**Aurora Pooled Fund**

**RWIS Life Cycle Cost Analysis**

**Task 3 Technical Memorandum**

**Summary of RWIS Manufacturer Survey (DRAFT)**

# Introduction

This technical memorandum presents the information gathered from the RWIS Manufacturer Survey. The purpose of the survey was to gather information from RWIS manufacturers on their products as related to costs, design service life, applicable warranties, recommendations regarding preventive maintenance, etc. A separate survey was conducted concurrently to gather similar information from public agencies (mainly state and local government departments of transportation). Upon collection and analysis of the results from both surveys, guidelines will be developed to provide a framework for estimating RWIS life cycle costs as well as supporting decisions on repair vs replacement/retirement of RWIS systems and components.

# Manufacturer Survey

The Manufacturer Survey asked RWIS manufacturers various questions concerning their RWIS products, including:

* General RWIS product information
* Information for each individual RWIS component, including:
* Air Temperature / Relative Humidity Sensor
* Surface Temperature Sensor
* Pavement Condition Sensor
* Wind Direction & Speed Sensor
* Visibility Sensor
* Precipitation Sensor
* Ultrasonic Snow Depth Sensor
* Subsurface Sensor
* Barometric Pressure Sensor
* Water Level Sensor
* Solar Radiation Kit
* Traffic/Vehicle Detection Sensor
* CCTV Camera
* The following information was inquired for each component:
* Product name and model
* Equipment cost
* Recommended preventative maintenance activities and frequencies
* Estimated annual maintenance cost
* Warranty period
* Warranty cost
* Expected lifespan
* Software product name(s) and cost(s)
* Features/capabilities of the software products
* Software license fee information and limitations/requirements
* Telecommunication requirements and costs
* Data storage solution(s) and cost(s)

The manufacturer survey was developed by AECOM and reviewed by the Project Committee before being distributed to various RWIS manufacturers in September 2019. The survey was made available to responders in an online format created with SurveyMonkey and sent out to the manufacturers via email, which included a link to access the survey.

A number of RWIS manufacturers were contacted for this survey, including:

* Boschung America
* Campbell Scientific, Inc.
* Data Transmission Network (DTN)
* Frost Control Systems, LLC
* High Sierra Electronics, Inc.
* Lufft USA, Inc.
* MH Corbin, LLC
* Vaisala
* Judd Communications
* Optical Scientific, Inc.

A total of three manufacturers responded to the survey. Provided below are the three manufacturers that responded to the survey, as well as contact information for each respondent.

Table . RWIS Manufacturer and Contact Information

| **Manufacturers** | **Name** | **Title** | **Phone** | **Email** |
| --- | --- | --- | --- | --- |
| **High Sierra Electronics, Inc.** | Brett Hansen | RWIS Product Manager | 530-273-2080 | sales@hsierra.com |
| **Campbell Scientific** | Michael Burton | Market Development Manager | 780-454-2505 | mike.burton@campbellsci.ca |
| **OTT HydroMet**  **(Lufft)** | Erik Wright | Sales Manager - Road Weather | 805-886-2828 | erik.wright@lufftusainc.com |

# Survey Results

This section provides a comprehensive listing of the results from the RWIS Manufacturer Survey, as well as a side-by-side comparison of all manufacturer responses for each question.

## General Product Information

Table 2 presents the general RWIS product information provided by the manufacturers who responded to the survey.

Table . General Product Information by RWIS Manufacturer

| **Manufacturers** | **RWIS Products** |
| --- | --- |
| **High Sierra Electronics, Inc.** | High Sierra Electronics (HSE) provides a full range of road weather equipment to support the road weather management community. A typical complete RWIS site includes road and atmospheric sensors. Other considerations include the equipment structure, power (AC or solar/alternative energy) and communications.  HSE's typical RWIS:  5410 StormLink(R) RWIS Datalogger/RPU  5433 IceSight non-intrusive road condition and/or intrusive road sensor options Model 5422 and 5721  5432 Present weather sensor for precipitation/visibility  5723 Air temperature and relative humidity  5714 Ultrasonic anemometer or 5712 mechanical anemometer  Some alternative sensors include snow depth and solar radiation |
| **Campbell Scientific** | Recently standardized as "Campbell Scientific, Intelligent Route Information Systems" and consisting of component parts manufactured by Campbell Scientific in USA and other parts from national and international manufacturers. All Systems are based on Campbell Scientific CR Data Loggers (RPU). |
| **OTT HydroMet (Lufft)** | LCOM – RPU  WS100 - Precipitation Sensor (type and intensity)  WS200 - Wind Speed and Direction  WS300 – Relative Humidity/Temp/Pressure  WS600 - All in one (3 above combined)  VS2K - Visibility sensor up to 2,000m  VS20K - Visibility sensor up to 20,000m  NIRS – Non-Invasive Road condition sensor  IRS31Pro - Embedded passive pavement sensor with removable electronics  MARWIS - Mobile road condition sensor |

