

HEIF RFP Spring 2008 Cover Page

Proposal Title: Solar Radiation Monitoring Station Phase II: System upgrade to access solar data remotely and calibrate equipment for high quality data collection.

Applicants: Renewable Energy Student Union

Primary Contact:

Andrea Allen E-mail: ala25@humboldt.edu Tel: (707) 826-4345

Indicate: Student / Faculty / Staff If student, anticipated date of graduation: 8/2008

Juliette Bohn E-mail: jpb20@humboldt.edu Tel: (707) 826-0896

Indicate: Student / Faculty / Staff If student, anticipated date of graduation: 05/2008

James Apple E-mail: jja27@humboldt.edu Tel: (707) 832-6076

Indicate: Student / Faculty / Staff If student, anticipated date of graduation: 05/2010

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Indicate: Student / Faculty / Staff If student, anticipated date of graduation: 05/2009

Abstract / Brief Description

RESU is pursuing \$4685.56 in HEIF funding to purchase the equipment necessary to complete Phase II of the Solar Radiation Monitoring Station (SoRMS) project. In 2006, the Renewable Energy Student Union (RESU) initiated a project to directly measure radiation energy from the sun. The SoRMS project is located on the top of the library roof at Humboldt State University, and uses two pyranometers, a shadow band shading system, and a stand-alone data logger for measuring and recording solar radiation. Accurate measurements of the local solar energy resource provide important information for the design of solar energy systems at HSU and the surrounding area. The measurements are also very useful when estimating economic payback and CO₂ emissions reductions for solar energy systems. The monitoring station also provides HSU students with a valuable opportunity to participate in solar energy resource evaluation activities and to interact with senior researchers at the National Renewable Energy Laboratory (NREL). The data from the SoRMS project at HSU are part of NREL's National Solar Radiation Database (NSRDB).

While the SoRMS project has operated successfully since its inauguration in May of 2007, the system is not yet fully functional and its future is not assured. In this proposal, we request support for funding required to complete the system in a way that will allow it to collect accurate solar energy resource data for years to come. Key items include (i) an upgrade of the data logging equipment to make it fully compatible with NREL's NSRDB and (ii) the purchase of a third pyranometer that can be used to allow for regular calibration of the system without interruptions in data collection.

Implementing Phase II of this project will allow for this student project to continue into the future. Students involved in the SoRMS project will gain experience in solar resource data collection, monitoring, and processing. In addition, students writing solar related HEIF proposals will benefit from the availability of the data. The data will also be valuable for use in classes in areas such as engineering, statistics, and math modeling.

The project serves to reduce the environmental impact of fossil-fueled energy production by facilitating the development of local solar energy generation. Two alternative approaches to the data logger upgrade are described in detail in the proposal. The first alternative is a radio antenna that will send a signal from the data logger to a receiver. This option would be "Awardee Implemented" if selected. The second alternative is the installation of an Ethernet jack to directly connect the data logger to the internet. This option would be "HSU Implemented" if selected. RESU, Arne Jacobson, and other project partners will be responsible for selecting the appropriate alternative, purchasing the equipment, and installing the third pyranometer.

Budget Request: \$4,685.56 **Indicate:** HSU Implemented / Awardee Implemented

Starting Date (mo/yr): April 2008 **Completion Date (mo/yr):** June 2008

Partners

1. Arne Jacobson, Assistant Professor Environmental Resources Engineering (ERE)

E-mail: Arne@humboldt.edu

Tel: (707) 826-3184

Indicate: Student / Faculty / Staff Commitment to Project: Confirmed / Anticipated

2. Stephen Wilcox, National Renewable Energy Laboratory (NREL)

E-mail: Stephen_Wilcox@nrel.gov

Tel: (303) 384-7785

Indicate: Student / Faculty / Staff Commitment to Project: Confirmed / Anticipated

3. Scott Rommel, Electronics Technician, Schatz Energy Research Center (SERC)

E-mail: dsr7001@humboldt.edu

Tel: (707) 826-4345

Indicate: Student / Faculty / Staff Commitment to Project: Confirmed / Anticipated

4. Marty Reed, Equipment Technician, College of Natural Resources & Sciences (CNRS)

E-mail: mmr7001@humboldt.edu

Tel: (707) 826-3234

Indicate: Student / Faculty / Staff Commitment to Project: Confirmed / Anticipated

Agreement to Grant Terms

(Adapted from the Humboldt Area Foundation RFP)

