MTO, other weather conditions may also be monitored. These may include:

- Air temperature and humidity
- Precipitation (rain, snow, etc.)
- Road status
 - Surface state, (dry, wet, icy)
 - Salt concentration
 - Friction coefficient
 - Ice %
 - Water film height
 - Surface temperature
- Water level

Other Data Inputs

Data from other parties or devices may potentially be integrated into Weather Warning Systems.

Sources may include:

- Environment Canada
- Other MTO RWIS Stations
- Other Federal/Public Weather Stations

Processing

Datalogger

Depending on the conditions being monitored, the data from the sensors may collect at a field processor (e.g. datalogger) which collect the outputs and signals from the various sensors. The datalogger typically has onboard memory to record and save the data. There is also an Ethernet port to connect the datalogger to a network for communications to the TMC/TOC via a cellular or fibre optic backhaul.

Dataloggers may vary based on size, operating temperature range, number of sensors supported, and other factors.

Analysis Software

The information processed by the datalogger can be analyzed locally, on-premise, or through a Software-as-a-Service (SaaS) configuration.

Operations

Data may also be interpreted manually by TMC/TOC Operations resulting in the appropriate response when certain weather conditions are prevalent (e.g. notify maintenance or update local VMS(s)).

Traveller Information

Weather warning messages can be relayed to different sources.

Variable Message Signs

- Digital message signs upstream of the weather station relay relevant information via messages to approaching travellers

Ontario 511

- Broadcast weather information to the Ontario 511 portal and support open-source data feeds

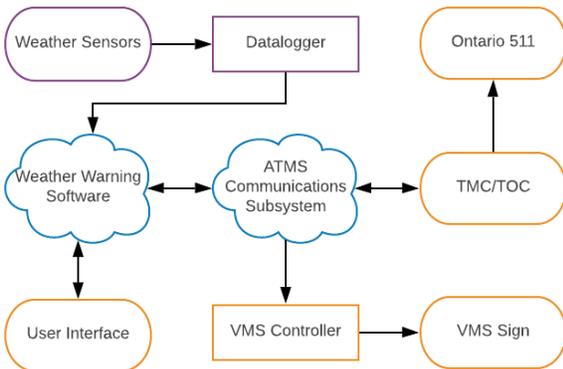
Media

- Communication with media partners

Architecture

The following architecture provides an overview of the system components, their interaction and the flow of information.

Roadside and/or road embedded sensors connect to a local datalogger. The datalogger communicates over an IP network to a centralized software system which analyzes the data and relays it to the appropriate respective Traveller Information channels such as field VMS signs and Ontario 511.

