



STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P.O. BOX 621
HONOLULU, HAWAII 96809

STAFF SUBMITTAL

for the meeting of the
COMMISSION ON WATER RESOURCE MANAGEMENT

March 28, 2012
Honolulu, Oahu

Request to Enter Into a Contract for Professional Services
To Update the Irrigation Water Requirement Estimation Decision Support System (IWREDSS) for
the Determination of Reasonable Water Use Quantities for Selected Crops in Hawaii

SUMMARY OF REQUEST:

Staff requests that the Commission on Water Resource Management (Commission) authorize the Chairperson to:

1. Enter into a contract for professional services to update the Irrigation Water Requirement Estimation Decision Support System (IWREDSS) computer software application by incorporating updated soil information from the U.S. Department of Agriculture Natural Resource Conservation Service and updated rainfall information from the 2011 Rainfall Atlas of Hawaii, and
2. Authorize up to \$50,000 in funding to update the IWREDSS.

LOCATION MAP: Statewide application

BACKGROUND

On May 24, 2005, the Commission authorized staff to enter into a contract with the University of Hawaii's College of Tropical Agriculture and Human Resources to develop a computer software application for estimating reasonable irrigation water requirements statewide for various vegetation types based on regional climate. The software development was an initial attempt to standardize net irrigation requirements to aid in the evaluation of water use permits and implementation of the Hawaii Water Plan. The final report for this effort was published in May 2008 under Water Management Software to Estimate Crop Irrigation Requirements for Consumptive Use Permitting In Hawaii, which is more commonly referred to as the Irrigation Water Requirement Estimation Decision Support System (IWREDSS).

Since May **2008**, the IWREDSS application has been used by the Commission staff to estimate reasonable and beneficial water use requirements in its analysis of water use permit applications involving irrigation uses, setting instream flow standards, and for long-range planning. It will also be used extensively in estimating reasonable and beneficial needs in the upcoming Na Wai Eha surface water use permitting decisions.

In December 2011, the Commission accepted the 2011 Rainfall Atlas of Hawaii, which was updated by the University of Hawaii's Geography Department under a separate contract. The updated Rainfall Atlas of Hawaii provides a set of mean monthly and annual maps of the spatial patterns of rainfall for the major Hawaiian Islands that represents the best estimates of the mean rainfall for the 30-yr base period 1978–2007. The prior Rainfall Atlas of Hawaii, published in 1986, used the best available rainfall data as of 1983.

In addition to rainfall updates, there has been and will be additional updates to soils coverages and evapotranspiration that affect the best information available for IWREDSS

NEED FOR IWREDSS UPDATE

The IWREDSS estimates gross plant irrigation requirements based on a water budget approach taking into account regional climate and recognizing crop root zone considerations. The term gross irrigation (i.e., irrigation make up water) is used to indicate the total amount of water required with the irrigation efficiency, rainfall, and groundwater contributions factored in. This can be described by the following simplified equation:

$$IRR = \frac{ET_c - R_e - G}{f_i}$$

Where *IRR* is gross irrigation requirement, *ET_c* is crop evapotranspiration, *R_e* is effective rainfall, *G* is groundwater contribution, and *f_i* is the irrigation efficiency. The pan evaporation method is utilized to determine reference evapotranspiration. The product of reference evapotranspiration and published crop coefficients will yield *ET_c*. Effective rainfall is the portion of rainfall available in the root zone for plant use and can be expressed as precipitation minus the combined groundwater drainage and surface runoff. Irrigation efficiency varies depending on the method of application.

In order to standardize analysis of irrigation requirements, crop coefficients, soil type, rainfall, and evaporation, data is extracted from published long-term data and analysis. The application utilizes Geographic Information System (GIS) technology to overlay Tax Map Key data with rainfall and evapotranspiration datasets to determine local climate and soil characteristics.

The current IWREDSS uses the Department of Land and Natural Resource's Rainfall Atlas (R76, 1986), which had been used as the standard long-term baseline monthly rainfall average and median throughout the state. With the recent publication of the 2011 Rainfall Atlas of Hawaii, the IWREDSS model needs to be updated.

The U.S. Geological Survey has analyzed trends at streamflows at seven of its long-term gaging stations and rainfall for the period 1913-2002. Statistically significant downward trends in annual

base flow during 1913–2002 were detected at all seven stations. Long-term downward trends in base flow are consistent with long-term downward trends in rainfall over much of the State during this period. <http://pubs.usgs.gov/fs/2004/3104/pdf/fs20043104.pdf>

While a comparison of the 1986 and 2011 Rainfall Atlas of Hawaii has not been done, preliminary analysis of the Pearl Harbor Aquifer Sector Area shows a decline of 10% to 12% in rainfall. If these results are indicative of rainfall differences statewide, this would indicate the IWREDSS is underestimating crop irrigation requirements.

