

Remote Monitoring for Water Level of Bridges and Flood Zones

with Resensys Wireless Water Level SenSpot™ (Ultrasonic Level Meter SenSpot™) Sensors and Wireless Solar Cameras

Water level of rivers can rise in heavy rainfall and cause flooding and damage to bridge structures. As a result, monitoring water level under a bridge is one of the significant aspects of a bridge's health monitoring. This kind of monitoring can also help to evaluate flood zones. The ability to monitor the water level of bridges, especially at an early stage, before it becomes a major issue or a flood event which may lead to the compromise of a bridge, a bridge road closure, and/or expensive repairs can be important to bridge authorities and owners.

Sensing technologies can be put in place for initial water level assessment and then used to understand how much and how quickly the water level changes with rain events. The applicable, measurable and monitorable quantities in this kind of monitoring are water level and ambient temperature/humidity. Typically, water level monitoring data is used for **decision support** (monitor water level, detect flood condition, close bridge during massive floods) and **structural assessment prioritization after major events**. When paired with other sensing technologies such as tilt, displacement, strain SenSpot™ and other Resensys gauges (these are extras and not part of the "basic" water level monitoring solution), owners can also quickly detect structural integrity after major distress events such as massive floods, hurricanes and earthquake. Since rainfall and flooding conditions are largely unpredictable and can have wide-spread, concurrent impact within a geographic area, long term continuous monitoring is required at assets and locations susceptible to these threats.

To allow owners to make timely, data-driven decisions after a rainfall or flooding event, Resensys has developed a unique wireless structural health monitoring solution (SHM), which includes wireless water level meter and wireless solar powered cameras. This allows owners to conduct complete and fast condition awareness and remote monitoring on water levels of bridges and flood zones even when timely physical access to these assets for inspection is challenging. The water level sensor provides constant monitoring of water level, helping to detect flood condition. The wireless camera provides visual feedback, helping to conduct quick assessment of conditions after severe floods when time is of the essence. Like all Resensys products, the [Wireless Water Level Meter SenSpot™ \(Ultrasonic Level Meter SenSpot™\)](#) and the Wireless Solar Powered Camera are ultra-low power and low-maintenance, so they are extremely well-suited for long-term continuous applications where cost-effective, accurate monitoring is needed.

Resensys SenSpot™ sensors are able to monitor water levels in concrete, steel and composite materials under wet, humid and extreme weather conditions. Resensys products are corrosion resistant and can withstand salty environments.

A Resensys Water Level Monitoring solution comprises [Wireless Water Level Meter SenSpot™](#) and Wireless Solar Powered Cameras to measure and collect the data required for required situation, a [SeniMax™ Gateway](#) to transmit data away from the site and the [SenScope™](#) display user-interface. (See

images below). Although not discussed in detail in this application note, other sensors can also be added to provide more extensive monitoring of other factors such as tilt, displacement, strain etc. in the event that the rainfall/ flooding event does cause structural damage.



Resensys Wireless Water Level SenSpot™ sensor and Wireless Solar Powered Camera on bridge

Resensys SenSpot™ sensors are easily placed/ installed on bridge (specific pier or abutment) as determined by inspection (before or after flood event) or authority's/client's suggestion. The Wireless water level is driven into specific pier or elements, top of the river water surface and can extend over the top of the river to be in contact with the water without need for diverse or complex installation procedures. Since all Resensys sensors are wireless, no additional wiring is required, reducing installation cost and time. The sensors are mounted with adhesive or flange mounted depending on the application. The products can be extended on brackets or custom support arms to obtain the best visual line of sight or ultrasonic water level measurement reading. A Senimax™ data acquisition unit is conveniently mounted nearby or conveniently mounted within 1.0Km (0.62miles) free space of the SenSpot™ Sensors, cameras and a SenScope™ Module is installed on the client's/authority's laptop or PC. Also, no on-site calibration is required for installing gauges.

All system components communicate using cellular or satellite data services, and as a result, the system operates in real time. The system provides an alarm function that allows agencies to react in timely manner, allowing them to take precautionary actions and perform subsequent and cost effective remediation, avoiding major or safety-compromising issues. The ultra-low power usage means that batteries do not need to be replaced, as Resensys' systems have a 10yr+ expected battery life.

A complete Resensys SHM system includes software and hardware components for (1) the reliable collection of SenSpot™ data, (2) aggregation of the data, (3) the addition of timestamps, (4)

communication of encrypted data to a remote server, and finally, (5) an interface for data visualization and detection of structural issues. Figure below shows a picture of a practical Resensys SHM system. The system includes the following components:

- SenSpot™ sensors (Wireless Water Level and Wireless Solar Powered Camera as required): which are attached to a bridge (Required number of sensors and camera per structure, depending on design and monitoring needs).
- SeniMax™: which collects SenSpot™ and camera data at the site and sends it to a remote server (one unit can cover as many as 100 SenSpot™ sensors).
- Repeater: may be used to extend the range of the SenSpot™ sensors.
- SenScope™: software for data analysis and visualization

