A NEW INFORMATION SYSTEM FOR OPERATIONAL & LABORATORY DATA

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ABSTRACT

This paper highlights the process employed by Goulburn Valley Water (GVW) in the identification, development and implementation of a suitable information system for the collection and management of all field, laboratory, plant and calibration information collected for water and waste water services within the Authority.

A partnering approach was undertaken between GVW and Bridge-Soft LLC of the United States to develop a specific product suitable for the water industry, based upon an existing product of Bridge-Soft.

Specifically, the paper outlines the history dictating the need for the Information System, as well as the key processes undertaken and issues encountered during the development of the database. In addition, the benefits to GVW and generally to the Water Industry will be discussed.

KEY WORDS

Goulburn Valley Water, Bridge-Soft QMS, Information System

1.0 INTRODUCTION

Goulburn Valley Water (GVW) covers 20,000 square kilometres in northern Victoria, and serves a population of over 120,000 in 55 towns, with 40 water treatment plants and 27 wastewater management facilities. Owned by the Victorian state government, it was formed in 1994 by integrating 23 smaller water boards to create one of Victoria's largest regional managers of urban water supply and wastewater treatment services. The region is home to several major food processing industries, including seven of the top 200 national export earners. As a result, water consumption and waste treatment capacity throughout the region is equivalent to that of over 1.5 million people.

The obligations and expectations for the water industry to provide high quality water and waste management services that meet public health and environmental requirements have increased greatly in emphasis in recent years. More stringent drinking water requirements, legislated in Victoria as the *Safe Drinking Water Act 2003*, have been instigated. Additionally, the water industry in Victoria is now regulated by the Essential Services Commission (ESC), adding another layer of regulatory responsibility.

GVW has met these challenges by recently implementing an environmental management system certified to ISO14001, and a drinking water quality management system based upon the principles of the Australian Drinking Water Guidelines (ADWG) "Framework for the Management of Drinking Water Quality" and HACCP. These quality systems have necessitated a significant upgrade in data collection, record keeping and information analysis.

2.0 THE NEED FOR NEW INFORMATION SYSTEMS

The technical departments of GVW generate and collect enormous amounts of data on a continual basis. These fall into three distinct categories (Morris 2003):

1. Analytical test results reported by accredited laboratories that are used for regulatory compliance and formal reporting purposes, in relation to:
   - Drinking Water Quality.
   - Wastewater / Environmental & Trade Waste.

2. Operational data collected by GVW's field and technical staff, such as analytical test results, readings, observations, checklists and comments.

3. Real-time process data acquired by electronic and on-line instrumentation and transmitted to the SCADA system and/or treatment plant PLCs.

Considerable resources are expended generating and collecting this data which forms an essential element of GVW's operations. Previously, this data was neither collected nor stored in a readily useable format that could be easily accessed and converted into useful information to enhance the performance of the organisation.

2.1 Drinking Water Quality Data

There had previously been no water quality database for laboratory test data for GVW's drinking water supplies. Records were maintained via electronic copies of individual analytical reports from external laboratories. Reports were generated manually, which proved to be extremely time-consuming and susceptible to error.

A dedicated water quality database was desperately needed to be able to efficiently store and retrieve analytical test results for:

- Generation of reports for government, industry customers and the general public;
- Verification of compliance with regard to operational and regulatory requirements;
- Use by engineers and consultants in the design and upgrade of treatment plants;
- Process optimisation and operational improvement of treatment facilities and distribution systems.

2.2 Wastewater / Environmental & Trade Waste Data

GVW had previously used an outdated Access database for maintaining laboratory results for wastewater and environmental samples. Trade Waste data was maintained in an Excel spreadsheet, and required double-handling of test results previously entered into the Environmental database. Although these information systems were functional, they involved manual entry of data and were deemed inadequate for meeting long-term requirements.

2.3 Operational Data

There had previously been no computer-based information system for maintaining operational data collected by field staff. Disparate Excel spreadsheets were used at some sites, particularly at the wastewater management facilities, but the majority of sites only used paper logsheets and diaries.

The major benefits of providing a data management system for operational data were identified as being:

- Improvement in the accessibility and dissemination of operational data;
- Centralisation of data storage to provide greater assurance of records maintenance;
- Elimination of the double-handling of data;
- Leverage of raw data as valuable information for process optimisation and continuous improvement of treatment facilities and distribution systems.

