INSTALLATION, EVALUATION, AND MODIFICATION OF ADCON TELEMETRY SYSTEMS

By

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- Req's weak, missing ethics.

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3/27/15
Date

ACKNOWLEDGEMENTS

First, I'd like to share my gratitude with Dr. Stuart Styles, my project advisor. It is his guidance that permitted the success of this project. However, his support has extended throughout my academic career at Cal Poly.

Second, my parents, brother, and best friend have been my most influential supporters throughout college and deserve many thanks.

ABSTRACT

This project involved an evaluation of addVantage Pro, the data management software used for telemetry systems belonging to the Irrigation Training & Research Center. A primary consideration during evaluation is usability of the program. Modifications were made to improve the usability and written procedures were produced to promote ease-of-use for future users. Also to improve accessibility of information, McCrometer Connect Trendview mobile application was established to users to access the data from mobile devices. Additional strategies to improve the usability of Cal Poly's telemetry network have been included in the recommendations section of this report.

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INTRODUCTION

Californians are facing a number of consequences imparted by the current drought including diminished water allocations to farmers, increased water prices, and dramatically less hydroelectricity generation (CDRSS, 2014). Temporary fixes are mandated by regulatory agencies such as the State Water Resource Control Board, which has initiated emergency conservation regulations that prohibit irrigation runoff, hoses without shut-off valves, and various uses for potable water (SWRCB, 2014). More permanent changes are also transforming business practices for industrial water users and especially farmers. Supervisory control and data acquisition (SCADA) is a technology that has been growing and improving significantly in the last decade (Kloepper, 2014).

SCADA is a tool for growers and water conservationists that enables more efficient water management by monitoring variables in the environment. Many water districts in California, for example, are enhancing their operations by equipping water delivery systems with SCADA systems to closely monitor the movement of water in real-time (MID, 2014).

A leader in the SCADA industry is an Austrian company, Adcon Telemetry. They promote water quality monitoring, remote meter reading, and early leak detection among many other benefits of their products (Adcon, 2014). Cal Poly has created an Adcon network of weather stations, water level sensors, and other sensors to support the Cal Poly Agriculture Operations department with efficient water management and create an interactive learning environment for the Irrigation Training and Research Center.

Each sensor on the campus has a variety of components that provide varying types of data to the Adcon network, which are displayed on their software program called AddVantage Professional. Due to the complexity of the entire system, it is necessary to develop procedures and methods so that faculty, students, and others may utilize and learn from these tools in an effective manner. A number of improvements should be made to the software to enhance usability as well.

The entirety of this project includes a new installment at Middlecamp reservoir, procedures for using the AddVantage program, modifications to the program, and recommendations for future improvements to the network. A principal consideration during the project is increasing the network's user friendliness and establishing detailed documentation as a reference for future users.

LITERATURE REVIEW

Network Structure

The following image depicts the basic nature of Adcon's network of telemetry stations. Cal Poly possesses a very similar structure. These core components of the network are shown below and include a sensor, a remote transmission unit (RTU), a solar panel, a battery, a receiving unit, and a human machine interface (HMI). At Cal Poly, the data is transmitted to the AddVantage software and displayed in various charts and graphs.

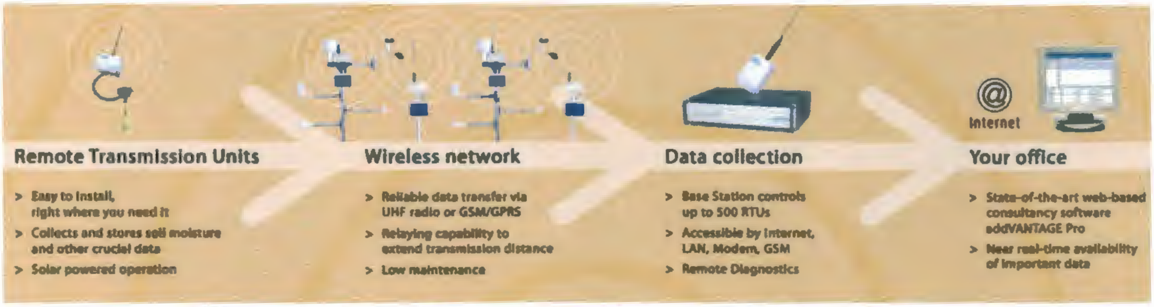

Figure 1. General Adcon network structure (Adcon, 2014).

Although there are hundreds of sensors, the most relevant to this project and the telemetry stations is a water level sensor. This sensor will provide data to observe changes in water levels at the reservoir where it is installed. Such data is useful for efficient water allocations and managing water supply. The RTU that is used in Adcon's telemetry stations will be powered only by the energy captured through the solar panel and it will send data across the radio to be collected by the receiving network, which is at the Irrigation Training and Research Center (ITRC). In this case, the HMI component refers to the ITRC website where students can access data collected by the Adcon stations.

Below is a depiction of Cal Poly's system of Adcon stations that was developed by BioResource and Agricultural Engineering student, Shelsie Kloepper. In her research each site was evaluated and given recommendations to improve efficiency and usability. Her efforts produced a map that was utilized in this project to identify areas of improvement and install the sensor at Middlecamp reservoir. Each green highlighted circle is the site of an Adcon station on campus. A recommendation that was made by Shelsie, was to install a station at Middlecamp reservoir so that water leaving the state's water plant could be monitored because it feeds directly into Middlecamp reservoir.

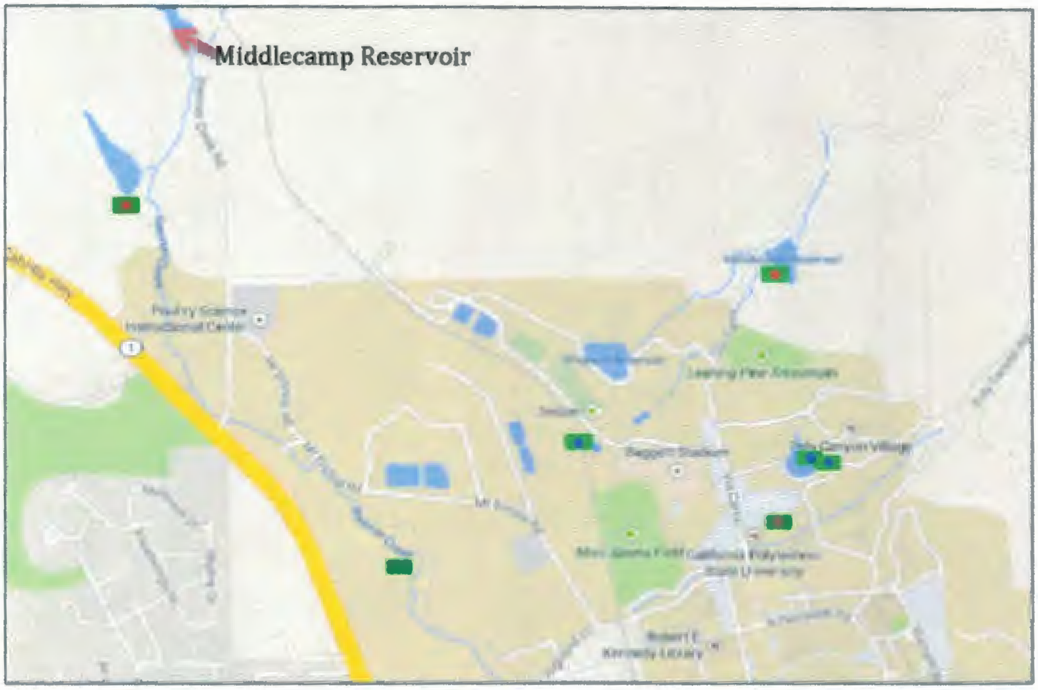

Figure 2. Map of Cal Poly Adcon stations (Kloepper, 2014).

