Aquarius: Shellfish Sanitation Simulator, Rainfall and Water Quality Closure Rule Evaluator Version 2.0*

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PROJECT OBJECTIVES

The long-term goal of this project was to develop a version 2.0 of the Aquarius simulation and statistical analytical software designed for public health agencies and the shellfish industry to evaluate water quality closure regulations for the shellfish industry, based on the National Shellfish Sanitation Program. This project has regional, national, and international application. With the success of Aquarius version 1.0***, a series of meetings were held with industry and state and federal agency representatives of the regional Pacific Rim Shellfish Sanitation Conference, in which they were asked what improvements they would like to see in a new version of the software program. State and federal shellfish regulators and industry in the western states expressed enthusiasm for an expanded program, and identified 12 additional components that they considered essential to a fully mature program that could be used as a decision-making tool in their processes for initiating changes in rainfall closure regulations.

> *** Conte, FS and A Ahmadi. 2005. Aquarius: Shellfish sanitation simulator; rainfall and water quality closure rule evaluator. Department of Animal Science. Copyright 2004–2006. Regents of University of California. Software program and program manual. 40p.

Aquarius Version 2.0 has a similar basic format as exhibited by Version 1.0; however, the program has been enhanced to accommodate increased parameters in the simulation mode and incorporate additional statistical analyses. Version 2.0 incorporates 12 primary changes as follows:

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* A second software program, "Weather Processing Computer Programs" not included in the grant proposal was also produced as a companion program for Aquarius v.2.0, and may also be used to convert data associated with any other rainfall program datasets.

Primary Rules: In Version 1.0, the user can operate the program using only one primary rule. Version 2.0 will allow the user to run up to three primary rules. Growing areas vary in the number of primary rules assigned by the health department. Most have one primary rule, but some may have two to three primary rules.

Sample Type: In Version 1.0, the user can operate the program using only one sample type. The health service agencies often separate their own archived data sets from other agency water samples, or even water samples data that are taken by commercial growers participating in cooperative sampling programs. Version 2.0 will allow the user to isolate individual sample types, or combine up to four samples in a single analysis.

Cumulative Rainfall: In Version 1.0, rainfall is fixed at 10-day accumulative. In Version 2.0, cumulative rainfall will not be fixed and the user will be able to change the cumulative rainfall to any number of days. Health departments are now considering changing the traditional 10-day accumulative rainfall to 7-day accumulative rainfall. This feature allows the health service to apply a greater variability in accumulative rainfall.

Rainfall Resolution: InVersion 1.0, the rainfall data are imported from daily values. In Version 2.0, the rainfall data will be improved from daily, hourly, or 6-hourly values. Most rainfall monitoring stations have archived data on a daily basis, but recently, agencies are considering 6-hour and 1-hour intervals. In California, there are six production bays, and in only one of the six bays is data accumulated on 6-hour intervals. Rainfall from the remaining five bays is now reported on an hourly basis. These criteria are also being considered by other state and international health service agencies.

No Rain: Version 1.0 has an option to treat trace rainfall below 0.01 inch as zero rainfall. Version 2.0 will allow the user to adjust the 0.01 inch to any amount.

Adverse Condition Data: Version 1.0 does not allow the user to isolate the adverse condition data. Version 2.0 will allow the user to isolate and run only data taken during adverse conditions. This conforms to traditional health department protocols for conservative analysis placing public health as the first priority.

Sample I.D.: Version 1.0 does not allow tracking of sample IDs. Version 2.0 allows tracking of sample IDs. Health departments assign a unique sample ID to each official sample, which can be traced for authentication and validation.

Rainfall Data Format: In Version 1.0, the rainfall data format is saved in Excel. In Version 2.0, the rainfall data format will be saved in General Comma Separated Values (CSV), which allows data to be freely exchanged between different systems. Almost all archived rainfall data can be downloaded in this format.

Fecal Coliform Format: In Version 1.0, the fecal coliform data format is saved in Excel. In Version 2.0, the fecal coliform data format will be saved in General Comma Separated Values (CSV). Almost all archived fecal coliform data can be obtained in this format.

Confidence Level: In Version 1.0, the statistical package only allows analysis at the 95th percentile. In Version 2.0, the statistical package will have options to run at the 95th, 98th, and 99th percentile, thus allowing greater sensitivity and greater choice for health-related decisions.

Non-Parametric Test: Sometimes samples do not follow the normal distribution pattern, and hence the T-test alone may not be applicable. In these cases, the program will provide equivalent non-parametric tests which are not sensitive to normality of the sample distribution, but at the same time, can detect statistically the difference between two scenarios.

Type II Error: Version 1.0 only applies Type I error, but Version 2.0 handles both Type I and Type II errors. Type II errors occur when the new rule is actually worse than the current rule in terms of health protection, but the program would report the rules as equivalent. This type of error is primarily due to an insufficient number of

samples. The side effect of such error is significant in terms of public health, because the agency would be relaxing the rule without sufficient samples to justify the decision. The Type II error is usually around 1.0 to 2.0 percent, and a higher value should force the agency to resample the growing site to obtain sufficient sample numbers. Version 2.0 will calculate the number of samples required for 1.0 to 2.0 percent Type II error.