2.4 Real-Time Process Data

GVW has an extensive and well-developed SCADA network that provides real-time monitoring of critical parameters at each of its sites. Data is automatically stored by the SCADA application, but is overwritten within 12 months. There has been no system or strategy for maintaining real-time data records beyond this time-frame.

3.0 SELECTION OF PREFERRED INFORMATION SYSTEM

Investigations into a water quality database and an operations database were initiated as separate projects in 2001/2002. The need for a new environmental database and a 'historian' database for SCADA data were also recognised at this time.

3.1 Assessment of Options

Many proprietary databases have been developed by Australian water authorities for management of drinking water quality data. The same is true for environmental and wastewater data. It was an option for GVW to undertake development of its own water quality database, but due to resource limitations and risk considerations the utilisation of an existing, proven information system was preferred. In the initial stages, several existing water quality and environmental databases were inspected and evaluated.

There were very few commercially-available databases specifically designed for water industry use. However, it was recognised that there were many commercially-available software packages designed for other industries, as Laboratory Information Management Systems (LIMS) or as Statistical Process Control (SPC) software that may be adaptable to the needs of the water industry. During this assessment process, it was recognised that the more sophisticated software packages may not only be capable of fulfilling the requirements of a water quality database, environmental database or operational database, but potentially could serve all of these areas.

The assessment of the available information systems was based on the following criteria:

- User-friendliness and intuitiveness for data entry by Operators.
- Flexibility and adaptability to the informational needs of the water industry.
- Ability to record all data types, including numerical values, qualitative attributes, calculated values, 'censored' data, observations and comments.
- Capacity to import data from external laboratories and other sources.
- Assignment of specification and control limits with instantaneous alarming to users.
- Data validation functionality to avoid acceptance of invalid or erroneous data.
- Extensive graphing and data querying capabilities, with the ability to export data.
- Database platform compatible with a multi-user, geographically-dispersed network.
- Security functionality supporting multiple levels of access and privileges.

3.2 Evaluation of Viable Options

Of the scores of software packages that were initially identified and assessed, five information systems were short-listed, as they were considered viable solutions for the majority of GVW's technical data requirements. Evaluations of each of these software packages were made from presentations or evaluation copies of the software.

The respective scopes and capabilities of each of the short-listed software packages were rated, with priority weighting applied, for their suitability is fulfilling the following aspects:

- Manual entry of operational data.
- Water quality database.
- Environmental & wastewater database.
- Instrument calibration records and scheduling.
- Chemical QC records.

This evaluation process revealed that two of the software packages were clearly superior in meeting GVW's required scope and capabilities. These two information systems then each underwent a more thorough evaluation and trial process.

3.3 Pilot Trials

One of these two information systems was configured for manual entry of treatment plant readings and results. A small group of Operators were trained in the use of the software and participated in the project across four sites. After two months, the trial was considered a resounding success. This direct involvement at such an early stage in the project provided a real sense of ownership to those Operators who would ultimately be the end users.

The other system, Bridge-Soft QMS, was piloted to a more limited extent. Bridge-Soft, a USA-based software company, were engaged on a consultancy basis to provide system configuration and customisation to GVW's requirements. During the trial period, Operators maintained their involvement in the project by participating in several demonstrations and workshops centred around the use of the software.

Both information systems offered highly-developed solutions that were well suited to the data management needs of GVW. Each system had strengths and weaknesses, but following a comprehensive comparison of existing and potential functionality, performance reliability and technical service offerings it was determined that the Bridge-Soft QMS database would provide the better long-term solution. It demonstrated a very high level of adaptability and configurability to meet the specific data needs of the water industry and featured an impressive web-based reporting and ad-hoc data querying application (Morris 2003).

4.0 FURTHER SOFTWARE DEVELOPMENT

Bridge-Soft is a software development company based in Manchester, New Hampshire, USA. The company's QMS (Quality Management System) database was originally established in the mid-1990s as an information system utilised by such diverse manufacturing industries as the food and beverage, chemical, electronics and gas industries.