AddVantage Pro

The software program experienced many progressions since its initial release as Adcon continually improves the convenience and usability of their product. The purpose for AddVantage Pro software is to generate graphs, trends, and extensions for analyzing the data collected by sensors on the field stations. For users with large networks, this task is monotonous and time consuming. In the newest software release, however, Adcon enabled administrators to create templates that greatly accelerated the process. (Adcon, 2014)

In the new Basic Export Extension (BEE), users previously had to configure each export file but this package made creating, recreating, and duplicating export parameters, field delimiters, headers, and target directories easier and simpler. Another inconvenience with the system has been configuring a new RTU, but a tool called RTU Wizard saves time and trouble by assisting with the creation of a data source and setting up user rights. (Adcon, 2014)

The AddVantage Pro platform possesses numerous capabilities including Internet browsing, data visualization, data processing, data distribution, alarm and event scheduling, disease and irrigation models, and customizing for countless applications (Adcon, 2014). The following images exemplify the complexity and adaptability of the program.

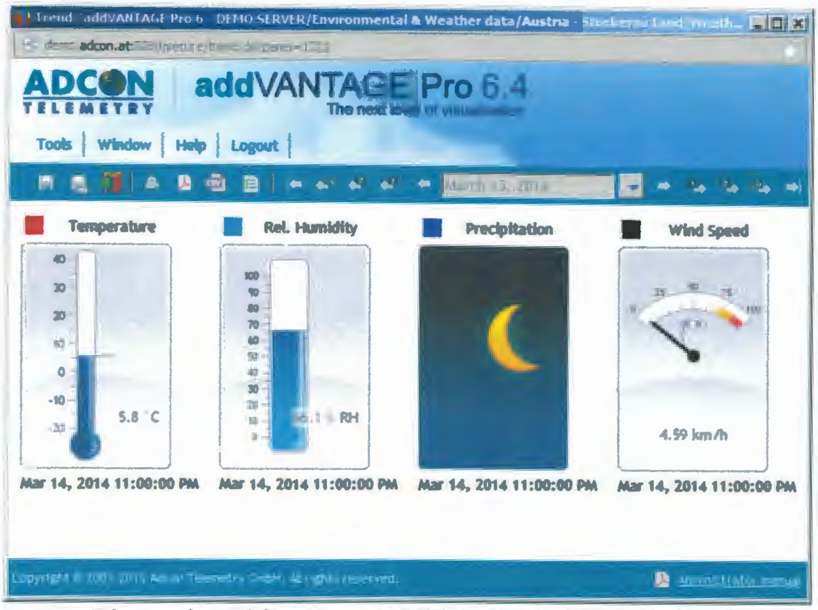

Figure 3. AddVantage HMI (AddVantage, 2014).

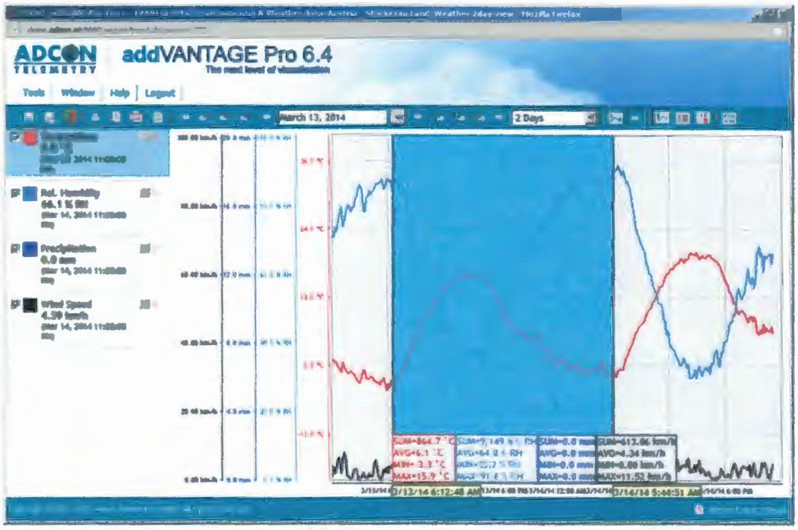

Figure 4. AddVantage data distribution and visualization (AddVantage, 2014).

California Water Management

In response to the severe drought and dwindling water supply, California's Department of Water Resources (DWR) has multiple programs in place to evaluate current water usage and forecast future demand. The California Water Plan is a "collaborative planning network" available to everyone to "develop findings and recommendations and make informed decisions for California's water future" (DWR, 2014). It is updated every five years and presents trends in water demands and supplies. In addition, it evaluated resource management strategies. Another component of DWR is its Land and Water Use Program, which is "tasked with collecting land use data and developing water use estimates required for statewide water planning" (DWR, 2014). This program involves the collection of weather and other data to determine water use estimates. SCADA systems like Adcon's telemetry stations are installed in reservoirs, irrigation systems, lakes, and many other locations where water must be managed. They provide the data necessary for farmers, Cal Poly, and California's DWR to make informed decisions about managing resources.

PROCEDURES & METHODS

addVantage Pro Software

To make any changes in the program, a staff member must provide access information from the Irrigation Training and Research Center. The information needed includes a username and password for the account on apro.mccrometer.net. Once logged in, all of the data that is collected from Cal Poly's telemetry stations can be read, analyzed, and shared from this program.

In order to change the scale on graphs of data from any of the sensors, the chart must be opened from the main screen on the program. The chart is opened by clicking on the magnifying glass to the right of the chart's title. Right click the mouse to access the properties of the graph. A window will appear with a display of the graph's scale and units. Modifications of the scales were performed for the following charts:

1. Sports Complex: Water level from PA1 pressure (17871)
2. Sports Complex: Flow rates at Sports Complex (18963)
3. Sports Complex: Raw Reservoir Pressure (37170)
4. Indonesian: Water level only (18438)

The following image exemplifies a typical graph with a scale that is too large to display minor changes in the data collected by that sensor.

