

U-GEMS Manual

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Manufactured by

Green Eyes,LLC

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Section 1 Description of the UMCES-Gust Erosion Microcosm System (U-GEMS)

1.1 System Overview

U-GEMS is an adaptation of the Gust Microcosm using a combination of a spinning disk and a central suction to generate a nearly uniform shear stress across sediments in a cylindrical container. U-GEMS is designed to measure the erodibility of fine grained sediments in a 10 cm (or 11.4 cm) core tube over a calibrated range of shear stresses from 0.01 – 0.45 Pa (higher stresses are now achievable, but are outside of the calibrated range). The system provides all of the automation and control, and data logging capabilities to conduct erodibility measurements that can be analyzed to determine erodibility parameters of intact sediment cores. The system is available in a dual core arrangement with two 10 cm cores run simultaneously, or as a single core system. Alternate core sizes are possible within a range of 10cm +/- 2cm at customer's request (additional cost may apply). The components of the system have all been integrated so that the user can input the desired shear stress (τ_b in Pascals). The system will adjust the disk spin rate and pumping rate to the proper setting and the data from the turbidimeter(s) and the motor speed output will be recorded to a data file. Effluent water from the experiment is collected and analyzed for Total Suspended Solids (TSS), and the used in the post experiment data analysis.

1.2 System Components

1.2.1 Green Machine

The Green Machine(GM) is a Microchip PIC18 based processor board that is plugged into a system board with various components including a digital to analog converter (DAC) that sets the motor speed and pumping rate, and digital inputs to monitor motor speed via an encoder mounted on the motor. Motor speed is maintained through a feedback loop between the encoder counts and the DAC, and GM switches power to various U-GEMS elements. Communication to the GM is through a serial interface with the baud rate set to 57600 bps, DataBits = 8, StopBits=1, Parity=None.

1.2.2 ComScript

The ComScript software (by Green Eyes, LLC) is designed to interface and control external devices connected either through a serial or TCP connection to a host computer. ComScript is designed to run on the .net platform (version 3.5 or later) and the source code is written in C# language. Although ComScript has numerous system control and data collection applications, U-GEMS includes a complete ComScript profile designed to control all components and record scientific and diagnostic data. The profile name for this system is “**Erosion2p1s**”, which is the folder name that contains the profile.xml, config.xml, and other files that are required to run U-GEMS. ComScript has the

following key features:

- A program (**profile**) that controls system components and records data. The profile uses a friendly xml scripting language to simplify programming.
- A **Data Interface window** that allows users to change variables such as the shear stress, and monitor variables such as motor RPM and step time while the profile is running.
- The **Image Watcher window** is used to view live plots of experiment data, GNU plot (shareware) is used to make real time plots from the U-GEMS profile data file that are displayed in the Image Watcher for convenient monitoring of the experiment.

The supplied ComScript profile controls the experiment by sending commands to the GM and logs data from the turbidimeter(s) and the motors to a text file. The user is free to modify the ComScript profile.xml or config.xml file for their application, but caution is urged to prevent unwanted errors. If changes must be made, such as to change the COM port assignments, users are encouraged to contact SES or refer the ComScript help file for support. **Note: ComScript is a new version of the software that was previously called Water2Web (W2W), also by Green Eyes, LLC. There remains some references to W2W in this manual, which are still relevant for ComScript.**

1.2.3 Motor(s)

The motor(s) used to drive the spinning disk on the erosion head is a Maxon Precision Motors brushed DC motor, gearbox, tachometer combination. The motor mounts directly on top of the erosion head and has a plate with magnet pairs connected to its output shaft. The motor is connected to the Power/Control box with a plug at the end of the motor cable. The motor is driven by a Maxon linear motor controller (LSC 30/2, p/n 250521) that is located inside the Power/Control box (see drawings in section 1.3 and section 7). The motor controller receives the encoder signal, and accepts the reference voltage from the GM that sets the motor speed. The motor (p/n 268214), encoder (p/n228452), and gearbox (p/n166159) are the components for this motor assembly (p/n 333189). Specifications can be found in the materials from Maxon supplied with your system (pdf format). The dip switches on the motor controller (LSC 30/2) are set to encoder mode and external speed reference of +/- 3.9 VDC (see Maxon LSC 30/2 controller manual for more information, included separately).