Additionally, the U.S. Department of Agriculture's Natural Resources Conservation Service (USDA NRCS) has updated the soil map for the Big Island (tentatively to be adopted by August 2012) and is working on the rest of the State. The prior soils mapping was done in the early 1970's. The IWREDSS update should also incorporate any newly available soil maps, which will determine rooting depth, soil moisture storage, and infiltration characteristics.

The staff would also like to include additional crop types in the updated IWREDSS, including potential biomass crops.

Finally, the staff desires that the IWREDSS model be calibrated and field validated using at least one test plot in an actual working farm or other commercial agricultural operation.

SCOPE OF SERVICES

The proposed services are to update the IWREDSS computer software application by:

- Replacing the existing rainfall data source with the 2011 Rainfall Atlas of Hawaii;
- Replacing the existing soil type data source with the latest GIS digitized maps from the USDA NRCS;
- Including daily, weekly, and monthly pan evaporation/potential evapotranspiration, total and effective rainfall for additional National Oceanographic and Atmospheric Administration (NOAA) cooperative observer stations representative of the climate regimes in each of the aquifer systems statewide;
- Including additional crop types/vegetation types from a list to be provided by the STATE; and
- Calibrating and field validating the updated IWREDSS.

The existing network operating system; IWREDSS methodology; user-input interface capabilities for location selection, climate data, crop and irrigation method selection; and all other existing features and capabilities of the current IWREDSS application shall be maintained.

A copy of the proposed scope of services is attached (Exhibit A).

FUNDING

Staff requests that the Commission approve up to \$50,000 in funding to update the IWREDSS software application. Funds would derive from the Commission's general fund, special fund, or a combination of both, subject to available funding.

ENVIRONMENTAL REVIEW (Haw. Rev. Stat. Chapter 343)

HRS Chapter 343 does not apply because this is a planning study. Administrative Rule 11-200-5(d) provides:

"For agency actions, chapter 343, HRS, exempts from applicability any feasibility or planning study for possible future programs which the agency has not approved, adopted, or funded. Nevertheless, if an agency is studying the feasibility of a proposal, it shall consider environmental factors and available alternatives and disclose these in any future assessment or subsequent statement. If, however, the planning and feasibility studies involve testing or other actions which may have significant impact on the environment, then an environmental assessment shall be prepared."

The proposed study is a planning study, which does not involve testing or other actions that will impact the environment. Therefore, HRS Chapter 343 is not applicable to this agency action.

RECOMMENDATIONS

Staff recommends that the Commission:

1. Authorize the Chairperson to enter into a contract agreement and to approve funding not to exceed \$50,000 to update the IWREDSS software application.
2. Authorize the Chairperson to make such further amendments or modifications of the contract agreement (consistent with the terms set forth above) as may be necessary to accomplish the goals described here, provided that any amendment or modification does not require additional Commission funding.

The terms of this agreement will be subject to the approval of the Chairperson and the Attorney General.

Respectfully submitted,



for WILLIAM M. TAM
Deputy Director

Exhibit A (Proposed Scope of Services)

APPROVED FOR SUBMITTAL:



WILLIAM J. AILA, JR.
Chairperson

DRAFT PROPOSED SCOPE OF SERVICES

1. The CONTRACTOR shall perform, complete, and provide, in a satisfactory manner as determined by the Commission on Water Resource Management, hereinafter referred to as the STATE, professional services described below related to the update of the Irrigation Water Requirement Estimation Decision Support System (IWREDSS) for the determination of reasonable water use quantities for selected crops in selected geographic areas in Hawaii (Project).
2. In updating the IWREDSS, the CONTRACTOR shall complete the following tasks:
 - 2.1. Replace existing rainfall data source from *Rainfall Atlas of Hawaii* -R76, 1986 with data from the updated *Rainfall Atlas of Hawaii* (Giambelluca TW, Chen Q, Frazier AG, Price JP, Chen Y-L, Chu P-S, Eischeid J., and Delparte, D. 2011. The Rainfall Atlas of Hawai'i. <http://rainfall.geography.hawaii.edu>).
 - 2.2. Replace existing soil type data source with the latest GIS digitized maps from the USDA NRCS
 - 2.3. Include daily, weekly, and monthly pan evaporation/potential evapotranspiration, total and effective rainfall for additional National Oceanographic and Atmospheric Administration (NOAA) cooperative observer stations representative of the climate regimes in each of the aquifer systems statewide. Climate stations would be limited to available NOAA climate stations with long-term data records within each aquifer system.
 - 2.3.1. The CONTRACTOR shall provide a list of the additional NOAA stations to be added.
 - 2.3.2. The CONTRACTOR shall update GIS map of aquifer systems and NOAA climate stations.
 - 2.4. Include additional crop types/vegetation types from a list to be provided by the STATE. The CONTRACTOR shall conduct extensive literature review to determine applicable crop water management parameters.
 - 2.5. Calibrate and field validate the updated IWREDSS using at least one test plot in an actual working farm or other commercial agricultural operation.
 - 2.6. Maintain existing network operating system; IWREDSS methodology; user-input interface capabilities for location selection, climate data, crop, and irrigation method selection; and all other existing features and capabilities of the current IWREDSS application.