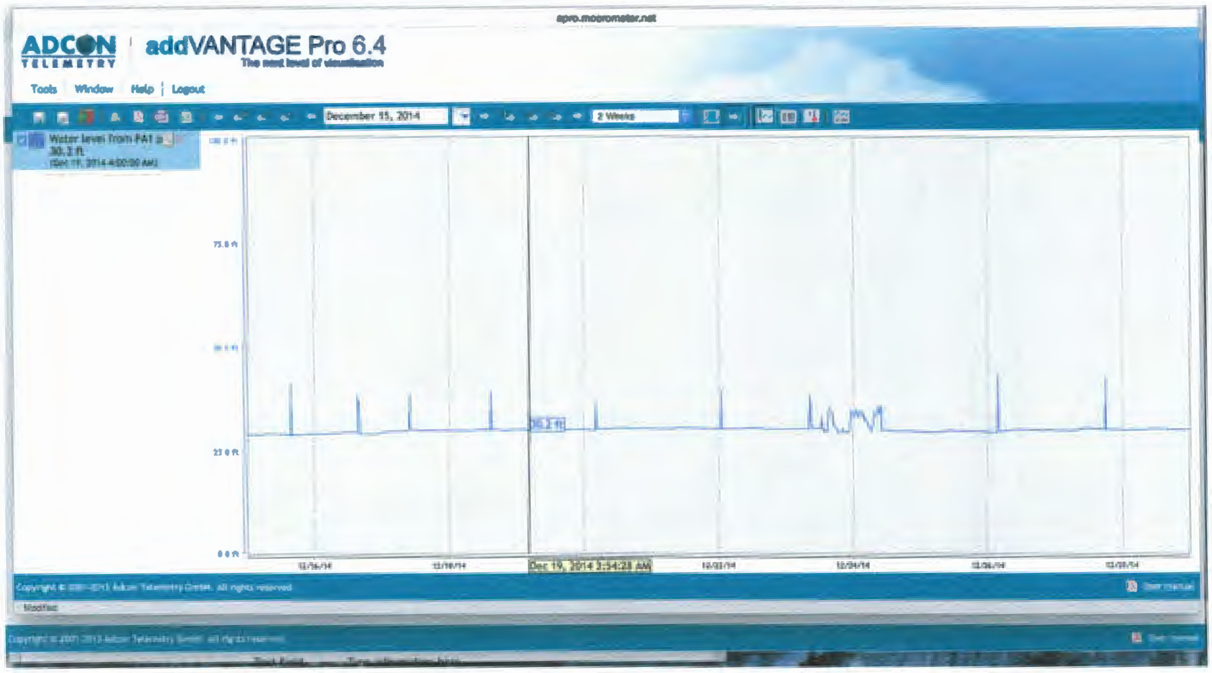

Figure 5. Flow Rates at Sports Complex

Figure 6 is an image of a graph that has a properly adjusted scale to clearly show fluctuations in the data.

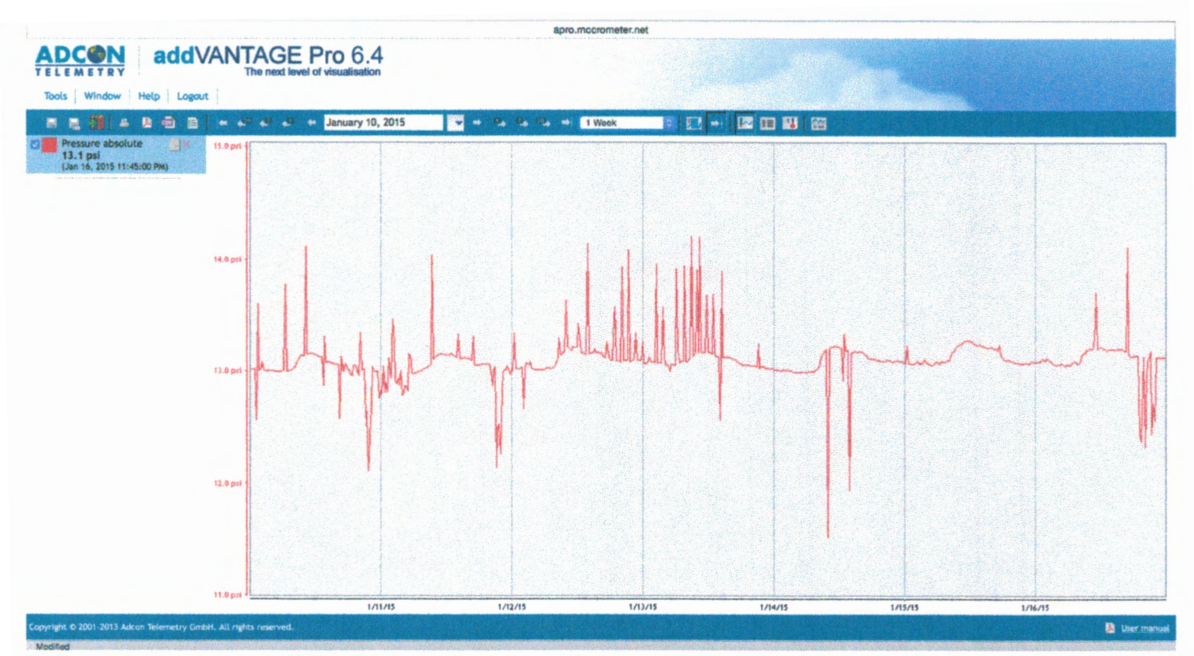

Figure 6. Raw Pressure Data at the Sports Complex.

Another change to the program involved creating an extension calculation to express data in a different form. Calculation extensions are just one alternative method for presenting data that has been collected in the field. The raw pressure data from the Sports Complex, for example, is expressed in pounds per square inch. To change the units of this graph to feet of head, start by right clicking on the sensor that is called Pressure Absolute. It can be found under the Sports Complex menu. Choose the option called, Create New Node: Calculation Extension: Formula Calculation. This will open will window where the conversion from pounds per square inch to feet of head can be entered. In the formula box, simply enter the conversion, 1 psi = 2.31 ft. Under the tab titled, General, the title for the calculation extension can be modified, otherwise it will be called Generic Output, by default. When complete, click OK to close the window and a new dropdown menu will appear below the Sports Complex. This is the new graph that has converted the raw pressure data to feet of head. Figure 7 shows the first steps to create a calculation extension.

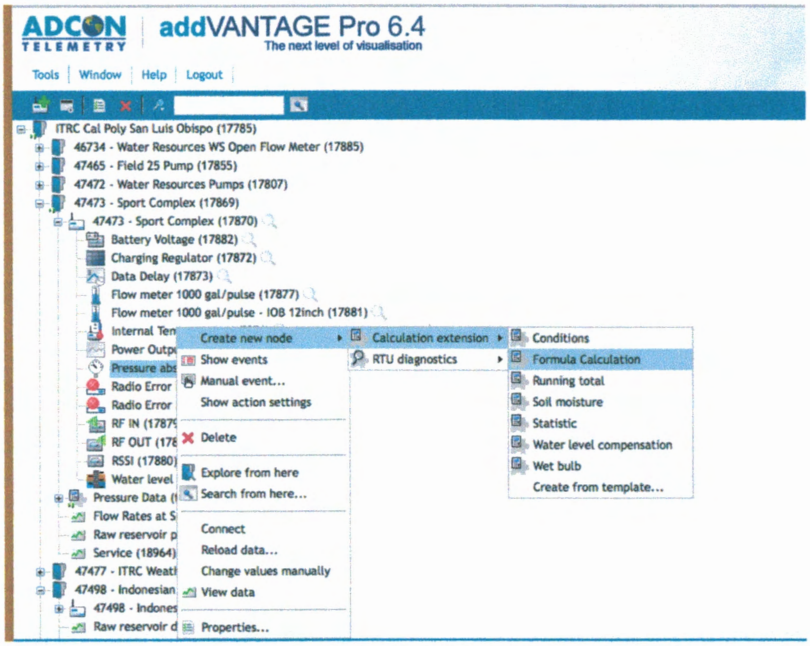

Figure 7. Sports Complex: Pressure Absolute.