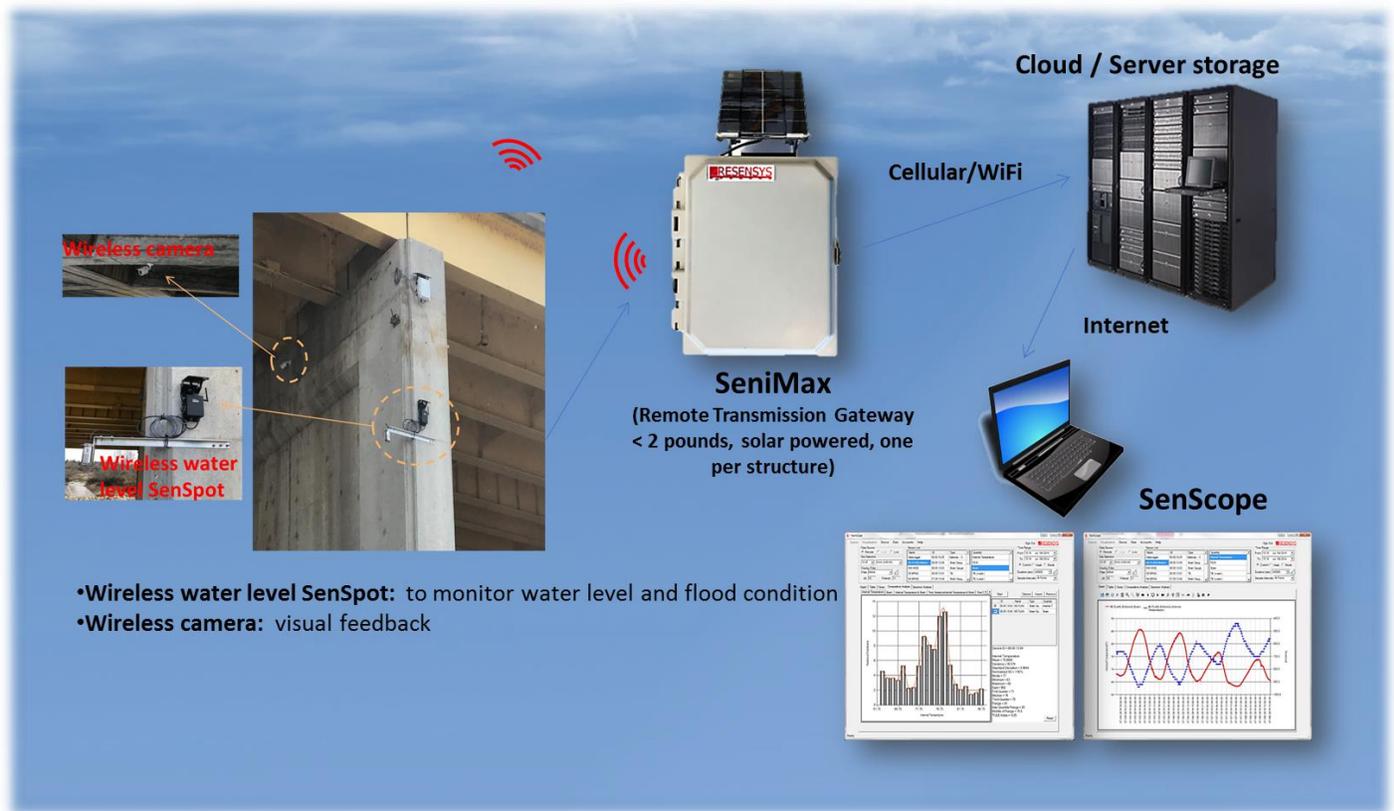


Illustration of Resensys SHM based on SenSpot™ sensors for remote monitoring for water level of bridges and flood zones

Technical Specifications:

	SenSpot™ Wireless Level/Height Meter
Size (Dimension)	-Ultrasonic Probe Dimension: Height 11cm (4.33") Radius : 2.5cm (1") Mounting: 15cm(5.90") *10cm (3.94") corner brace
Weight	-Wireless transceiver: 450g (1 lb) -Ultrasonic distance meter: 0.8kg (1.8lb) -Solar panel: 100 g (3.5oz)
Mounting	Flange-mount or adhesive tape
Accuracy (Resolution)	3cm (0.1ft)
Measurement Range	-Optimal Range: 6.1m (20ft.) -Max Range: 9.1m (30ft.)
Operating temperature	-40°C to +65°C(-40°Fto +150°F)
Lifetime	Battery life of 10 years (Ultra-low-power)
Installation Time	1-2 minutes
Complementary sensing	Temperature, battery voltage, etc.
Communication range	1.0km(0.62mile)free space
Power source	Replaceable lithium ion battery
Wireless communication	No wiring is required for data collection- IEEE 802.15.4



An ultrasonic wireless water level sensor and cameras used for monitoring flood condition on a number of bridges in California



Wireless solar powered cameras used on California and Pennsylvania scour critical bridges.