By signing this application form, the applicant enters into an agreement with HSU and HEIF that would take effect should the grant be awarded. The applicant attests that:

1. **Accuracy:** The information contained in this application and in any attachments thereto is true and correct to the best of your knowledge.
2. **Use of Funds:** Understands and agrees that, where applicable, all grant funds will be applied to the project in accordance with the description and budget provided in this application as set forth in the award letter. Any significant change in the use of these funds will require prior approval by HEIF. Requests for changes must be submitted in writing. If the revisions are not accepted or funds are not expended for the purpose and the manner agreed to by the grantee, HEIF reserves the right to cancel the grant and any further payments and said funds must be returned to the Foundation. All funds must be spent in accordance with State financial rules and regulations.
3. **Expiration:** Understands and agrees that, where applicable, grants must be paid within one year, unless otherwise specified. Any requests for extensions of time must be submitted in writing prior to the expiration date. Grants not paid or granted an extension can be cancelled without notice after the expiration date.
4. **Grant Report(s):** Understands and agrees that, where applicable, report(s) will be submitted to HEIF by the phase or date specified in the grant award letter. Report guidelines will be forthcoming.

To indicate acceptance of the foregoing terms and conditions, please sign below. Please retain a copy of this agreement for your files.

Applicants:

Primary Contact: Andrea Allen

Print Name Andrea Allen Signature _____ Date _____

Print Name Juliette Bohn Signature _____ Date _____

Print Name James Apple Signature _____ Date _____

Print Name Colin Sheppard Signature _____ Date _____

Proposal Narrative



Figure 1: Students and RESU members, Andrea Allen (Foreground) and Juliette Bohn (Background), performing maintenance of the SoRMS project.

Project Description:

In 2006, the Renewable Energy Student Union (RESU) began a project to directly measure radiation energy from the sun, or insolation, from the top of Humboldt State University's library roof. These data are intended for use by residents, solar installers and engineers when designing solar energy systems, passive solar designs, or planning gardens for next season. Reliable measurements of local solar energy are useful for determining solar array sizing, battery storage requirements, and project payback including CO₂ emission offsets.

Due to the highly localized weather in the coastal zones, also known as a microclimate, it can be difficult to accurately model the available insolation in these regions. The Solar Radiation Monitoring Station (SoRMS) project is our solution to the need for measured solar radiation data on the North Coast. The HSU library roof is now equipped with two Eppley Precision Spectral (PSP) Pyranometers, which are state-of-the-art instruments for measuring the solar resource. One measures global radiation, or total solar radiation, and the other measures diffuse radiation. Diffuse radiation is sunlight reflected by the sky, the ground, or any other surface. In order to capture the diffuse component, a "shadow band" is positioned over the second pyranometer to block the direct light from the sun over the course of the day (See Appendix C). The combined measurements of global and diffuse solar radiation allow for complete characterization of the solar resource. These data form the basis for design calculations for solar energy systems.

The data generated by the SoRMS project are available on RESU's website, <http://resu.humboldt.edu/~resu/sorms/chart/daily.php>, and are also a part of the National Solar Radiation Database (NSRDB) maintained by the National Renewable Energy Laboratory (NREL), <http://www.nrel.gov/midc/hsu>. NREL provides national and regional estimates of the solar resource. Their ability to make accurate estimates depends on careful measurements at "primary" solar monitoring sites. RESU has been working with NREL to become a primary site in an area where they do not currently have any measured data (i.e. California's North Coast).

In order to become a primary site, and to participate in the NSRDB program, there are two requirements. First, pyranometers must be calibrated annually. The calibration, which is necessary to ensure accurate data, takes place at NREL's facility during a two-month period in the summer. RESU is seeking funding to purchase a third Eppley Precision Spectral Pyranometer (PSP) so that each summer one pyranometer at a time can be calibrated without disrupting the continuous data stream.

The second requirement is that the data are remotely accessible by NREL. These data will be used by NREL to validate and refine their solar resource estimates for the Western United States, and as such they need access to the data from primary sites. In order to meet this requirement, the SoRMS data logger system must be upgraded. We have developed two alternative approaches to accomplish this.