## Air Temperature / Relative Humidity Sensors

Table 3 presents the information on Air Temperature/Relative Humidity Sensors provided by survey respondents.

Table . Air Temperature/Relative Humidity Sensor

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **High Sierra Electronics, Inc.** | 5723 Air Temperature & Relative Humidity | $1,300 | Clean one time per year and calibrate every 2-3 years |  | 1 |  | 9 to 11 years | When calibrated properly |
| **Campbell Scientific** | HygroVUE10 | $418 (10 ft cable) | We recommend replacing the sensor element annually but clients may wish to adhere to a less frequent schedule. Less than 1% drift/year | Purchase replacement unit 35219 | 1 | $0 | 9 to 11 years | Replacement sensing element $130.  We integrate Air temp and RH sensors from a number of manufacturers based on what is best for the client's specific application. |
| **OTT HydroMet (Lufft)** | WS300 |  | Clean the sensor and check cable connections yearly | Minimal. Whatever it takes to wipe down a sensor | 2 | $0 | 6 to 8 years | Also capable of measuring barometric pressure |

## Surface Temperature Sensors

Table 4 presents the information on Surface Temperature Sensors provided by survey respondents.

Table . Surface Temperature Sensor

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **High Sierra Electronics, Inc.** | 5439 Surface Sentinel | $1,200 | Clean once per year |  | 2 |  | 9 to 11 years | Also capable of measuring air temp and RH in addition to surface temp;  Non-intrusive |
| 5721 Road Sensor | $1,000 | Inspect for damage once per year |  | 1 |  | 9 to 11 years | Also capable of measuring road/pavement conditions (dry/wet indication);  Intrusive |
| **Campbell Scientific** | Apogee SIF1H1 SS | $680 | Recommend re-calibration every 2 years |  | 4 | $0 | 9 to 11 years | We are currently completing development of another surface temperature sensor that will be released soon |
| **OTT HydroMet (Lufft)** | NIRS |  | Re-calibrate yearly if you want, can be remote. Replace $200 bulb every 2 years | Should be done on a yearly maintenance trip so bundled in with everything else | 2 | $0 | > 11 years | Also capable of measuring road/pavement conditions.  If maintained and bulb changed every 2 years you should be able to keep these running for a long time. They are non-invasive and can be moved. They also do the surface conditions, water film height, freeze temp etc. |
| IRS31Pro |  | Clean the sensor head and check wiring, same as all the others | Just a trip to the site | 2 | $0 | 3 to 5 years | IRS31Pro is an embedded passive sensor. Capable of measuring road/pavement conditions, ice percentages, water film heights, up to 2 sub-probe measurements and it has removable electronics for when a road is re-paved. |
| WST2 | < $1,000 | Minimal, wipe down the sensor head and check cable connections | Just a yearly PM trip out | 2 years (limited warranty based on defects in workmanship) | $0 | 3 to 5 years |  |

## Pavement Condition Sensors

Table 5 presents the information on Pavement Condition Sensors provided by survey respondents.

Table . Pavement Condition Sensor

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **High Sierra Electronics, Inc.** | 5433 IceSight | $11,000 | Clean, inspect and calibrate once per year |  | 2 |  | 9 to 11 years | Also capable of measuring surface temp/air temp/relative humidity;  Non-intrusive |
| 5422 Intelligent Road Condition | $8,000 | Inspect once per year |  | 1 |  | 6 to 8 years | Intrusive |
| **OTT HydroMet (Lufft)** | NIRS – Non-invasive road sensor |  |  |  |  |  | 3 to 5 years |  |

## Wind Direction & Speed Sensors

Table 6 presents the information on Wind Direction/Speed Sensors provided by survey respondents.