1.2.4 Pump

A Fluid Metering Inc (FMI) Q type metering pump moves water from the replacement water container through the erosion head, through the turbidimeter(s) and into the sample collection bottle. The FMI pump has features that include positive displacement, valveless, variable speed, and a rotating and reciprocating piston. The pump consist of a

motor (QV), ceramic pump head (Q1CKCW), and a stroke rate controller (V300). The pumping rate is determined by; 1) angle of pump head, and 2) motor speed driving pump head which is controlled by stroke rate controller. Flow rate for the U-GEMS system is in the range of 20-230 [ml min⁻¹]. To achieve this flow rate the pump head angle is set to deliver maximum flow rate desired when the stroke rate controller is at 100% speed, typically a pump head angle setting of about 4 on the indicator. A calibration was made of DAC set value on the GM, which sets the reference voltage to the stroke rate controller, and pump flow rate (see fig 4.3.1). This calibration is programmed into the ComScript profile, which automatically sets the proper pumping rate based on shear stress and temperature. It is recommended users periodically verify the pumping rate against the calibrations for given shear stress settings (see calibrations section). The stroke rate controller has a selectable speed reference source; to run an erosion experiment the 0-5 V setting should be used, whereas the manual setting can be used to run the pump manually for priming and flushing. It is important that the stroke rate controller is in the “Run” mode when starting an experiment. Refer to the FMI manuals for more information. If disassembly of the pump head is required, it is highly recommended that the user read and follow **FMI instructions** to avoid damage to pump head seals.

1.2.5 Tubidimeter(s)

A Hach 2100N turbidimeter (nephelometer) is used to measure the turbidity of the water as it is pumped out of the sediment core during the erosion experiment. The ComScript profile will poll the turbidimeter through a serial connection (**Null modem cable is required!**) at an approx 1 hz to record turbidity data (NTU). The turbidimeter has a flow cell where water flows in from the top and is exits through the bottom and/or the top of the cell that helps prevent air bubble accumulation. The flow cells and tubing connections are supplied with U-GEMS. The turbidimeter communicates at a baud rate of 1200 bps (yes really that slow!). Generally it is not necessary to calibrate the turbidimeters because the NTU values will normally be directly calibrated to TSS and the absolute accuracy of the NTU values will not affect results. However, there are calibrations standards provided with the turbidimeter and a calibration procedure in the Hach manual if performing an NTU re-calibration is required.

1.2.6 Erosion Heads

Erosion heads were designed and built at UMCES under the direction of Dr. Lawrence Sanford. The erosion heads are primarily made of polycarbonate and use a magnetic drive coupling to avoid any rotary seals (see drawing Section 7). The magnetic drive uses 0.500” x 0.200” Neodymium disc magnet pairs spaced at 120°. The rotating disk spins on a delrin bushing that fits over a stationary central shaft with a bored hole in the middle to allow for the effluent water path. The water flows in on the side of the erosion head and into a channel in the divider plate which enters the core tube on top of the spinning disk.

The water exits up through the central shaft and through another hole in the divider plate and out of the opposite side of the erosion head. Quick connect fittings are used to allow easy connection of the tubing to the erosion heads. The Maxon motor with the magnetic drive plate is mounted to the top of the erosion head by way of a mounting plate attached to the motor.