Alternative 1

In this alternative, we would achieve remote access by setting up a radio transceiver/receiver pair and antennae to send the data from the library roof to another location on campus with an internet connection and power. The "remote station" on the library roof would be equipped with a radio transceiver and antenna that would broadcast a 900 MHz signal to the "base station", a location within line-of-sight of the library. The base station will be equipped with a radio receiver and antenna, and an NL100 internet link box to connect the receiver to the internet. The equipment will be purchased from Campbell Scientific. A quote from Campbell Scientific including a complete list of the necessary equipment can be found in Appendix D. The cost of this alternative is \$4,685.56 (including the additional pyranometer as discussed below). This option would be "Awardee" implemented by RESU students with assistance from their advisor, Arne Jacobson, electronics specialist Scott Rommel from the Schatz Energy Research Center, and equipment technician Marty Reed from the College of Natural Resources and Sciences.

Alternative 2

In this alternative, achieving remote access would involve installation of an Ethernet jack directly on the roof of the library. This connection would enable us to connect our data logger directly to the internet through an NL100 internet link box, manufactured by Campbell Scientific. This direct connection to the internet will provide the most robust solution for remotely accessing our system and will enable NREL direct access to our data. At this time however, we have not yet received a quote from Information Technologies (IT) and Plant Operations for the cost of this alternative. Based on discussions with IT, and using cost information for a similar project on the roof of Science D, we believe this option will be comparable in price to Alternative 1, above. Assuming that the cost is equal to or less than Alternative 1, this is our preferred alternative. This alternative would be "HSU" implemented as it would involve both IT and Plant Operations.

Purchasing a Third Pyranometer

In addition to the upgrade of the data collection system, we are also requesting funds to purchase a third Eppley PSP pyranometer. Having this instrument on hand will allow the SoRMS project to calibrate its instruments according to the standards required for participation in the NSRDB without interruptions in data collection. In other words, the spare pyranometer is needed in order to allow RESU to send one pyranometer for calibration at NREL each year (calibration takes 4-6 weeks), while continuing to collect accurate measurements with the remaining two pyranometers. With this system in place, the SoRMS system will be in a position to collect solar resource data for years to come on a continuous, reliable, and accurate basis. The cost of the pyranometer and associated accessories is \$2,200. NREL has offered to provide calibration services for the project free of charge in order to ensure the accuracy of the measurements.

RESU is pursuing \$4,685.56 in HEIF funding to purchase the equipment necessary to complete Phase II of the SoRMS project.

Need Statement:

This project is well suited to the goals of HEIF. The SoRMS project was developed and implemented by RESU students. Students carry out daily maintenance tasks related to the project, and RESU members continue to work on refining the quality of data collection and presentation. Implementing Phase II of this project will allow for this project to continue, giving students the opportunity to gain experience in data collection, monitoring, and processing, in addition to providing the community with access to local, high-quality solar data into the long-term future.

The knowledge and experience gained from the development of the SoRMS data collection station is not the only project benefit. The data generated are also useful to students in the renewable energy curriculum at HSU. Students can use these data for making calculations in the development of HEIF solar projects, as well as other applications such as statistics and math modeling courses. The measured accountability for this project is the continued availability of these data for the development of solar energy projects at HSU and in the local community.

Outcomes:

Aside from the solar data, students will continue to develop skills associated with data collection and analysis. We also intend on creating a comprehensive operation and maintenance manual to help create institutional memory for future RESU members that will maintain the project.

The project serves to reduce the environmental impact of fossil-fueled energy production by facilitating the development of solar energy generation projects. Furthermore, this project is powered by a solar panel and small battery, and incorporates used components where available in order to have minimal environmental impact. This project generates the power it uses to collect and store data, and therefore has no direct impact on fossil energy use on campus.

Student Involvement:

RESU members will be responsible for the acquisition and installation of the Phase II equipment for the SoRMS project. RESU projects are designed to enhance the education of students

pursuing solutions to global environmental problems. Any HSU student interested hands-on learning through development of student-driven projects is welcome to join RESU.

Students involved in this project will develop data collection and analysis skills. Appropriate policy-making and resource management relies on high quality data collected from the environment. Students proficient in data collection and analysis will be prepared to provide the information needed to address environmental problems from pollution to global warming. Support and guidance from NREL, the Environmental Resource Engineering (ERE) department as well as the Schatz Energy Research Center (SERC) will ensure the success of this project.

Implementation:

As described above, there are two alternative approaches to upgrading our data collection system. As such, there are two distinct implementation plans.

Alternative 1

This alternative will primarily be implemented by RESU members with additional help from Plant Operations, the ERE department and SERC as needed. RESU members will purchase and connect the broadcast radio and antenna to the existing setup. The receiving antenna may need to be mounted by Plant Operations depending on the location chosen. RESU members will be responsible for the regular maintenance associated with the project such as cleaning the domes, sending the pyranometers out for calibration and making sure our data are received by NREL.