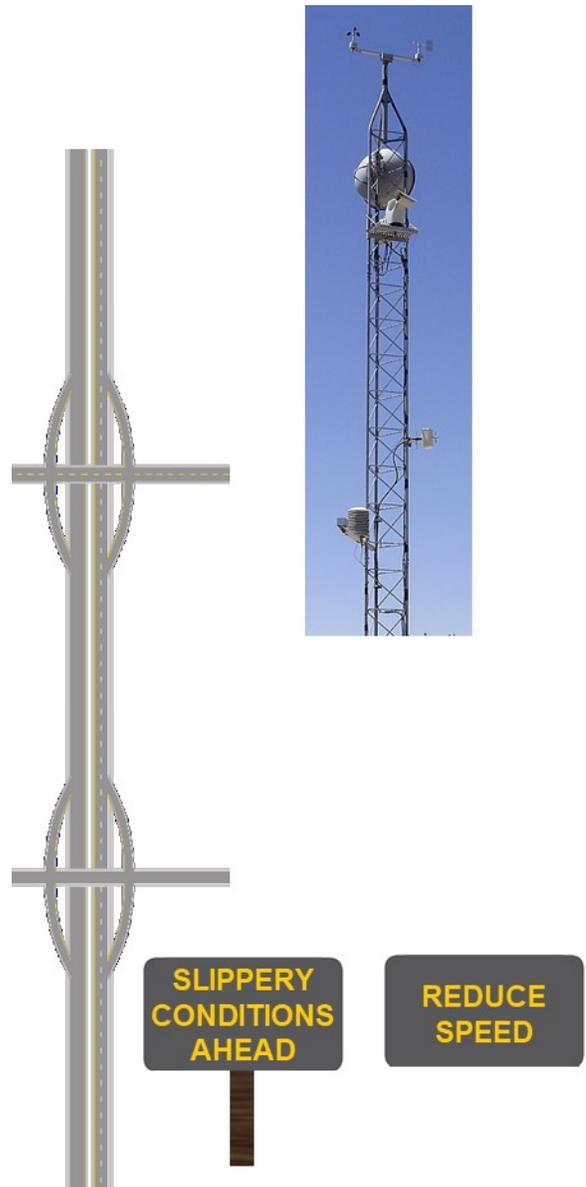


Traffic Management

Weather Warning Systems using field systems can operate autonomously to a VMS and/or have data provided to the TMC/TOC operations for appropriate responses.

Concept

An example concept of a Weather Warning System is shown in the following Figure.



Messaging Examples

Examples of existing messages. Additional sign types (static or hybrid with flasher beacons) may also be considered instead of full VMS displays.

Wind Warning

High Winds 40 to 65 km/h

HIGH WINDS ON SKYWAY
DRIVE CAREFULLY

Severe Winds 65 to 100 km/h

SKYWAY – SEVERE WINDS
REDUCE SPEED

Winds over 100 km/h

SKYWAY
CLOSED

Reduced Visibility Warning



Deployment Considerations

The following are some considerations as part of the deployment of Weather Warning Systems:

- Utilize existing infrastructure for mounting where possible. This may include poles and existing sign supports
- Utilize existing infrastructure for power and communications where possible
- For solar-powered applications, consider areas exposed to sunlight throughout the day. Effects of winter (reduced battery retention and limited daylight) should also be taken into account
- Try to place weather station as reasonably close as possible to the type of weather that should be monitored
- Consider geometric constraints, sightlines, and local grading when placing and orienting weather station and sensors
- Where upstream VMS is used for Traveller Information, place the VMS within 2 km of areas prone to the anticipated weather
- For long sections of roadway prone to bad weather, consider deploying multiple VMS signs along the corridor, especially after on-ramps
- For sections of roadway prone to similar conditions, limit the maximum distance between adjacent stations to 50 km in urban conditions and 150 km in rural conditions.
- Ensure messages are reset to pre-weather conditions once the unsafe weather conditions are abated.
- Consider leveraging Environment Canada or existing RWIS station data where possible to confirm detected conditions
- Consider local terrain and clear zone requirements to assess the placement of VMS
- Consider maintenance roles, responsibilities, and processes for each component
- Consider safe maintenance access in locating the equipment
- Consider trigger levels for each type of sensor(s).
 - Wind levels
 - High wind advisory when sustained winds at 40 km/h (MTO Skyway bridges)
 - Severe wind advisory when sustained winds at 60 km/h (MTO Skyway bridges)
 - 80 km/h used by Alberta Transportation for provincial highway
- Visibility
 - Visibility detection triggers on at visibility less than 500 m and triggers off once visibility is above 750 m (401 Reduced Visibility Warning System)
- Flood warning

- Agencies have used 3 cm of water above the roadway, but local roadway topography is important
- CCTV camera monitoring is optional for the detection zone but can be very helpful for remote confirmation of adverse weather conditions
- Maintain communications with the Maintenance Contractor or any other parties to help optimize snow plow or road maintenance operations

Costs and Procurement Strategy

Budgetary costs are provided for system components. A combination of the components can help to provide an estimate based on the application.

There may be additional costs to integrate the Weather Warning System to MTO’s TMC/TOC Operations and associated systems.

Refer to HiCo for additional details and regional estimates.