Grace Period: The accumulation of fecal coliform in a bay usually results from fecal coliform washing into the bay due to runoff from the watershed. Because watersheds differ in their conformations, two bays with the same rainfall closure rules may not accumulate fecal coliform at the same rate. If conditions permit, a slower accumulating bay may be granted a grace period that allows continued harvest for a time period after a given rainfall accumulation trigger occurs. Version 2.0 will allow establishment of a grace period in analysis.

All objectives were completed, including two additional statistical programs determining adequacy of sample sizes, and application of the upper limit of the 95% confidence interval for compliance sampling. In addition, a second software program, Weather, was produced as a companion program for preparation of weather data sets for application in Aquarius v.2 and any other weather data program

TECHNICAL SUMMARY AND ANALYSIS
In September 2006, after receiving WRAC funds, a core development team including University of California Davis (UCS) and California Department of Public Health (CDPH) personnel was formed; the UCD responsibility was to design and build the program, and the agency responsibility was to Beta-test the program using real data and cross-check the accuracy of the program against its own statistical analysis and procedures.

The software was developed and constructed during 2007 through 2008. All 12 proposed improvements to the program were completed, including the addition of two statistical programs that are used to determine if the sample size in the data sets are of sufficient size to provide a correct analysis. The program is written in the Visual Foxpro database programming language and uses the Visual Basic for Application (VBA) codes for communicating with Microsoft Excel. The major upgrades in the new version not only include the two additional sample size statistical programs, but an upper limit of the 95% confidence interval that is used by the agency to determine, with greater sensitivity, adequacy of compliance analysis. Aquarius v.2 expansions include improved data filtration options, and the inclusion of additional parametric and non-parametric statistical analyses that increase the reliability of the decision-making process necessary for public health objectives. Rainfall data can show cumulative daily, 6-hourly, hourly, and Tip-data format, and there are options for Three-Tube Test, Five-Tube Test, 12-Tube Test, Membrane Filter (MF), and Restricted 3-, 3-, and 12-Tube Test. An option was incorporated to use data from Wet Antecedent Conditions only, and options to define these conditions. Options for statistical parameters include choices of Alpha and Beta level for Statistics. There are also options to apply either the standard NSSP method to meet the NSSP criteria, in which the Geometric Mean must be less than 14 and the Estimated 90th percentile must be less than 49 for 3-Tube Test, or a NSSP-CI method in which CI stands for Confidence Interval. The second choice is a more sensitive option described earlier in which the NSSP method is modified by using the upper limit of the 95% confidence interval. This is only used for compliance sampling, but not used to consider a rule change. After extensive beta-testing of the program by the public health evaluation team, Aquarius v2.0 was finalized and adopted by the CDPH in January 2009.

A second software program was developed as a direct spin-off of Aquarius v2.0, the Rainfall Processing Program v.1.0 (RPP). This was not proposed in the grant proposal, but was added at no cost to WRAC. The RPP program was also developed in a cooperative project with personnel of the Shellfish Sanitation Branch of the CDPH. The CDPH and all other federal and state shellfish sanitation agencies spend numerous hours converting databases by hand to formats that could be used in analytical spreadsheets and/or software. The primary problems involved are human error caused by duplicate data, the need to reverse data entries without error, and conversion of tip rainfall

data to cumulative rainfall data without error. The RPP program is composed of four modules designed to prepare databases for use in any analytical rainfall program, and has specific application to Aquarius v2.0. The Dup Program is designed to remove duplicated data in any dataset. The Sum Program is designed to calculate cumulative tip rainfall data from hourly or semi-hourly rainfall data and at the same time removes the duplicate rows from any weather file. The Rev module is designed to reverse the sorting order of rainfall data. The Tip Program is designed to convert rainfall data collected from tipping-bucket and converts the data into hourly rainfall, and even by seconds, into datasets. The RPP program was beta tested and adopted by the CDPH in February 2009.

Based on the successful adoption of Aquarius v2.0 and the RPP v1.0 by the CDPH, funds were provided by WRAC to conduct three regional workshops in the spring of 2009 to extend the technology to shellfish producers in California (Bodega Bay) and Washington (Union City), and to state and federal shellfish regulators at the Pacific Rim Shellfish Sanitation Conference (Olympia, Washington). Representatives of the CDPH were co-presenters during the workshops at the Pacific Rim Shellfish Sanitation Conference and the Bodega Bay shellfish producer's conference. The software programs are currently being used by the Washington shellfish industry to analyze rainfall harvest regulations in Puget Sound in Washington State. Personnel of the Federal Food & Drug Administration are also evaluating the program.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED

Publications

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