McCrometer Connect Trendview

To install and setup the McCrometer Connect Trendview mobile application, a smart device must be accessible. Download the application to the device and then open the program. Enter the server URL, which differs depending on the telemetry systems' network. For assistance, Mr. Jim Devore (McCrometer Technical Support Representative, Interview January 22, 2015.) guided this procedure. Below the server URL, the network's username and password must be entered. The username and password is equivalent to what was provided for access to the addVantage Pro software. Once the application has logged in, the main display will appear with a list of folders, which were created to separate the telemetry stations for improved accessibility but can be modified on any device. The following image is the main page of the Trendview application.

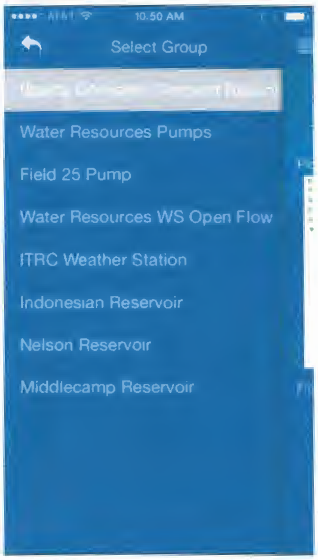

Figure 8. Data organization in folders.

By clicking on any of the folders, the same sensors and data that is provided on addVantage Pro is also available on the mobile application. When looking on a graph, use a finger or stylus to slide the circle at the top of the screen to any time frame that is desired. This will change the graph to show the dates within the selected time frame. In Figure 8 below, the image shows some data at Middlecamp reservoir that has been filed into its own folder.

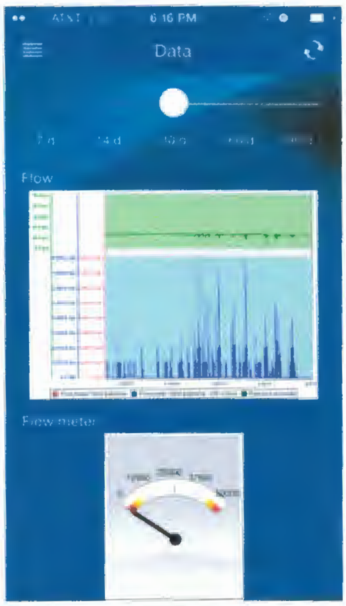

Figure 9. Trendview Data.

RESULTS

addVantage Pro Modifications

Multiple modifications were made to the addVantage Pro program. The scales on various graphs were adjusted to more clearly define changes in data. Calculation extensions were made to present field data in different formats that would allow users to read the data more effectively. In addition, the transducer locations were identified in each reservoir and properly labeled in the program. The top of the water level in each reservoir was verified or adjusted in the program as well.

addVantage Pro Manual

For faculty, students, and ITRC staff to reference in the future, a manual was created to describe the modifications that were made to addVantage Pro. The manual was initially created in Shelsie Kloepper's senior project and the additions from this project will be compiled with it. Procedures that will be added to the manual are described in subsequent sections.

Adjusting graph scales. The following is a step-by-step procedure for changing the scale any graph in addVantage Pro 6.4:

1. Open the graph of choice by clicking on the magnifying glass to the right of the graph's title.
2. Right click anywhere on the graph.
3. Choose, Properties.
4. In the new window, look for the scale section in the left column.
5. Enter the desired scale. The maximum value on the graph should be entered in the box titled, High.
6. Click OK to save changes and close the window.
7. Verify the changes on the graph.

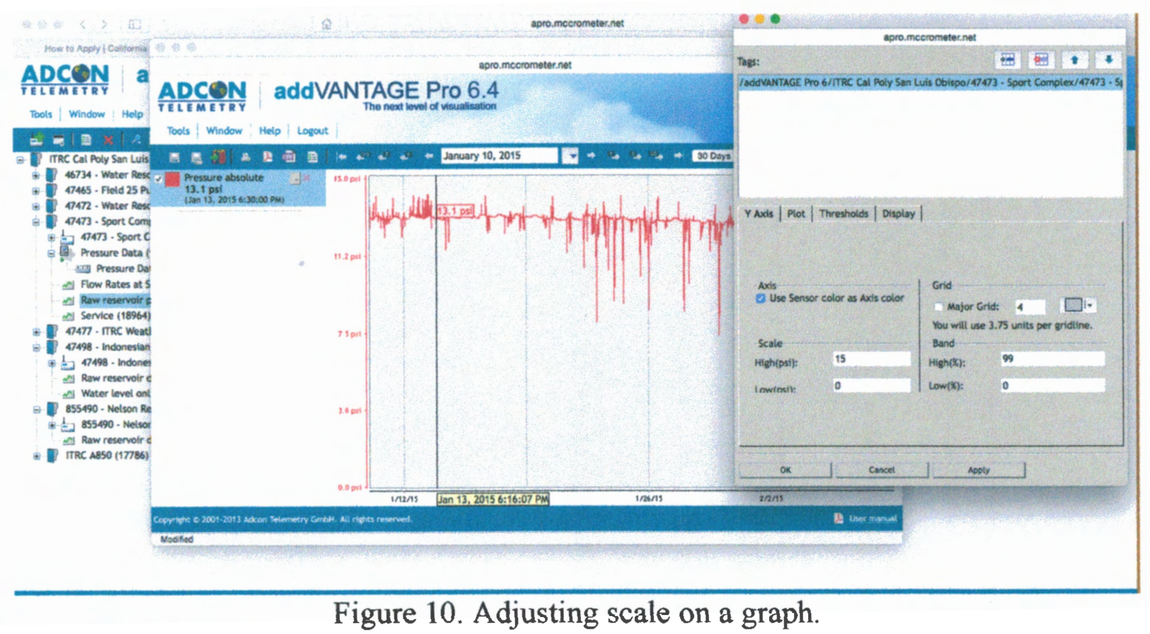

Figure 10. Adjusting scale on a graph.

Creating calculation extensions. The procedure for creating a calculation extension, specifically a formula calculation, is as follows:

1. Expand the dropdown menu for the telemetry station of choice.
2. Identify the desired sensor and right click on the sensor's logo (i.e. pressure gauge).
3. Select Create New Node.
4. Select Calculation Extension.
5. Select Formula Calculation or some other type of calculation extension. Continue with the following steps only if performing a formula calculation.
6. A Formula Calculation will appear at the bottom of the menu. Right click on the logo to the left of it.
7. Select Properties.
8. Under the Extension tab, enter a formula and click 'Evaluate!'
9. Be sure to select an Output type and Output units appropriate to the calculation.
10. Under the General tab, the formula calculation can be renamed and enabled/disabled.
11. Click OK when finished and verify the calculation by opening the graph. Open the graph by clicking on the magnifying glass to the right of the title.