The key challenges to the implementation of the project will be finding an appropriate location for the base station and receiver. Good line of sight between the antennas is important for reliable communications. In addition, the receiver will need to be near a location accessible to the internet and AC power.

Alternative 2

Several parties will implement this scenario. Plant Operations and IT will be responsible for the installation of the Ethernet jack on the library roof; RESU members will collaborate with them to find the location best suited for our needs. RESU members will be responsible for the purchase and installation of the NL100 internet link box from Campbell Scientific, and the additional Epply pyranometer. As listed in Alternative 1, RESU members will continue the regular maintenance associated with the project such as cleaning the domes, sending the pyranometers out for calibration, and making sure our data are received by NREL.

Partners:

Partners for this project include Stephen Wilcox of NREL, Arne Jacobson from the ERE department and SERC, Scott Rommel from SERC, and Marty Reed from the CNRS workshop. Additional assistance will come from IT and Plant Operations. NREL will continue to use the measured data as part of the NSRDB and will provide annual calibrations for the pyranometers. The ERE department will incorporate the data in classes such as: Engineering 322 (Probability and Statistics), Engineering 475 (Renewable Energy Power Systems), and Engineering E477 (Solar Thermal Engineering). SERC will provide technical support and will work with RESU to create the institutional memory needed to maintain the project into the future. Marty Reed will assist in equipment installation.

Timeline:

The entire system upgrade will take two to three months depending on the alternative chosen. Once IT has finished the installation of the Ethernet line, or all transmission equipment has been received, the remaining part of the data system upgrade, to be performed by RESU, should be complete in one month's time. The third pyranometer will be installed in early summer 2008 when the calibration period begins at NREL's facility. The calibration requires 4 - 6 weeks, after which, the calibrated pyranometer will be replaced.

Alternative 1

The project should take 3-4 weeks to implement not including the time it takes to receive the hardware. Once we receive the hardware, we will set up the broadcast radio and receiver to communicate with one another and the existing data logger. We will also construct a base for the broadcast antenna and secure it to the library roof. Once the new equipment is setup we expect 10-20 hours of work to test and troubleshoot.

Alternative 2

The time it takes to implement this scenario is greatly dependent on the availability of Plant Operations and IT. Once the jack is installed it should take approximately 10-20 hours to install, test, and troubleshoot the remaining equipment.

Sustainability:

RESU, in collaboration with NREL, RESU advisor Arne Jacobson and other HSU partners, will make sure that the SoRMS system is properly maintained over time. An in-depth operation and maintenance manual will provide institutional system knowledge to maintain continuity over the long-term.

We anticipate the SoRMS project to continue to collect data for 30 years or more with proper maintenance. The hardware that has already been purchased for the project was purchased with longevity in mind and the additional new hardware should also be long-lasting. Campbell Scientific builds their equipment for use in the field under harsh conditions for long periods of time. When we asked Campbell Scientific about the prospect of the existing equipment, as well as the proposed new equipment, lasting for upwards of 30 years they were confident that this is possible with proper maintenance. The Epply pyranometers are also built to last for upwards of 30 years.

When the project eventually comes to an end and/or there is equipment that needs to be replaced, we anticipate the equipment will be disposed of in a responsible manner. There is currently a movement underway in the California to dispose of electronic waste in a more environmentally responsible manner including recycling. HSU has procedures to properly dispose of e-waste and we anticipate that future persons responsible for the replacement or decommissioning of the project will follow these procedures for disposal. The equipment poses no more of a hazard than any other electronic equipment in use throughout campus.

Assessment:

This project will facilitate future HEIF projects by providing accurate measured data of the solar resource on campus. While upgrading the SoRMS project will not directly reduce the energy used on campus, it will be very useful in estimates of energy use that can be offset by future projects involving solar energy. Additionally it will provide a service to the community in general, as the data will be publicly available on both the NSRDB and RESU websites.