Bridge-Soft's software provided these manufacturers with sophisticated tools for managing product test specifications and limits, logging/tracking samples, collection of test results (manual or real-time), automated generation of certificates of analysis, extensive reporting and analysis, and scheduled calibration of measuring instruments. However, to more precisely fit the unique needs of the water industry, several aspects of the software were explored for potential improvement. Bridge-Soft was very receptive to enhancing the capabilities of their software, so entered into a partnering arrangement with GVW to develop new functionality. It was anticipated that this would provide benefits to GVW, Bridge-Soft, and the water industry in general.

The most notable areas of software development involved:

- Redesigning the manual data entry interface;
- Introducing a new application for importing data from external sources; and
- Integrating a new module for tracking and resolving non-conformances.

4.1 Data Entry Interface

It was recognised that the existing QMS manual data entry screen, whilst impressive, was not well suited to the efficient input of high volumes of data. A new data entry screen was designed with the following features:

- A spreadsheet-style layout that would be highly intuitive for users.
- Controls to enable the user to easily select the required site and testing program.
- Dynamic display of previous results in both tabular and graphical formats.
- An interactive interface to automatically provide messages and visual/audible prompts for data validation and informational purposes.

A data entry system that was easy-to-use and provided instantaneous feedback were considered major keys to the acceptance of the system by end users. Considerable time and effort was spent on the design and development of the data entry screen. The end result has proven to be extremely successful. The data entry screen is considered as simple-to-use yet highly sophisticated and informative.

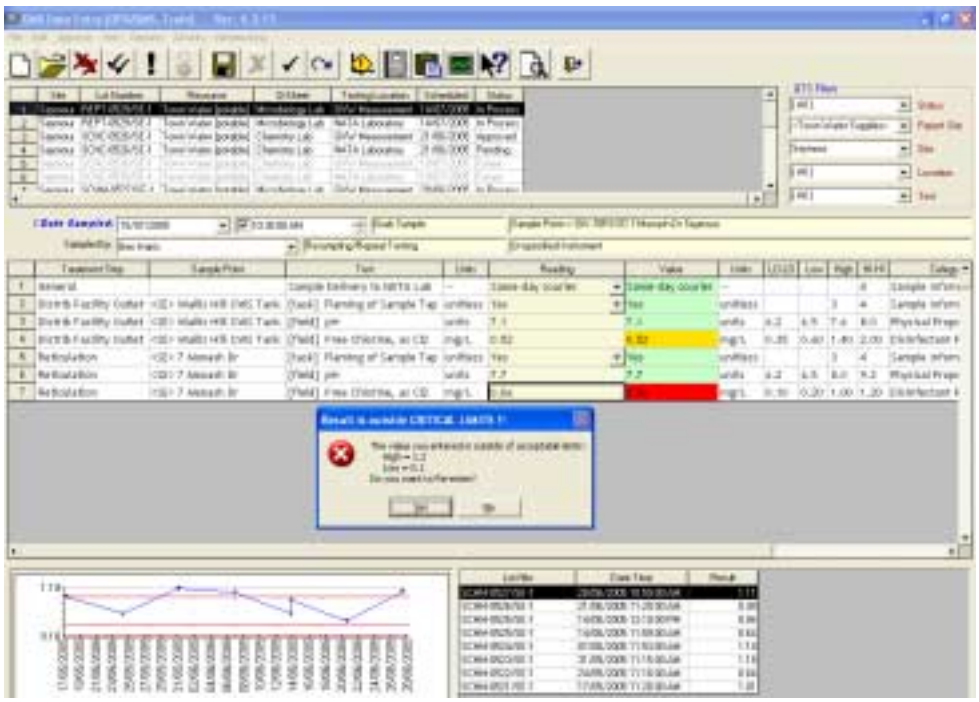

Figure 1: ***Data Entry Screen***

Some additional functionality is planned for the future, but the basic layout of the data entry screen is not expected to change.

4.2 Importing of External Data

An improved data transformation services (DTS) application was developed. From their experience in helping to design the US EPA's new standardised data exchange protocols, Bridge-Soft developed the DTS application based upon the generic XML language. The DTS data importing system is an extremely flexible tool that enables the transfer of any data by a simple process of mapping the data sources to the appropriate database fields in QMS. GVW is also using this application to schedule its testing programmes.