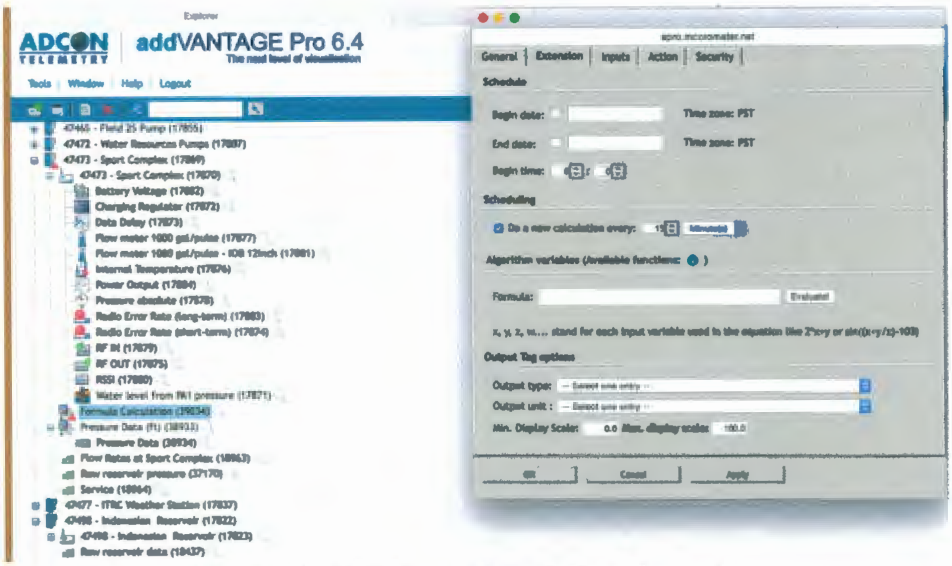

Figure 11. Creating a Calculation Extension.

Connect Trendview Mobile App

After learning about McCrometer's Connect Trendview mobile application, it was installed and setup to access Cal Poly's telemetry stations. Aside from initial setup, application was modified to organize all of the stations and their data into folders that would be easily accessed by others.

Mobile application setup. With guidance from Jim Devore, the McCrometer Connect Trendview was setup and organized so future users can easily access the data from mobile devices. Below is a detailed procedure to setup or modify the application.

1. In an internet browser, go to trendview.mccrometerconnect.com
2. Enter the access information provided by the ITRC. The server URL is apro.mccrometer.net for Cal Poly's telemetry network.
3. In the home screen, a list of groups will appear.

Figure 12. Mobile application setup.

4. To add a group, enter a title in the box under the Your Groups section.
5. Click Add. The new group should appear in the list.
6. To add a new item in a group or view the items already in a group, click on the group of choice.
7. To add a new item, first log in to the addVantage account by opening a new window in the Internet browser.
8. After logging in to addVantage, identify the item (i.e. sensor or graph) that will be added and note the Node ID in parenthesis.
9. Return to the McCrometer Connect webpage.
10. Under the Your Trends section, select the type of item being added from the dropdown menu. An instrument is any item that is a sensor. A trend refers to any graph created from the data.
11. In the next box, enter the title of the item.
12. In the last box, enter the node I.D.
13. Click Add. The item should appear in the list below.
14. To verify the new changes, log on to the mobile app on a mobile device. Instructions for installing the application are in the procedures section of this report.

DISCUSSION

Evaluating and modifying Adcon's addVantage program leads to enhanced usability for future users. The resulting changes that were made allow students and faculty to more easily access the information collected by sensors in the field and read the data in a format that is better understood.

A primary challenge that hinders the improvement of the overall network and the data's usability is a lack of information. It was noted throughout the project that background information about the telemetry stations is not available for people wanting to understand the purpose and potential of the technology. Helpful information regarding the use of addVantage Pro and previous development of a manual for the program, is not compiled in a useful and accessible fashion. For instance, students have created step-by-step procedures as reference for future users, but their work is not organized or made available for people to use.

addVantage Modifications

The most useful results of this project are the procedures created for using addVantage Pro and Connect Trendview. Usability of the programs is greatly enhanced when the procedures are available for reference. Because the programs are unique and complex, the procedures are limited to use for these specific programs. However, the procedures may be transferrable to various applications, aside from Cal Poly's telemetry network. In other words, different agencies and companies can make use of these procedures by applying them appropriately to their telemetry network.

The first procedure added to the manual described adjustment of scales on graphs that represented data from the telemetry stations. A graph may show valuable information, but the manner in which it is presented has a great impact on the readers' ability to interpret the data. By adjusting the scale, the data can be seen more clearly and fluctuations in the data are more apparent. Improved ability to read data collected from the field allows users to more effectively apply the information to management strategies. This change is universal to any graph on addVantage Pro and can be done in a few simple steps. As Cal Poly's network grows, the procedure can be applied to new graphs.

Another procedure included in the manual tells how to create calculation extensions. There are two different types of calculation extensions and each is slightly different to create. A formula calculation is the one performed in this project, but both can be used to improve the usability of this program. The formula calculation converted the pressure data from a reservoir by telling the program to send each data point through a unique formula. In this case, the formula converted pounds per square inch into feet of head. By expressing the data in terms of feet, users can more readily interpret the data and understand that the information offered by this sensor is referring to the feet of water in a reservoir. These calculation extensions have the potential to greatly ease the difficulties with interpreting and utilizing data. Unfortunately, the formula that is used for this specific extension reduces the precision of the data collected, but it is not a major concern for the purpose of this sensor. Calculation extensions could create problems for the validity of data if the applied formula is not precise.

Connect Trendview

With the help of a knowledgeable representative from McCrometer, this mobile application was easily installed. It offers convenience and simplicity to users wanting to quickly access data from a mobile device. As the network grows at Cal Poly, the application will need to be updated so the procedure for modifying the program is useful for future administrators. The application is very simple to use and clearly organized so that users concerned with a particular telemetry station can view all of that data on one page. It is also limiting, however, in that the data can only be read from the application and cannot be modified. To make modifications or control sensors, the user must access the network through addVantage Pro. According to Jim Devore, this mobile application is expected to progress in usability and capability. As this happens, it will be more complex to use the program and the necessity of a manual will grow.

System Installation

Unfortunately, the installation of a new telemetry station at Middlecamp reservoir did not take place. The sole purpose for installing the station is to collect data regarding the reservoir's water level and how it changes. Data collected from this station would allow managers to understand when, where, and how much water travels in and out of the reservoir. A water level sensor is needed to collect the necessary data and it had to be ordered from the manufacturer. It was not ordered early enough for the sensor to arrive before the completion of this project. The installation will take place next quarter and be installed by ITRC staff.

RECOMMENDATIONS

The numerous procedures that result from this project and others need to be compiled in the form of a manual that can be readily accessed by students and staff members. It may be best to accomplish this by providing an online version on the Irrigation Training & Research Center's website. Perhaps it is also possible to share a copy of the manual on addVantage Pro. By offering step-by-step procedures that are commonly used on Cal Pol's network and easily accessed by any user, the usability of the entire program is greatly improved. A major component of an effective manual is photos that offer useful clues to readers. Although detail and clarity are important when describing a procedure, photos and screenshots often express details that resolve confusion.

Future Modifications

On many of the graphs that collect pressures related to water level in reservoirs, the data collected doesn't accurately reflect the depth in the reservoir. This is due to the location of the sensor in the reservoir that is collecting the data, being misrepresented on the graph. In order to correct this mistake, someone must record the location of the sensor in the reservoir with relation to the deepest point and the top of the reservoir. This information is then used to modify the data points on the correlating graph so that the top of the reservoir is located at zero feet. It is anticipated that a calculation extension will need to be created in order to make the adjustment. This change allows the data to best represent the information it is intended to convey to users.

