XT-DTS™ , ruggedized distributed temperature sensor, characterizes groundwater inflow areas to help mitigate environmental contamination

Client: Missoula Valley Water Quality District

Background Information

From 1957 to 2010, a paper and pulp mill operated in the historic floodplain of the Clark Fork River is western Montana (USA) as a large industrial complex, including 900 acres of unlined settling, sludge and wastewater ponds. The Clark Fork River forms most of the 5.8-kilometer-long western property boundary of the site and wastewater was discharged directly into the river when the mill was operational.

Since closing of the mill in 2010, environmental investigations of the site have found toxins in the sludge ponds, groundwater and river sediments adjoining the site. On-going investigations of the site seek to delineate the extent of contamination in the subsurface, aquifer and river to best inform remediation.

Previous studies of the mill site have found highly variable hydraulic conductivity and complex groundwater flow across the site, which make site modeling, characterization and contaminant sampling challenging.

Challenge

To localize and characterize groundwater inflow areas at a former mill site to enable site modeling and help mitigate environmental contamination.

Solution

Deploy Silixa's ruggedized XT-DTS to measure water temperatures utilizing a 5 km long fiber optic cable installed along the riverbed adjacent to the former mill-site, and use the collected data to identify regions of groundwater inflow.

Results

Several regions of likely groundwater inflow identified.

The solution

In July 2019, almost 5 km of fiber optic cable was deployed along the riverbed adjacent to the former mill-site for the purpose of measuring water temperature using DTS and thereby collecting data allowing identification of regions of groundwater inflow.

Deployment of fiber optic cable was made challenging by the large scale of the river, highly variable riverbank conditions, limited access and wildlife activity. To minimize environmental risks and impact, the fiber optic cable was secured to the riverbed using native rock only and completely removed from the river following this study. Silixa's XT-DTS was deployed on the riverbank and used to obtain temperature measurements along the installed cable over several days each in July, August and September corresponding to periods of relatively higher streamflow, base streamflow and higher groundwater, respectively.

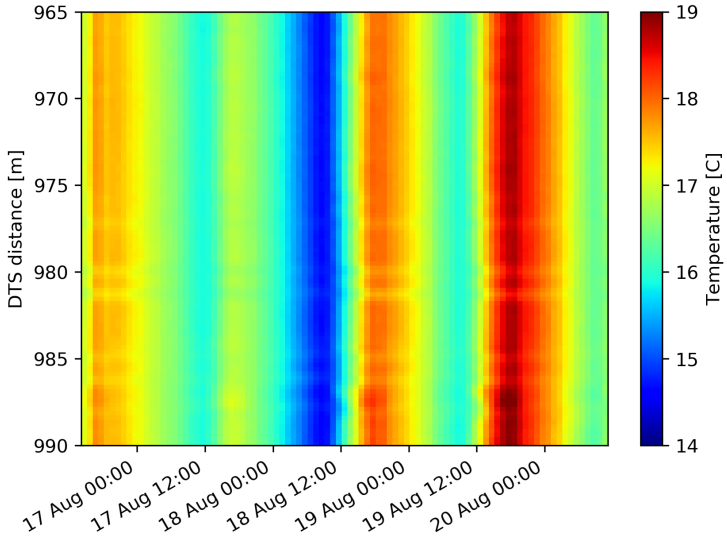
Designed for 12-24 V DC power input, XT-DTS was powered by a deep cycle battery and data was stored internally during each measurement period. Temperature data were obtained every hour with 10-min data acquisition at a sampling resolution of 25 cm.

Value creation to client

While surface water temperatures cycle diurnally due to solar heating, groundwater temperatures are much more stable. River water temperature data were therefore analyzed to identify regions where the temperature had a significantly lower standard deviation through time, indicating a more stable water temperature due to influx of groundwater. Regions of low standard deviation were correlated with lower average temperatures, consistent with groundwater temperatures being colder than surface water at this time of year.

Six regions of likely groundwater inflow were thus identified and mapping of the cable with GPS coordinates during installation allowed specific localization of these regions for targeted future study.

Data taken over the different measurement periods show variations in the groundwater signature due to changes in surface and aquifer discharge, as well as seasonal temperature variations.



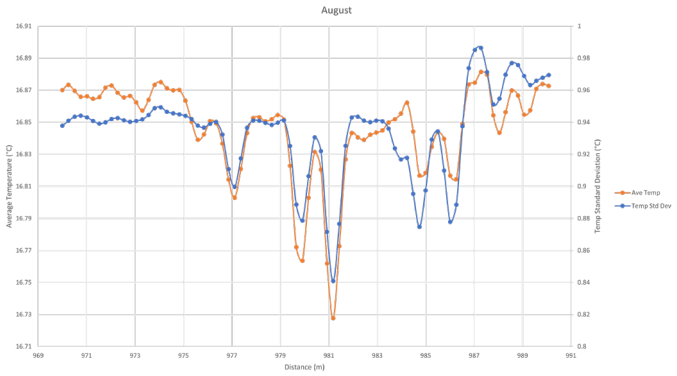


Figure 1: Temperature readings taken by XT-DTS over several days

Figure 2: Deviation in river water temperature profiles indicates influx of groundwater

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