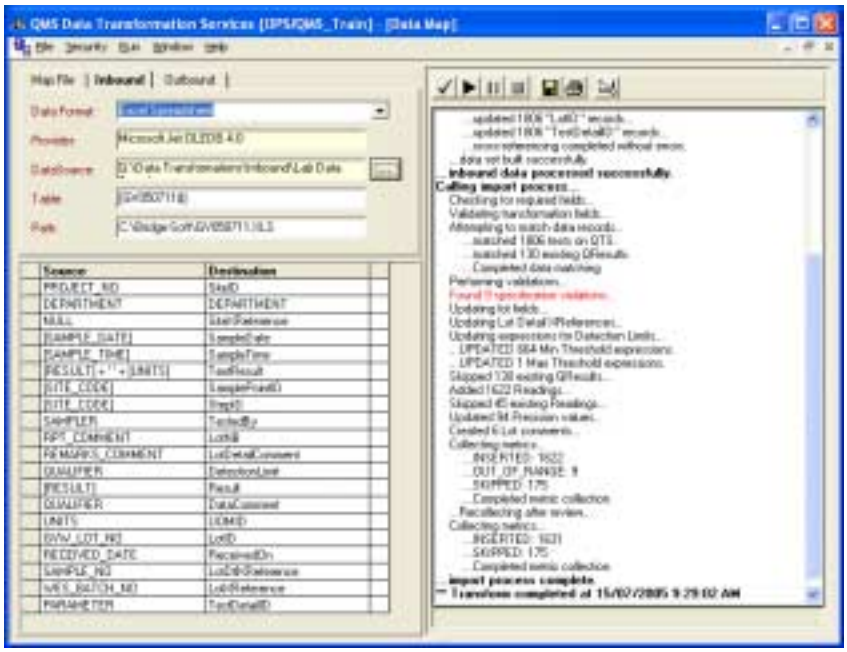

Figure 2: ***Data Transformations dialog screen***

4.3 Non-Conformance Resolution Module

As part of the quality assurance and continuous improvement systems employed by GVW, it is important that non-conforming test results are recorded and resolved through assessment, root cause analysis and corrective actions. A new module was added to QMS to automatically initiate the tracking and resolution of non-conforming test results.

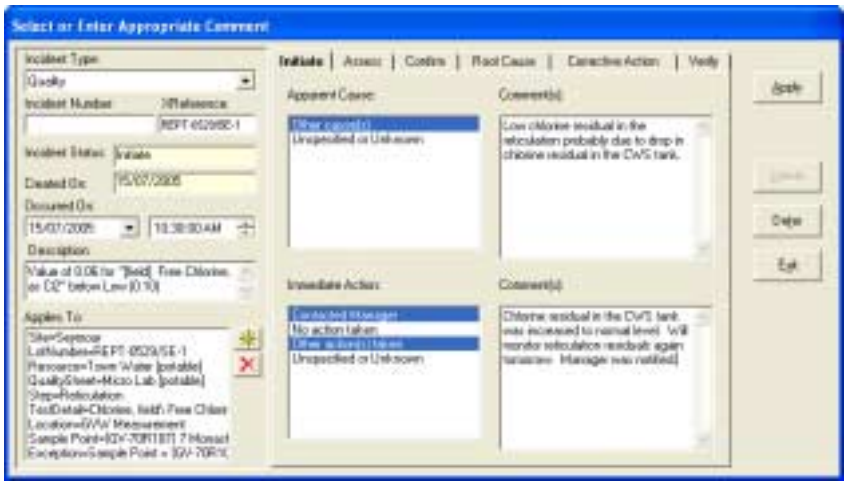

Figure 3: ***Non-Conformance Module***

This electronic non-conformance resolution module has replaced a paper-based system that was cumbersome and unpopular. The new system has been designed such that, in the future, it may be utilised for many other purposes, such as environmental, security and safety incidents, as well as recording and tracking proactive suggestions from employees.

4.4 Development Issues

The process of enhancing the existing software and developing new functionality provided a number of challenges. The development program took considerably more time and resources than was originally envisaged. In particular, the exhaustive testing and 'debugging' process following modifications to the software was a tedious and time-consuming process.