Another modification to the program that will enhance usability by creating simplicity is customizing the data that is displayed to each user. Different users are concerned with specific data and telemetry stations. If users only have access to view data that is pertinent to them, then the focus remains on key information and unintentional changes to data are avoided. Such a simplified presentation of data improves the ease of finding information and creates a friendlier display. In order to accomplish this, each user needs restricted permission to view certain data. It is important to create a procedure that describes how this change is completed so that administrators can keep user permissions updated.

Potential for Improvement

To maximize the usability of addVantage Pro and the data collected from Cal Poly's telemetry stations, specific areas of improvement must be identified. A great strategy for this is by collecting feedback from users of the program. By simply asking Ag Operations staff, ITRC staff, students, and users from other departments, necessary program modifications can be selected. If users dictate the changes that occur to the program, it should result in a program that is extremely user-friendly for the particular audience at Cal Poly. Although preferences differ, feedback from users will clearly identify weak points in the program and the primary demands for improvement. There

For a collectively improved network and complete data presentation, installation of a water level sensor at Middlecamp reservoir is necessary. There are other locations that should have sensors as well, but Middlecamp is important for completing the flow of water through all of the reservoirs that are relevant to water management strategies. An improved inventory of sensors and installation components is useful to understand what needs to be ordered in the event that a station is installed. It will eliminate confusion when determining what parts are appropriate for a particular installation as well.

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APPENDIX A

HOW PROJECT MEETS REQUIREMENTS FOR THE ASM MAJOR

HOW PROJECT MEETS REQUIREMENTS FOR THE ASM MAJOR

ASM Project Requirements

The ASM senior project must include a problem solving experience that incorporates the application of technology and the organizational skills of business and management, and quantitative, analytical problem solving. This project addresses these issues as follows.

Application of Agricultural Technology. The project involves the application of supervisory control and data acquisition (SCADA) technologies.

Application of Business and/or Management Skills. The project involves business/management skills in the areas of efficient productivity analyses and effective written communication strategies.

Quantitative, Analytical Problem Solving. Analytical problem solving techniques include evaluation and improvement of Adcon network usability. and...

Capstone Project Experience

The ASM senior project must incorporate knowledge and skills acquired in earlier coursework (Major, Support and/or GE courses). This project incorporates knowledge/ skills from these key courses.

BRAE129 Lab Skills/Safety
BRAE203 Engineering Economics
BRAE321 Ag Safety
BRAE324 Agricultural Electrification
BRAE340 Irrigation Water Management
BRAE402 AgMaterials
BRAE418/419 Ag Systems Management
ENGL148 Technical Writing

ASM Approach

Agricultural Systems Management involves the development of solutions to technological, business or management problems associated with agricultural or related industries. A systems approach, interdisciplinary experience, and agricultural training in specialized areas are common features of this type of problem solving. This project addresses these issues as follows.

Systems Approach. The project involves the integration of multiple functions including wiring and programming of a new Adcon station, and applies the management functions for analyzing data and evaluating systems to develop more effective practices for water management.

Interdisciplinary Features. The project touches on aspects of mechanical systems, computer systems, supervisory control and data acquisition systems, agricultural safety, and water management.

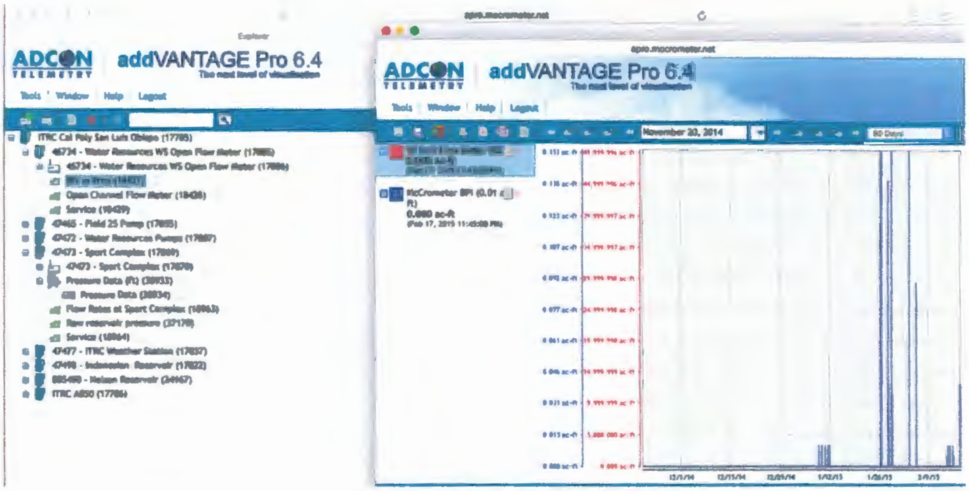
Specialized Agricultural Knowledge. The project applies specialized knowledge in the areas of water management and supervisory control and data acquisition.

Ethical Considerations?