Table . Wind Direction/Speed Sensor

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **OTT HydroMet (Lufft)** | WS200 |  | No moving parts so minimal - should be a yearly maintenance trip for all sensors | Cost of a person to go and check everything out | 2 | $0 | 9 to 11 years | Life span depends on maintenance, these should last a long time as there are no moving parts |
| Ventus |  | No moving parts so minimal - should be a yearly maintenance trip for all sensors | Cost of a person to go and check everything out | 2 | $0 |  | The Ventus is a heavy duty, metal anemometer which can handle extreme conditions. We have utilized this in coastal areas that get lots of cold and wet blowing snow. It has 2 heaters built in and can handle extreme temps.  Again, if maintained it has no moving parts and should last a long time |

## Visibility Sensors

Table 7 presents the information on Visibility Sensors provided by survey respondents.

Table . Visibility Sensor

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Campbell Scientific** | CS120A | $3,850 | System is self-regulating but we recommend calibration every 2 years |  | 1 | $0 | 9 to 11 years |  |
| **OTT HydroMet (Lufft)** | VS2K |  | Sensor has a built-in random vibration to prevent bugs from nesting in its optics. | Annual trip out to clean everything | 2 | $0 | 6 to 8 years | 2k (2,000 meter) range and 20k range with 100k range on the way.  Same as the others, if taken care of they will last |
| VS20K |  | Sensor has a built-in random vibration to prevent bugs from nesting in its optics. | Annual trip out to clean everything | 2 | $0 | 6 to 8 years | 20k (20,000 meter) range with 100k range on the way.  Same as the others, if taken care of they will last |

## Precipitation Sensors

Table 8 presents the information on Precipitation Sensors provided by survey respondents.

Table . Precipitation Sensor

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **OTT HydroMet (Lufft)** | WS100 |  | Minimal, no moving parts or open tipping buckets | Annual trip to check | 2 | $0 | > 11 years | This is a Doppler-based precipitation sensor giving you intensity and type (rain, sleet or snow). Again, if cared for we have some still in the field 10 yrs+ at the moment |
| R2S |  | Minimal, no moving parts or open tipping buckets | Annual trip to check | 2 | $0 | > 11 years | This is a Doppler-based precipitation sensor giving you intensity and type (rain, sleet or snow). Again, if cared for we have some still in the field 10 yrs+ at the moment |
| WTB100 |  | Minimal, no moving parts or open tipping buckets | Annual trip to check - may need to go remove leaves or build up as they are tipping buckets | 2 | $0 | 6 to 8 years | This is a tipping bucket which will give you accurate accumulation but won’t differentiate between type or give intensity |
| WS601 |  | Minimal, no moving parts or open tipping buckets | Annual trip to check - may need to go remove leaves or build up as they are tipping buckets | 2 | $0 | 6 to 8 years | This is a tipping bucket which will give you accurate accumulation but won’t differentiate between type or give intensity |

## Ultrasonic Snow Depth Sensors

Table 9 presents the information on Ultrasonic Snow Depth Sensors provided by survey respondents.

Table . Ultrasonic Snow Depth Sensor

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Campbell Scientific** | SR50A | $960  (10 ft cable) | Check Desiccant and replace if required. Replace Transducer every 3 years. |  | 1 | $0 | 9 to 11 years |  |
| **OTT HydroMet (Lufft)** | SHM31 |  |  |  | 2 | $0 | 6 to 8 years | Great ultrasonic snow height sensor giving up to 15m in depths.  Not 100% sure but like always, maintain and things last |

## Subsurface Sensors

Table 10 presents the information on Subsurface Sensors provided by survey respondents.

Table . Subsurface Sensor

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Campbell Scientific** | CS231 | $800 - $6339 (depending on depth and # of sensors) | No maintenance or calibration required |  | 1 | $0 | > 11 years |  |
| **OTT HydroMet (Lufft)** | IRS31Pro (can have 0, 1 or 2 sub probes) |  |  |  |  |  | 3 to 5 years | IRS31Pro is an embedded passive sensor. Capable of measuring road/pavement conditions, ice percentages, water film heights, up to 2 sub-probe measurements and it has removable electronics for when a road is re-paved. |
| 8160.TF50S |  | None | None | 2 | $0 | 3 to 5 years | Standard stand-alone sub probe with either 25m or 50m cables.  In ground sensors tend to get beat up a little more so shorter period |
| 8160.TF25S |  | None | None | 2 | $0 | 3 to 5 years | Standard stand-alone sub probe with either 25m or 50m cables.  In-ground sensors tend to get beat up a little more so shorter period |

## Barometric Pressure Sensors

Table 11 presents the information on Barometric Pressure Sensors provided by survey respondents.