The initial success of this project resulted in several other water authorities and commercial analytical laboratories, both in Australia and the United States, implementing the Bridge-Soft QMS information system. This initiated new waves of development that prolonged and complicated the development program. However, the end result has been tremendously worthwhile. On-going issues in this area are being minimised following the inception of a QMS users group in Victoria.

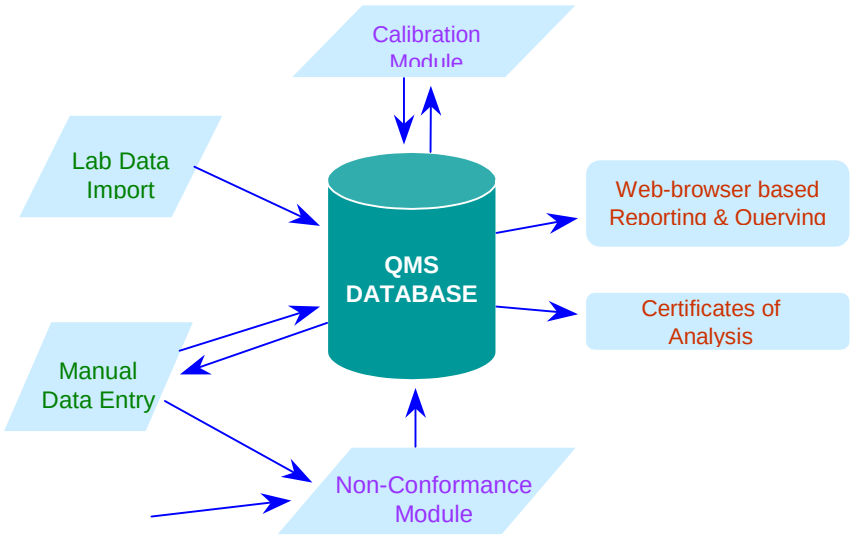

Figure 4: ***Bridge-Soft QMS Information System (Morris & Darmanin 2004)***

6.0 IMPLEMENTATION OF QMS

The ultimate implementation of the Bridge-Soft QMS information system has always been a major consideration since the inception of the project. It is believed that up to 75% of major information systems will be considered as failures, predominantly due to poor implementation or design (Laudon & Laudon 2000), so it was enormously important that the end users of the system were intimately involved in the direction of the project and have always been fully taken into account. For example, the redesign of the manual data entry interface was considered to be critical to the successful implementation of the software.

6.1 Software Configuration

Bridge-Soft initially provided a group of technical personnel with a week-long training program to enable GVW to undertake its own configuration work. There has since been a staged approach to configuration and a continual roll-out of the system.

6.2 User Training

Prior to the system going 'live', all prospective users of the data entry interface were given an intensive half-day training session. These sessions were conducted over a one week period and involved small groups of Operators and their supervisors having direct hands-on interaction with a 'training version' of the database to gain confidence and experience. A comprehensive user manual was also provided at this time. Whenever updates have been made to the software, changes have been communicated to all users and refresher training sessions have been provided to each work team.

6.3 Implementation Issues

Due to the strong consideration given to implementation throughout the course of the project, and the intensive training programs sessions that were provided, the new information system has generally been well accepted. The most significant issues have related to 'bugs' in the software and data entry errors. Any serious 'bugs' have been quickly eradicated by Bridge-Soft via immediate updates, whilst less serious problems have been corrected for future planned updates. Data entry errors are inevitable, but these have been reduced substantially through software modifications and targeted training.

7.0 CONCLUSION

The requirements for data collection and information processing have increased dramatically as a result of escalating regulatory and quality assurance requirements. Although the authority did identify the need to implement new information systems to manage drinking water data, waste water and environmental data, and operational data, the resulting outcomes of this project to date, and the acceptance of the system, have far exceeded initial expectations. The Bridge-Soft QMS information system has provided GVW with an extremely powerful and user-friendly mechanism for managing all of its technical data and helps to meet its quality assurance and service responsibilities.

One of the most significant aspects of this project has been the extensive scope of the undertaking. The future direction of the Bridge-Soft QMS information system is to continue to extend the scope of the system to encompass all facets of water industry operations.

8.0 ACKNOWLEDGEMENTS

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