Element	Cost (2019)
Purchase: Supply and Install	
Air Temperature and Humidity Sensor	\$1,500
Non-invasive Flood Sensor	\$2,000
Non-invasive Road Sensor	\$22,000
Visibility Sensor	\$9,500
Wind Meter	\$1,800
Datalogger	\$3,500
Cabinet Enclosure	\$1,000
Solar Power Kit	\$3,000
Cellular Modem	\$1,000
Pole-Mounted VMS	\$100,000
Overhead VMS Sign	\$400,000 - \$500,000

Element	Cost (2019)
Portable VMS	\$30,000
Hybrid Static/Variable Sign	\$6,000
Civil Provisions (Ducts, F/O, Power)	\$150,000 per km
9.0 m Concrete Pole	\$2,800
Traffic Control (per lane closure)	\$4,000
Operations and Maintenance	
Cellular Fees (if applicable)	\$75 per month
Data Processing (cloud)	\$100 per station per month
Maintenance of signs, cabinets, solar power systems, etc.	~10% of capital/year

Sample Cost Deployment

An example of a Weather Warning System may include the deployment of a wind meter

- Concrete Pole
1 x \$2,800 = \$2,800
- Weather Station Sensors
1 x \$1,800 = \$1,800 (wind meter)
- Datalogger
1 x \$3,500 = \$3,500 (datalogger)
1 x \$1,000 = \$1,000 (enclosure)
- Portable Variable Message Sign
2 x \$30,000 = \$60,000
- Power, Communications, and Civil
3 x \$3,000 = \$9,000 (solar power kit)
3 x \$1,000 = \$3,000 (cell modem)
\$15,000 (miscellaneous civil works)
- Total Deployment = \$96,100

Procurement Options

Weather Warning System can be procured and deployed through a variety of approaches including:

- Standalone contracts
- New highway/extension works
- Rehabilitation works
- Smart work zone systems

System Life Cycle

The expected life cycle may range from 5 to 10 years depending on the configuration.

The mean time between failures (MTBF) of relevant equipment for planning, and rehabilitation purposes:

- Cellular Modem – 5 years
- Civil Provisions – 25+ years
- Controller Cabinet – 25+ years
- F/O Cable – 25+ years
- Network Switch – 15 years+
- Overhead VMS – 15 years
- Pole-Mounted VMS – 15 years
- Poles – 25 years+
- Portable-Mounted VMS – 5 years
- Portable VMS – 5 years

Case Studies/Previous Deployments

Description	Components
<p>Advanced Road Weather Information System Ministry of Transportation Ontario</p>	<ul style="list-style-type: none"> • Stations deployed based on Ontario’s 5 primary and 40 sub-climatic zones • 151 stations, urban placement every 50 km while rural are about every 150 km • Utilized for proactive maintenance
<p>Low Visibility System Ministry of Transportation Ontario</p>	<ul style="list-style-type: none"> • Section of Highway 401 in Northumberland county was prone to foggy conditions • Sensors were deployed to provide upstream traffic of notification of low-visibility conditions. This utilized a combination of PVMS and hybrid VMS applications

Description	Components
<p>Non-Invasive Bridge Surface Sensor Maryland Transportation Authority</p>	<ul style="list-style-type: none"> • Deployed non-invasive spectroscopic surface sensor to monitor road conditions on the Francis Scott Bridge • Stable against vibrations
<p>Wind Advisory System on Highway 22 Alberta Transportation</p>	<ul style="list-style-type: none"> • 20 km stretch known as the “Wind Tunnel” • Many rollover events including 8 vehicles in a single day due to heavy winds • 1 weather station deployed • 6 advisory signs deployed prior to decisions points over 100 km stretch • SMS alerts • 80 km/h would trigger flasher beacons



Performance Measures

- Reduction in the number of weather-related collisions in the study area
- Increase in overall mobility due to reduced incidents

Emerging/Alternative Technologies

- PATeye – Solar-powered road-based ice detectors which flash blue when ice is detected
- Mobile Advanced Road Weather Information Sensor - Vehicle-mounted sensor providing the ability to collect GPS-based data including road condition, water, ice, surface temperature among other parameters
- Weather-based Variable Speed Limit Systems – systems which change to speed based on real-time conditions which may be related to slippery conditions as a result of snow, ice, or rain.