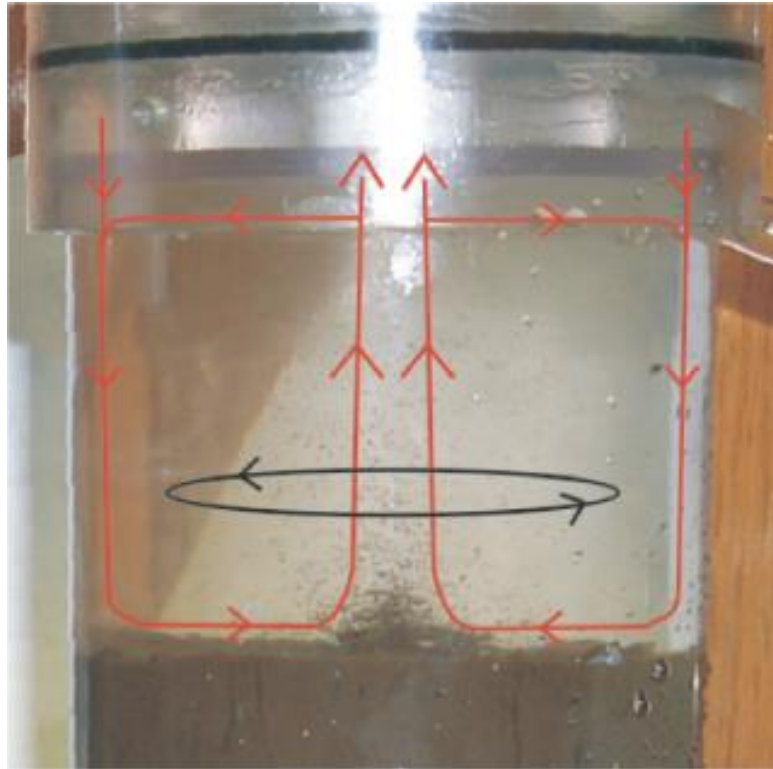


Figure 1.2.6.1- Photo of erosion head during experiment with flow pattern represented by drawn lines and arrows.

1.2.7 Power/Control Box

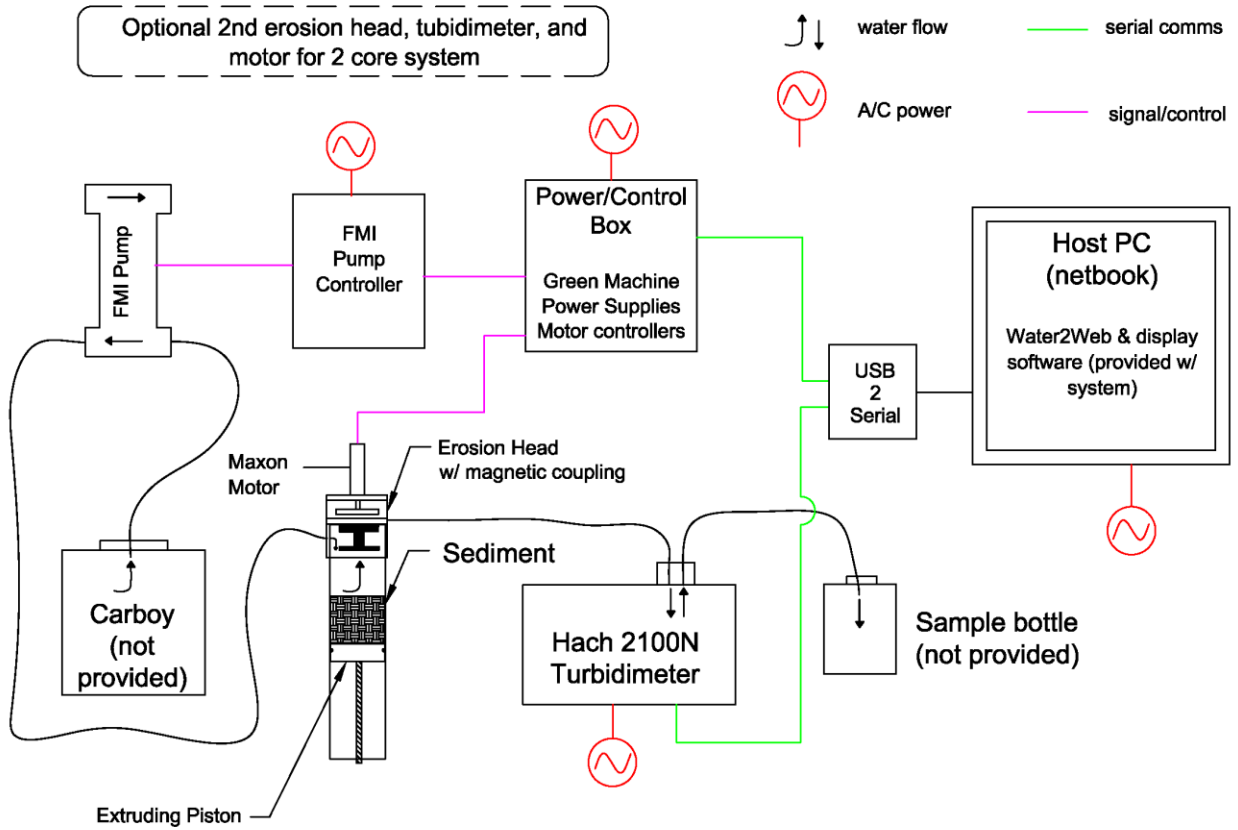
The Power/Control box houses the GM/system board unit, the Maxon motor controller(s), main 24 VDC power supply, DC/DC converter (12 VDC output), and relay(s) to turn on/off motor controller(s). There are connectors on the outside of this box for A/C power in, a 4 amp fuse, RS232 serial connection to GM, RCA plug to pump stroke rate controller, and 9 pin motor connector(s). When A/C power is supplied to the box there is an electrical shock hazard. **DO NOT TOUCH ANYTHING INSIDE THE BOX** when A/C power is connected. **Use extreme caution!!**

