



AQUARIUS Operational Environmental Systems Case Study: Near Real-Time Water Quality Monitoring and Data Distribution in the San Joaquin Valley Wetlands



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Dr Nigel Quinn, Berkeley National Laboratory

Solution Highlights

- ▶ Automated, continuous collection and processing of water quality data allows near real-time dissemination of results
- ▶ Improved QA increases confidence in published data
- ▶ AQUARIUS cuts data review time by 90%

Solution Summary

- ▶ **Client:** Berkeley National Laboratory
- ▶ **Application:** Water Quality Analysis
- ▶ **AQUARIUS packages:**
 - AQUARIUS Hydrologic Workstation
 - AQUARIUS Database
 - AQUARIUS Lite



Background

For decades, Nigel Quinn has worked with the farmers and landowners of the San Joaquin Valley. A hydroecological engineer with the Berkeley National Laboratory and other institutions, Dr Quinn leads a long-term initiative that strives to reduce the salinity of the wetlands' water through accurate water quality monitoring, QA, and forecasting. Working with the US Bureau of Reclamation and others, he has overseen the installation of hundreds of water quality sensors, wirelessly connected to an AQUARIUS Hydrologic Work station with an AQUARIUS Database.

Continual Monitoring, QA and Forecasting

Dr Quinn describes the area and its problems. "The valley is close to two million acres in area, of which a million are managed wetlands, with imported water that contains a mix of fresh and salt water. The entire area is drainage affected, with shallow groundwater and resultant salinity problems." He and his team are working in a 170,000 acre area, which acts as a microcosm of the two million acre basin. The objective is to use real-time water monitoring of the water's salt content, to increase the salinity that can be returned to the river.

The problem, Dr Quinn explains, is that the traditional method of setting the TMDL (Total Maximum Daily Load) for salt is quite conservative—it sets a salt load target that's based on 10% of the lowest water levels, measured as a 30-day mean. However, the legislation allows for an exclusion, if stakeholders can prove that they are capable of managing the salt load in near real-time. With near real-time salinity management, he says, they could export more salt load, coming much closer to the river's carrying capacity, without exceeding water quality objectives.

"We are attempting to set the standard for this practice," he says, "and to set the bar at a level that is achievable." The project has many components, including water monitoring, QA, forecast modeling, and the ability to police stakeholders. In the 170,000 acre area, the team has deployed a YSI Econet network of hundreds of water quality sensors. For the heart of the system, Dr Quinn selected AQUARIUS, for its data collection power, its automation capability, and—most importantly—its accuracy. "We can't afford to put out preliminary data that is wrong, because our forecasts will be wrong and people will lose confidence in our ability to characterize the system."

AQUARIUS Improves QA

"We're doing a far better job on QA now," he says. They routinely do data manipulations that would previously have been prohibitively time-consuming. "With AQUARIUS, we can see the raw data, and the QA points, and treat them as objects. We can create the best-fit line without going through tedious interpolations. We can create visualizations of the data and manipulate it in a graphical way." One of his personal favorites: "Being able to concertina a data set—to look at the whole data set and then extend the horizontal axis so you can visualize it in more detail. That's very powerful."

The AQUARIUS system is faster and less labor-intensive. "It used to take a lot of time and effort to move the data from where it is collected, migrate it into a QA system, and then disseminate it. With AQUARIUS, we can provide accurate information in near real-time." Dr



Quinn recommends processing data immediately, rather than at the end of an annual collection period. “If you keep your data current,” he says, “you’ll see, right away, when something has drifted, or when there’s an error. If you wait until the end of the year, the data has been lost. A lot of data gets thrown away, because it isn’t reviewed frequently enough.” In his project, they’ve discovered failed sensors and radio transmitters, and replaced them promptly before too much data was lost. “I think that may be the most important aspect of the AQUARIUS system.”

As the project moves forward, monitoring will grow to 20 times its current scale, and AQUARIUS will keep their costs contained. “Automating the data collection and management is where we’ll realize most of our savings. The AQUARIUS system can handle a huge number of nodes, and with one AQUARIUS whiteboard, we can batch-process the data.”

Logistical and Time-Saving Benefits of AQUARIUS Over Excel

Before acquiring AQUARIUS software, the team used Microsoft Excel spreadsheets to handle water quality data. Says Dr Quinn, “Doing this work with Excel—the tedium of it—was driving everyone insane. It really was.” He feared that they would lose staff. “These are fish and wildlife biologists. They want to be outside in the field, collecting data. They don’t want to be stuck in front of a computer, parsing data files.”

Establishing AQUARIUS as the core of their data sharing system has proved a breakthrough. “Now everyone can review the data with my annotations. They see the raw data and what I’ve done with it. If they have AQUARIUS Lite, they can share their comments on the data.” He describes the challenge that AQUARIUS has helped resolve. “We work with hundreds of entities, state, federal and private. They each have their own boards and their own water management procedures.” Once a year, he says, “We’d assemble a group in a room, and we’d view spreadsheets on a projector. To go through a year’s information from 30-odd sites could take a couple of days. With AQUARIUS, it takes a tenth of that time.”

Clear, Understandable Data Visualizations Build Trust

AQUARIUS has enhanced stakeholder trust in their forecasts, he says. “The managers have gained far more confidence, because their people can show them the data in a variety of formats—more flexible formats. They can be shown the original data and what has been done to it, all the QA points. AQUARIUS has provided a degree of confidence in the process that no one had before.” The AQUARIUS audit history is also a confidence builder.

Dr Quinn summarizes. “Our AQUARIUS experience has been very positive on all three levels—one, we have better data, two, we retain our employees, and three, we’ve gained more confidence among the management.”

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For more information on Nigel Quinn and his colleagues’ methods, see the academic paper “Use of environmental sensors and sensor networks to develop water and salinity budgets for seasonal wetland real-time water quality management” published by Elsevier Science & Health News, in their journal Environmental Modelling and Software

www.elsevier.com/locate/envsoft

¹Quinn, N.W.T., et al., Use of environmental sensors and sensor networks to develop water and salinity budgets..., Environ. Model. Softw. (2009), doi:10.1016/j.envsoft.2009.10.011