DRAFT PROPOSED SCOPE OF SERVICES

- 2.7. Data Output. The IWREDSS shall produce outputs in both hard copy and electronic format. The CONTRACTOR shall work closely with the STATE in the development of output format to ensure the output format is acceptable to the STATE. All outputs shall be approved by the STATE.
- 2.8. The CONTRACTOR shall provide the STATE with a beta version of the updated IWREDSS for testing on STATE computers 60 days prior to the delivery of the final updated IWREDSS.
- 2.9. The CONTRACTOR shall provide training sessions to instruct users on how to update the data source files and GIS data layers within the IWREDSS. The ease of data source and crop water management updating is very important to the STATE and shall be a consideration during the development of the IWREDSS update.
- 2.10. Meet periodically with the STATE to review and discuss the progress of the IWREDSS update at no additional cost to the STATE.
- 2.11. Fully document the update to the IWREDSS, including:
 - 2.11.1. Derivation of crop (plant) coefficients and assignment of equivalent crop (plant) types.
 - 2.11.2. Calibration and field validation of the updated IWREDSS.
 - 2.11.3. Accuracy of the updated IWREDSS.
 - 2.11.4. List update changes between old and new IWREDSS.
3. The CONTRACTOR shall submit to the STATE, the following deliverables:
 - 3.1. First interim progress report and milestone briefing to the STATE upon completion of tasks 2.1 to 2.5. The interim progress report shall be submitted to the STATE for review at least two weeks before the scheduled milestone briefing.
 - 3.2. Second interim progress report and milestone briefing to the STATE upon completion of task 2.7. The interim progress report shall be submitted to the STATE for review at least two weeks before the scheduled milestone briefing.
 - 3.3. Updated databases of the IWREDSS elements and parameters completed under tasks 2.1 to 2.5.
 - 3.4. GIS island maps showing aquifer systems and all NOAA climate stations developed under task 2.3.2.
 - 3.5. Beta version of the updated IWREDSS for testing on STATE computers.
 - 3.6. Results of IWREDSS calibration and validation.
 - 3.7. Final version of the IWREDSS that has been successfully beta tested, calibrated, and field validated.

DRAFT PROPOSED SCOPE OF SERVICES

- 3.8. IWREDSS user guide, including detailed instructions on how to use the updated IWREDSS and how to update the data source files and GIS data layers within the updated IWREDSS.
- 3.9. IWREDSS technical manual that includes: computer programming source code, details of the mechanisms and operation of the IWREDSS, assumptions made in its development, and its applications and limitations.
- 3.10. Pre-final draft report.
- 3.11. Final report (20 hard copies and electronic files on CD-ROM).
- 3.12. Up to four training sessions on how to update the data source files and GIS data layers.
4. Work performed under this Contract shall be in accordance with the following procedures:
 - 4.1. The CONTRACTOR shall undertake no work until a Notice to Proceed has been issued by the STATE. Notice to Proceed may be issued by telephone provided that it is subsequently confirmed in writing by the STATE. Facsimiles are acceptable.
 - 4.2. The CONTRACTOR shall immediately advise the STATE of any apparent or anticipated difficulties related to performance / completion of the Scope of Services.
 - 4.3. Prior to final acceptance, the CONTRACTOR shall turn over to the STATE the electronic versions of the deliverables prepared under this Contract at no extra cost to the STATE.
 - 4.4. The STATE may, from time to time, make changes in the SCOPE OF SERVICES to be performed hereunder by the CONTRACTOR. Any increase or decrease in the amount of the CONTRACTOR'S compensation, which is mutually agreed upon by and between the STATE and the CONTRACTOR, as a result of such changes and /or revisions, shall be incorporated by written amendment to this Contract.
 - 4.5. It is expressly understood that any equipment purchased by the CONTRACTOR under this Contract, shall result in the STATE taking title to such equipment. For the purposes of this Contract, equipment is defined as all non-expendable property having a unit cost of \$250.00 or more and a useful life of more than one year. The CONTRACTOR shall keep a detailed inventory, including description, cost, and purchase date, of any such equipment purchased under the terms of this Contract. All equipment purchased shall be turned over to the STATE no later than 30 days after final payment. Equipment may be retained by the CONTRACTOR if it is mutually agreed upon by both the STATE and the CONTRACTOR.
 - 4.6. Within six months of the completion of this Project, any problems including, but not limited to, performance problems and program execution errors, encountered with the function and operation of the IWREDSS shall be corrected by the CONTRACTOR at no extra cost to the STATE.