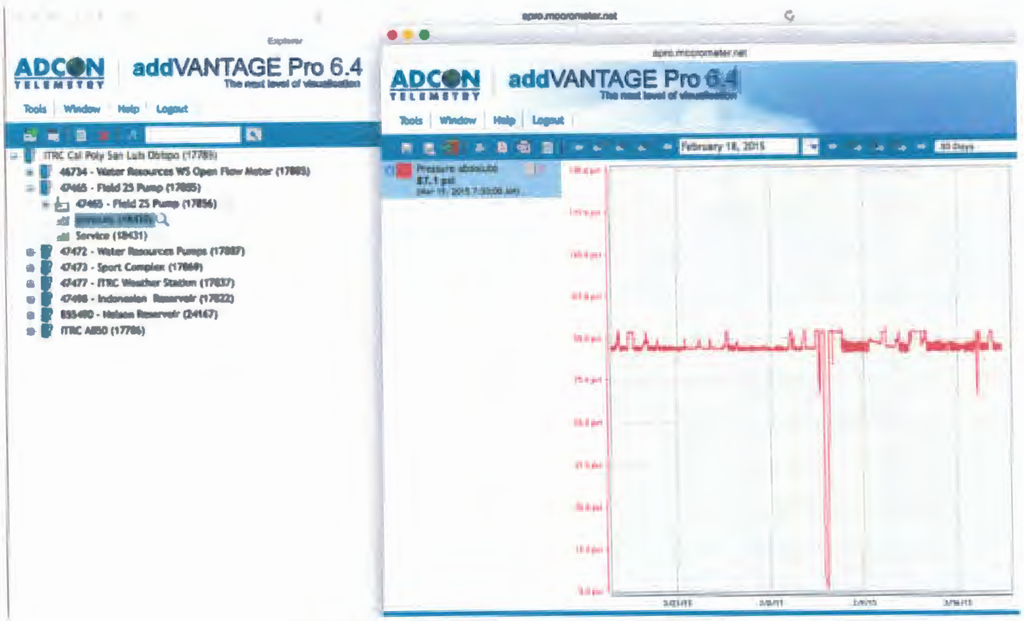
ASM Criteria

APPENDIX B

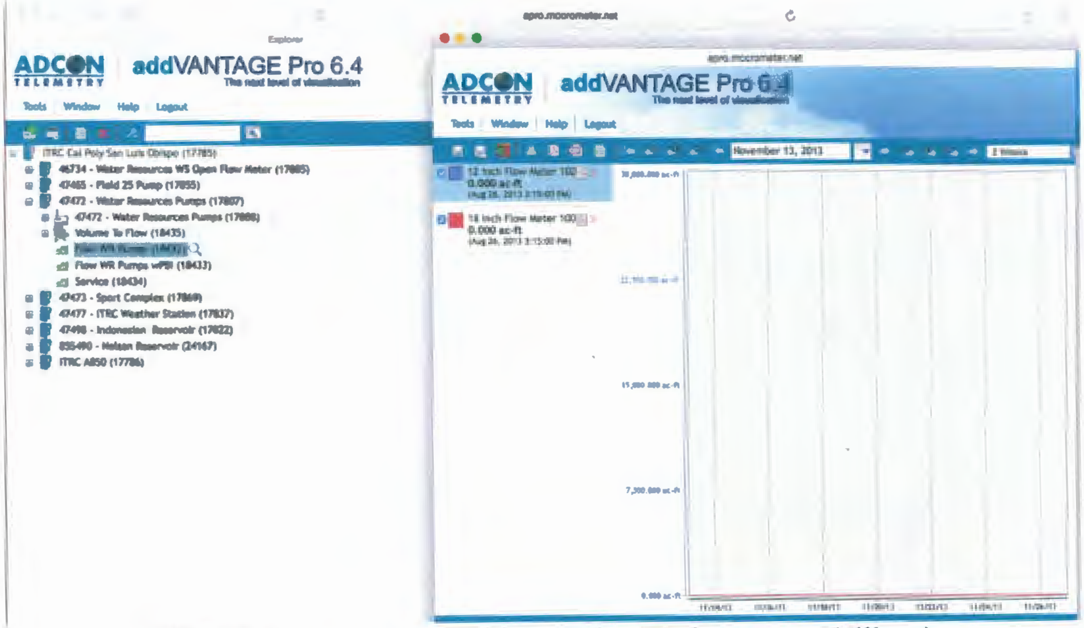
LOCATIONS OF TELEMETRY SITES



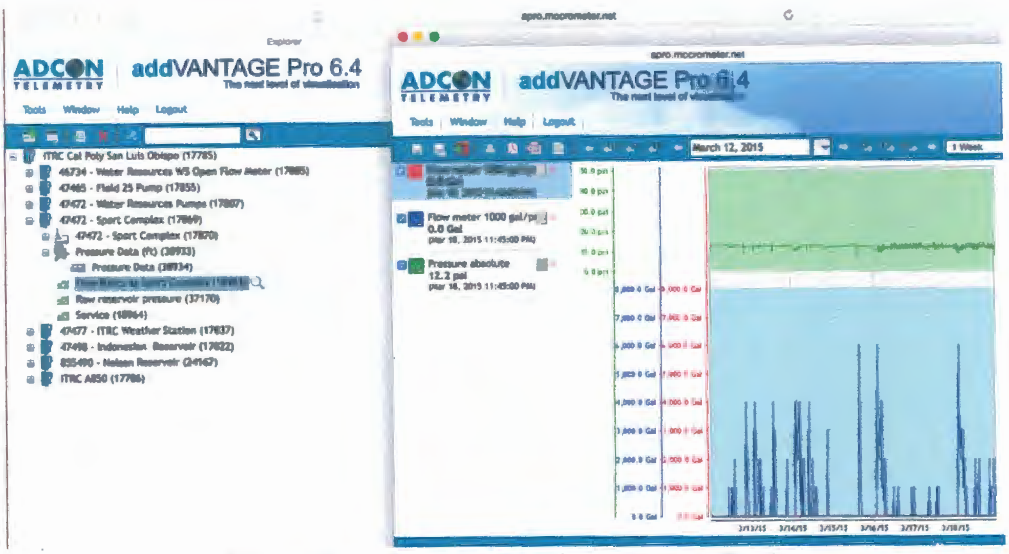
Water Resources WS Open Flow Meter (blue circle at Poly Canyon Village)



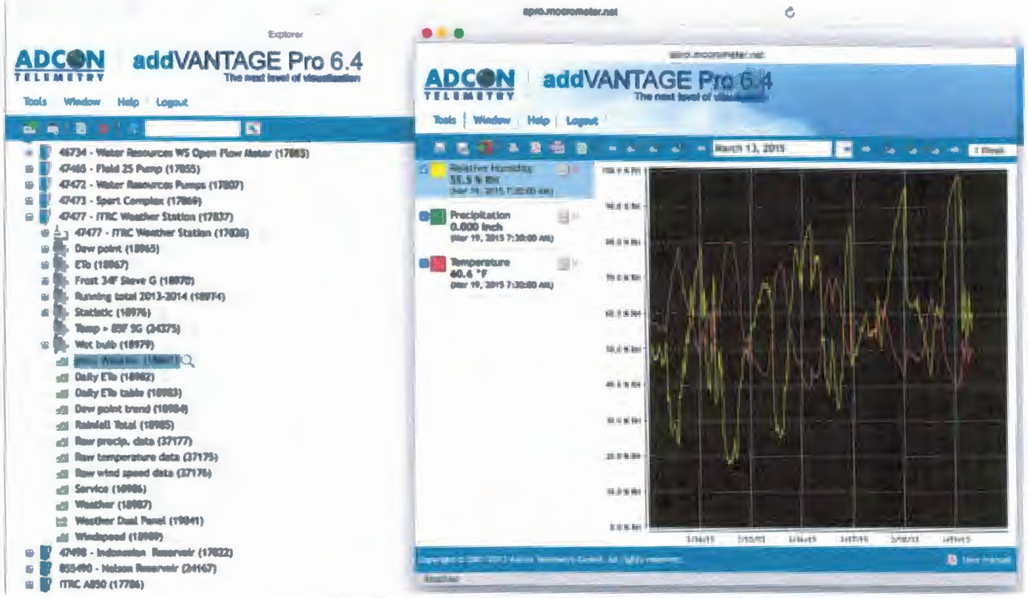
Field 25 Pump (blue circle at Soccer field)



