



Mapping Water Quality of Drinking Water Reservoir Using an AUV

A joint development project between OceanServer Technology and YSI Inc. has produced the first cost-effective and easy-to-use Autonomous Underwater Vehicle (AUV) designed specifically for water quality mapping. The vehicle can augment existing water quality monitoring programs that use instruments at fixed locations and even replace costly monitoring programs using small vessels. In addition, due to the vehicle's small size and draft, it is well designed for mapping in shallow waters where boat use is restricted.

The YSI/OceanServer AUV provides water resource managers with a valuable tool for easily collecting highly resolved spatial water quality data. This information can be critical for protecting water sources by:

- Mapping algae blooms
- Investigating impacts of storms
- Studying water quality and impact of point and non-point sources of pollution
- Understanding horizontal and vertical variability of water quality
- Choosing the most appropriate water intakes for drinking water abstraction
- Providing data on when and how long to apply treatment chemicals or pre-treatment systems

Managers who apply water quality data can quickly improve efficiency at drinking water plants – delivering a cleaner product at a more competitive cost, thereby increasing customer satisfaction.

Recently the YSI/OceanServer AUV was deployed in a Massachusetts reservoir in order to generate water quality maps. The vehicle was outfitted with a YSI 6600 multiparameter sonde with conductivity, temperature, depth sounder, pressure gauge, pH, dissolved oxygen, turbidity, and

chlorophyll sensors that were sampling at a frequency of 1Hz. The vehicle was flown at a constant depth of 3 meters from the surface (but it also has the ability to undulate in the water column).

The water resource managers in Massachusetts were interested in mapping the water quality in the area around the reservoir's primary water distribution intake as well as to investigate the water quality around an area of a local road-building project.



A YSI 6600 water quality sonde is mounted inside an OceanServer AUV for spatial mapping of drinking water reservoirs.



At less than 4 feet long and 40 pounds, the AUV is easily deployed and retrieved from shore.

Normally, the reservoir's water quality sampling cruises occur monthly. These were limited to specific sampling stations and required at least two personnel, a boat, and monitoring equipment. The YSI/OceanServer AUV allows them to sample at will and in any area of interest and resolution.

Mission Planning

The AUV missions were planned using Windows®-based software that allowed the users to plan directly onto geo-referenced map files of the field sites. The vehicle route was drawn directly on the map files, utilizing selectable settings such as vehicle speed, vehicle depth (distance from surface or distance from the bottom), and waypoint designation (where the vehicle can surface for data download). This took about 10-15 minutes.

Technicians from the Massachusetts drinking water plant oriented the vehicle using a GPS unit mounted into a floating 'puck' on the surface, ensuring the vehicle maintained the correct positioning in the water, even in strong currents. The GPS puck, attached to the vehicle by a tether, has an extremely low drag and does not impact the speed or maneuverability of the vehicle. A radio antenna was used to communicate with the vehicle when it was on the surface.

Data Retrieval and Analysis

Following a 3-hour survey of the areas of interest in the reservoir, the vehicle navigated itself back to the programmed launch point. ASCII data was immediately downloaded to a PC and graphed in the user's preferred data visualization software (see below).

This type of data provides valuable information on the distribution of various water quality parameters in a surveyed area. The operator determines the spatial resolution, but it is significantly higher than surveys conducted from boats. The vehicle's ability to undulate in the water column also provides vertical mapping in addition to horizontal mapping, resulting in 3-D profiles.

The YSI/OceanServer AUV has a 570 WHr rechargeable Lithium Ion power supply that can last for 12 hours at typical cruising speeds of 2-3 knots. On a single battery charge, it can survey over

60 miles in one day at a cost of ownership that is significantly less than using a boat and more than one operator.

YSI (www.ysi.com) designs sensor instrumentation and real-time monitoring systems for professionals who protect natural resources; OceanServer (www.ocean-server.com) develops autonomous vehicles and efficient power subsystems for electronic equipment. The two companies will continue to run field tests on the water quality AUV through 2006 with a planned product launch in early to mid 2007.