Appendix A

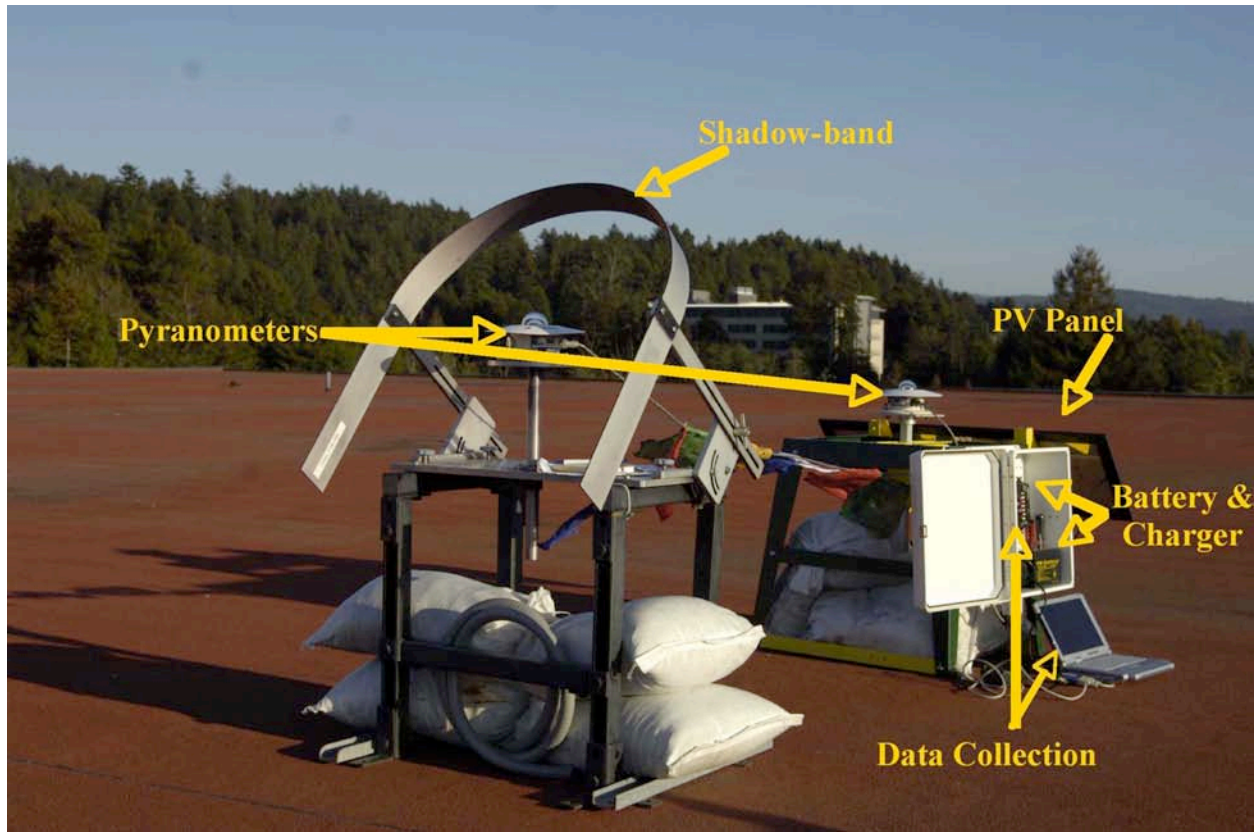
Budget

Project Title: Solar Radiation Monitoring Station Phase II

Awardee Implemented Project Budget

Category (list major items)	Unit (e.g. miles, each, etc.)	Cost per unit	Total cost	Amount requested from HEIF	Matching contribution to be provided by applicant or other source	Who/what is the other source?	Is the matching contribution confirmed or potential?
Durable equipment							
Weather Resistant Enclosure	each	264	264	264			
NL100-SW	each	408	408	408			
RF401-ST	2 each	436.8	873.6	873.6			
Antenna cable 15 ft	2 each	39.36	78.72	78.72			
HG908u Antenna	each	175	175	175			
RF401 Mounting Kit	each	21.12	21.12	21.12			
900MHz Yagi antenna with hardware	each	165.12	165.12	165.12			
Epply PSP	each	2200	2200	2200			
Consumable supplies							
Wages for student participants							
Professional services							
Technical Support	10 Hours	\$50	500	500			
Travel							
Other							
TOTAL:			4685.56	4685.56	0		

Appendix C
System Diagram



Appendix D

Campbell Scientific Quote and Equipment List



815 West 1800 North • Logan, Utah 84321-1784
 Phone 435.753.2342 • Fax 435.750.9540
 Fed. I.D. #87-0305157 • DUNS#06-796-0730

Quote Number	65191
Quote Date	02-19-08
Valid Through Date	04-19-08
Quoted By	Don Brown
Customer Number	71564
Est. Ship ARO	30 Days ARO
Page	1