Table . Barometric Pressure Sensor

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Campbell Scientific** | CS100 | $640 | Minimum maintenance required. Inspection of connections to make sure they are secure, check cables to ensure they are dry and clean |  | 3 | $0 | 6 to 8 years | This product is made for us by Setra in Massachusetts |
| **OTT HydroMet (Lufft)** | WS300 |  |  |  |  |  |  | Also capable of measuring RH/temp and pressure |

## Water Level Sensors

Table 12 presents the information on Water Level Sensors provided by survey respondents.

Table . Water Level Sensor

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Campbell Scientific** | CS451 | $771 - $935  (plus cable costs) | We recommend factory calibration every two years. Visual inspection at every site visit for desiccant condition and possible replacement |  | 1 | $0 | 3 to 5 years | Will have a 1-year life span if desiccant is not maintained |
| **OTT HydroMet (Lufft)** | RLS (radar level sensor) |  |  |  |  |  |  | This is from OTT HydroMet, our new "One Company" profile and comes from the hydro side. This sensor is easily integrated to new or existing Lufft sites |
| PLS (pressure level sensor) |  |  |  |  |  |  | This is from OTT HydroMet, our new "One Company" profile and comes from the hydro side. This sensor is easily integrated to new or existing Lufft sites |

## Solar Radiation Kits

Table 13 presents the information on Solar Radiation kits provided by survey respondents.

Table . Solar Radiation Kit

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Campbell Scientific** | CS320 |  | Online tool to determine if calibration is required |  | 1 | $0 |  | We have multiple solar radiation sensors from our extensive work in renewable energy. |
| **OTT HydroMet (Lufft)** | WS301 (and stand-alones) |  |  |  |  |  |  | Lufft bought Kipp and Zonen, leaders in solar radiation monitoring. They can be bought with our all-in-one sensors that have every parameter needed, or as stand-alone sensors. |
| WS401 (and stand-alones) |  |  |  |  |  |  |

## Traffic / Vehicle Detection (MVDS) Sensors

Table 14 presents the information on Traffic/Vehicle Detection Sensors provided by survey respondents.

Table . Traffic/Vehicle Detection Sensor

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Campbell Scientific** |  |  |  |  |  |  |  | We integrate sensors from a variety of manufacturers. If you do not have sufficient information from those manufacturers, we would be happy to Liaise with them and provide data to you. |
| **OTT HydroMet (Lufft)** | We can integrate anything WaveTronix into our systems |  |  |  |  |  |  |  |

## CCTV Cameras

Table 15 presents the information on CCTV cameras provided by survey respondents.

Table . CCTV Camera

| **Manufacturers** | **Product Name and Model** | **Equipment Cost** | **Recommended Preventative Maintenance Activities and Frequencies** | **Estimated Annual Maintenance Cost** | **Warranty Period**  **(Years)** | **Warranty Cost** | **Expected Lifespan** | **Additional Information** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Campbell Scientific** | CCFC | $2,875 | Clean lens as required |  | 1 | $0 | 6 to 8 years | We recommend this camera for solar and remote applications. We typically use Panasonic cameras for AC powered stations requiring PTZ. Camera technology typically changes faster than the technology fails so replacement every 5-7 years is probable |
| **OTT HydroMet (Lufft)** | We can incorporate and integrate almost any camera into our RWIS sites |  |  |  |  |  |  |  |

## Software Products, Features and Costs

Table 16 presents the general product, features/capabilities, and cost information on RWIS software provided by the survey respondents.

Table . RWIS Software

| **Manufacturers** | **Software Products** | **Features/Capabilities** | **License Fees** |
| --- | --- | --- | --- |
| **Campbell Scientific** | Campbell Cloud (under development, currently used in municipal applications). |  |  |
| **OTT HydroMet (Lufft)** | Smartview3, ViewMondo (we can work with any other provider out there). | SV3 and ViewMondo can poll data in real time, give brief pavement forecast estimates, show historical data, camera images and graphs and diagrams. We also can partner with major forecasting companies such as DTN and Iteris. We are all about giving the customer what they want and what is the best fit. | ViewMondo and SV3 = $495 a year per site or mobile sensor. |