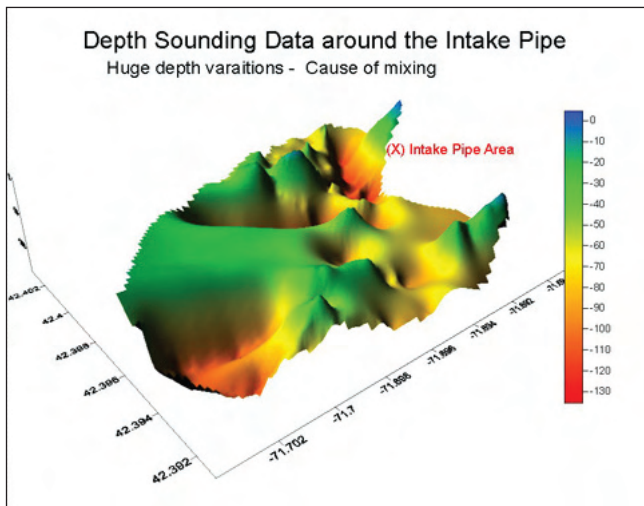
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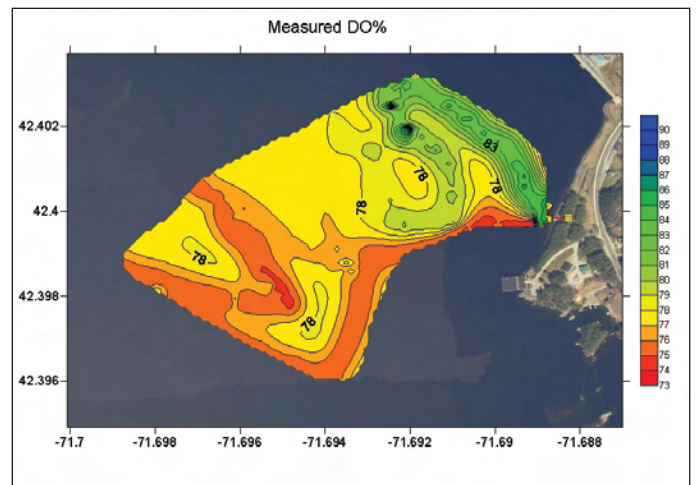
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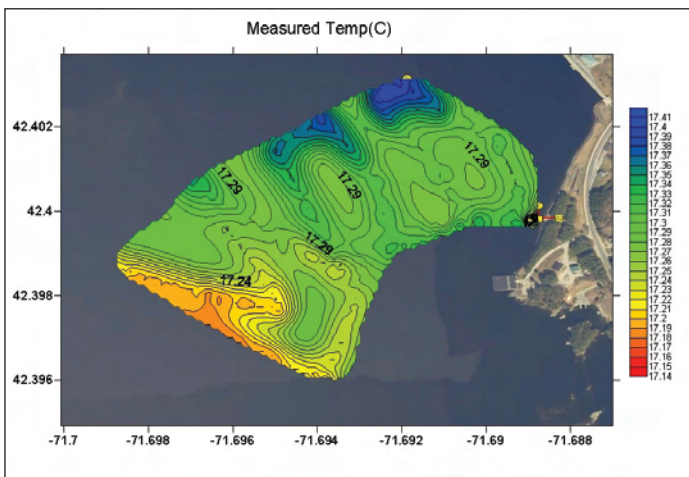
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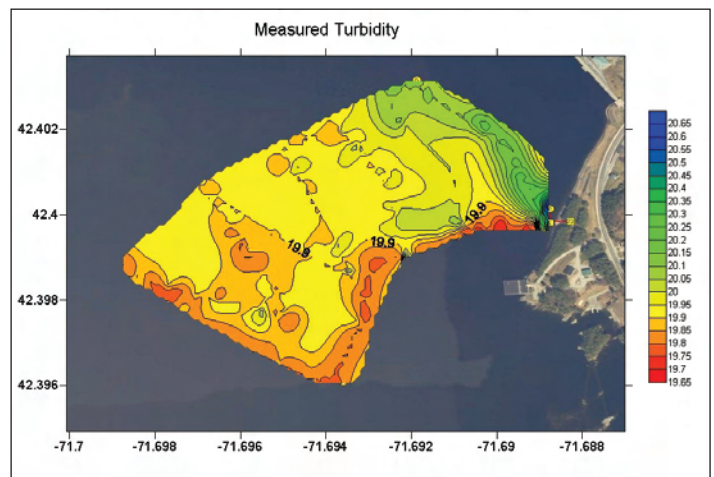
Depth sounding of reservoir plotted in 3D using Surfer Software (ver. 8).



Distribution map of dissolved oxygen around intake area. DO, a critical water quality parameter, is impacted by algae blooms and can also be used to control aeration systems for controlling manganese or improving vertical mixing.



Distribution map of temperature around intake area. Temperature indicates vertical stratification and can also trigger algae blooms.



Turbidity distribution in the area of the water intake. Turbidity is often used to measure the impact of storms or run-off on water quality.