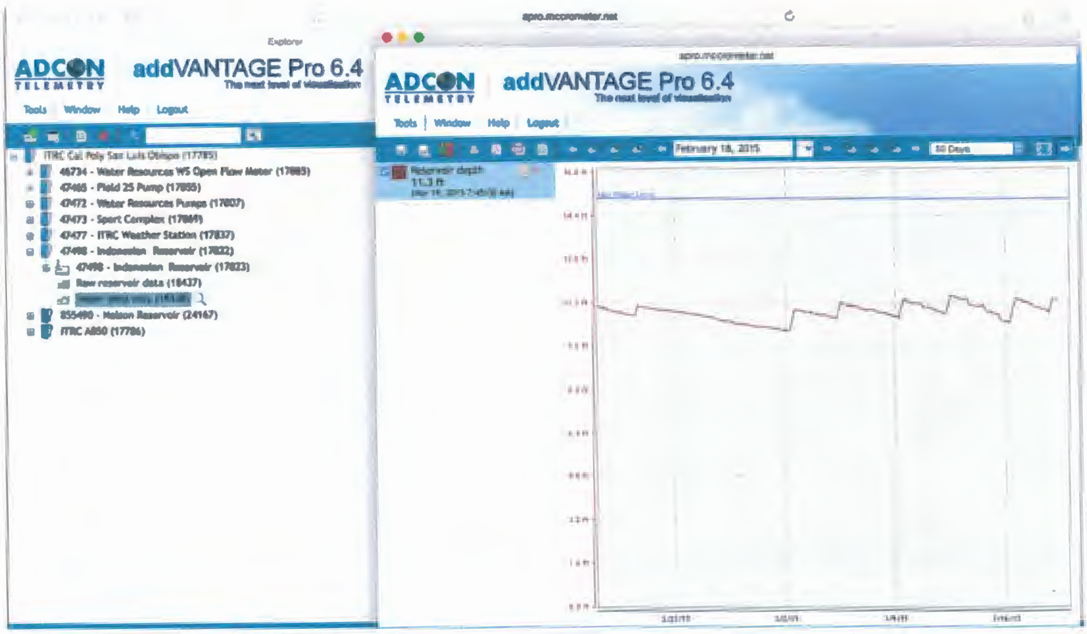
Water Resources Pumps (blue circle at Poly Canyon Village)



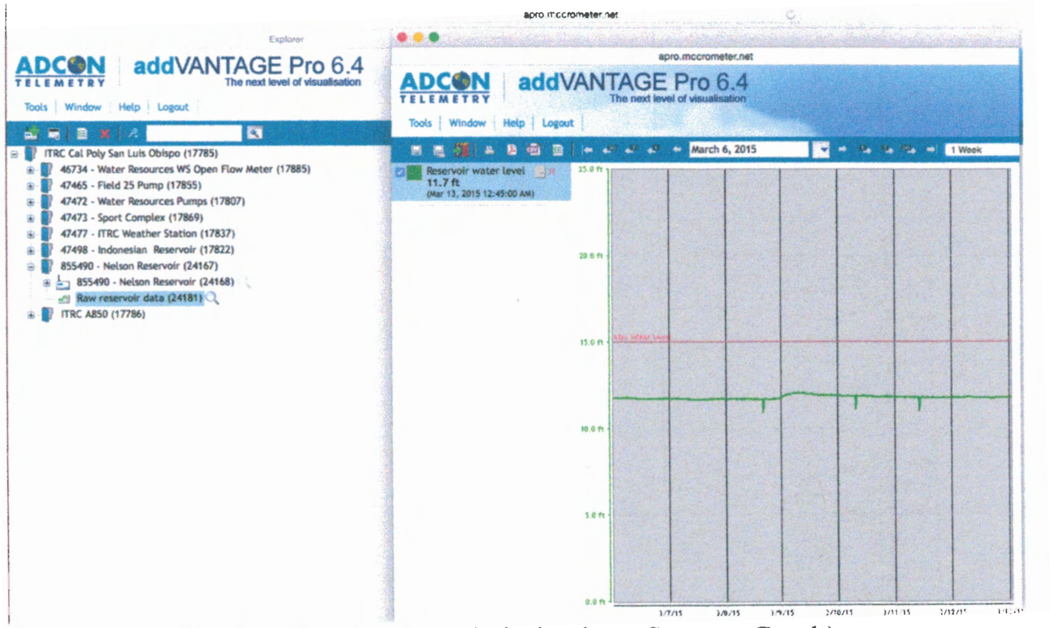
Sports Complex (blue circle at Soccer field)



ITRC Weather Station (pink circle)



Indonesian Reservoir (red circle along Via Carta)



Nelson Reservoir (red circle along Stenner Creek)

Map of stations on campus (from Kloepper, 2014)

APPENDIX C

INSTALLATION PROCEDURE

Nelson Reservoir Adcon Telemetry Station Installation

The following information has been compiled from Shelsie Kloepper's senior project as reference for installing a station at Middlecamp reservoir.

On May 6, 2014, an Adcon Telemetry Station was installed at the Nelson Reservoir. A pump and filter station is currently being developed at the Nelson Reservoir and will utilize the Adcon Telemetry station in the future. The concrete pad for the pump and filter station has already been poured by a group of BRAE 433 students. The first step in installing the sensor was the assembly of the pole. The first element to add to the pole is the RTU placed at the top of the pole followed by the solar panel placed below the RTU (see figure 23 below) (Kloepper, 2014).

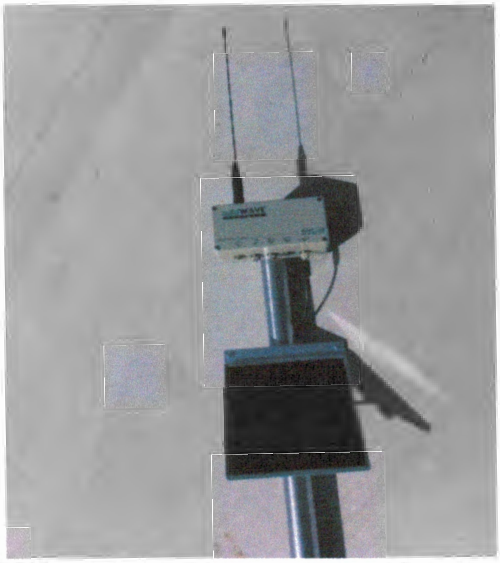


Figure 23: RTU and Solar Panel Assembly (Kloepper, 2014)

Before attaching the water level sensor breather box to the pole the water level sensor cord had to be fed through the eyelets of both the float and weight. In order to accomplish this, the wires had to be disconnected inside the breather box to fit the cord through the eyelets. Figure 24 below shows the inside configuration of the water level sensor breather box (Kloepper, 2014).

Figure 24: Breather Box Configuration for water level sensor (Kloepper, 2014)

Once the cord was fed though both eyelets the breather box was reassembled. The water level sensor was then zip tied to the bucket handle in order to maintain a constant level (see figure 25 below) (Kloepper, 2014).

Figure 25: Water level sensor secured to weight (Kloepper, 2014)

Next the breather box was attached to the pole underneath the solar panel as shown in figure 26 below (Kloepper, 2014).

Figure 26: Full assembly of Adcon pole (Kloepper, 2014)

The pole was mounted to an existing pole at the pump pad for the pump and filter station that will be installed at the Nelson Reservoir in the future (see figure 27 below). The pole was mounted to the closest pole to the reservoir in order to get the sensor as far into the reservoir as possible with the limited cord length (Kloepper, 2014).

Figure 27: Pump pad at Nelson Reservoir (Kloepper, 2014)

The next step was to place the sensor in the reservoir. In order to accomplish this process the ITRC's boat was used (see figure 28 below). The boat was rowed out into the open water as far as was possible with the length of cord available. Next a rope was used to lower the concrete bucket weight to the bottom of the reservoir. The float was successfully held in place by the tension in the cord from the weight. While in the same location as the water level sensor a staff gauge was used to record the water level of the reservoir (Kloepper, 2014).

Figure 28: Boat used to lower weight and sensor into the Nelson Reservoir (Kloepper, 2014)