Domestic Sales Quotation

Q U O T E	Jacobson Arne Humboldt State University Environmental Resources 1 Harpst St Arcata, CA 95521 United States
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S H I P T O	Jacobson Arne Humboldt State University Environmental Resources 1 Harpst St Arcata, CA 95521
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Contact:	Arne Jacobson	Cust RFQ:	
Phone:	707-826-3184	Terms:	Net 30 Days
Fax:	707-826-3616	Freight Terms:	
Email:	arne@humboldt.edu	FOB:	LOGAN, UT

Li	Model	Part	Description	Qty	UM	Unit Price	Ext. Price
Preliminary - shipping charges are estimated at the time of order.							
1		note	base station-	1	EA	0.00	0.00
2	ENC12/14-SC-MM	15875-50	Weather-Resistant 12 x 14 inch Enclosure -SC 1 Conduit for Cables -MM Tripod Mast Mounting	1	EA	264.00	264.00
3	NL100-SW	16366-12	Network Link -SW Standard 1yr Warranty	1	EA	408.00	408.00
4	RF401-ST	18101-9	900MHz Spread Spectrum Radio -ST Tested -25 to +50C	1	EA	436.80	436.80
5	COAXRPSMA-L15	16113-3	Antenna Cable LMR195 w/Reverse Polarity SMA & Type N Male Connector 15ft per antenna cable	1	EA	39.36	39.36
6		special	hg908u pro antenna	1	EA	175.00	175.00
Continued							

This Quote is for Domestic purposes only.

Authorized Signature X_____

Warranty Policy: CSI warrants product manufactured by CSI to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise, subject to the following conditions:
 CSI's obligation under this warranty is limited to repairing or replacing (at CSI's option) products which have been returned prepaid to CSI. CSI will return warranted equipment by surface carrier prepaid. This warranty shall not apply to any CSI products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. Batteries are not warranted. Under no circumstances will CSI reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This warranty, and CSI's obligation thereunder, is in lieu of all other warranties of suitability and fitness for a particular purpose. CSI is not liable for consequential damages.



815 West 1800 North • Logan, Utah 84321-1784
 Phone 435.753.2342 • Fax 435.750.9540
 Fed. I.D. #87-0305157 • DUNS#06-798-0730

Quote Number	65191
Quote Date	02-19-08
Valid Through Date	04-19-08
Quoted By	Don Brown
Customer Number	71564
Est. Ship ARO	30 Days ARO
Page	2

Domestic Sales Quotation

Q U O T E	Jacobson Arne Humboldt State University Environmental Resources 1 Harpst St Arcata, CA 95521 United States
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S H I P T O	Jacobson Arne Humboldt State University Environmental Resources 1 Harpst St Arcata, CA 95521
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Contact:	Arne Jacobson	Cust RFQ:	
Phone:	707-826-3184	Terms:	Net 30 Days
Fax:	707-826-3616	Freight Terms:	
Email:	arne@humboldt.edu	FOB:	LOGAN, UT

Li	Model	Part	Description	Qty	UM	Unit Price	Ext. Price
7		note	field station-	1	EA	0.00	0.00
8	RF401-ST	18101-9	900MHz Spread Spectrum Radio -ST Tested -25 to +50C	1	EA	436.80	436.80
9		14162	RF401, RF411, or RF416 Mounting Kit	1	EA	21.12	21.12
10		14201	900MHz 9dBd Yagi Antenna w/Type N Female & Mounting Hardware	1	EA	165.12	165.12
11	COAXRPSMA-L15	16113-3	Antenna Cable LMR195 w/Reverse Polarity SMA & Type N Male Connector 15ft per antenna cable	1	EA	39.36	39.36
						SUBTOTAL	\$1,985.56
						TAX	\$0.00
						TOTAL	\$1,985.56

This Quote is for Domestic purposes only.

Authorized Signature X _____

Warranty Policy: CSI warrants product manufactured by CSI to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise, subject to the following conditions:
 CSI's obligation under this warranty is limited to repairing or replacing (at CSI's option) products which have been returned prepaid to CSI. CSI will return warranted equipment by surface carrier prepaid. This warranty shall not apply to any CSI products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. Batteries are not warranted. Under no circumstances will CSI reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This warranty, and CSI's obligation thereunder, is in lieu of all other warranties of suitability and fitness for a particular purpose. CSI is not liable for consequential damages.