1.2.8 Accessories

A USB to serial converter is supplied with the system to allow multiple serial ports on a computer with no on-board serial ports. Users will need to make sure the USB to serial

converter is configured correctly and that the COM port assignments match the ComScript profile. Extruding pistons and extruding rod extensions are supplied to extrude the core to the proper height below top of the core tube (10 cm). A clamp mechanism is supplied to hold the erosion head securely to the core tube and a core holder is supplied to hold and level the core(s) while running an experiment. Two cm PVC disks with a central push pin are supplied to block out the sediment at the center of the core where an artificially high pressure gradient exists from the proximity to the effluent water intake at the bottom of the central shaft. Sample polycarbonate core test chambers are supplied with the system.

1.3 System Schematic



Section 2 System Operating Procedures

2.1 System Set-Up

- 2.1.1 Unpack system components from the case to a suitable working surface.** The following components should be located on the bench top: turbidimeter(s), FMI pump, FMI pump drive, Power/Control box (Green Machine, power supplies and motor controllers), host computer (Lenovo x140e), USB to serial adapter. Note: Arrange turbidimeter(s) and pump on bench top so that the tubing connections for the water flow can be made with the length tubing supplied. Tubing length should be minimized to reduce water flow path.
- 2.1.2 Connect power, signal, and communication cables.** The motor, pump drive rca cable, RS232 GM Comms cable (DB9 on 1 end and 9 pin Bulgin Buccaneer connector on other), and A/C power supply cable connect to the outside of the Power/Control box. Note: There is also a 4amp fuse in the fuse holder beside the A/C power cable socket in the rear of the box. Connect opposite end of RS232 GM Comms cable to first COM port on USB to Serial converter. Connect turbidimeter Null Modem cables (DB9) to second COM port on USB to Serial converter, but Do Not connect to turbidimeter yet!! Connect RCA cable end with RCA to double banana plug adapter to FMI pump drive 4-20mA input connector. Note: User should verify that your COM port assignments are correct (see Windows Device Manager). If they do not the ComScript profile that runs the experiment might need to be modified. You can use ComScript terminal emulator mode or other terminal programs (e.g. Procomm, Hyperterm, etc) to check COM port assignments. See “Appendix B: COM Port Assignment Test w/ ComScript Terminal Emulator” for a description of how to use ComScript terminal emulator to check COM port assignments. See section 2.2.4 for making sure COM port assignments are correctly set in the “profile.xml” file. Note: Cables have been marked to help aid in proper hook-up.
- 2.1.3 Connect tubing and install flow cells.** Remove tubing adapters from pump head and disconnect adapters from storage tubing. Note: Trying to remove or install tubing while adapters are connected to pump head could damage pump head, it is therefore highly recommended that they be removed for connecting and disconnecting from tubing. Install adapters onto tubing ends numbered 1 & 2. End number 1 is intake side of pump and number 2 is outflow. Reinstall adapters onto

pump head by loosening locking nut, inserting, then tightening locking nut (hand tight only!!). Carefully unpack glass flow cells and install end caps making sure threads are aligned properly and sealing o-ring is properly positioned in end cap; tighten snugly using hands only. Inspect the outside of the flow cell, clean if necessary, and periodically apply small amount of silicone oil using cloth supplied by Hach (see instructions in Hach manual). Install flow cells in turbidimeters and secure tubing in guides. Close turbidimeter sample chamber lid and let it rest on tubing. Do NOT make tubing connection to the erosion head yet.

2.1.4 Connect power to pump drive and turbidimeters. Install A/C power cable and plug into power strip for pump drive and turbidimeter. If you have not yet connected pump to pump drive do so now (“pump module” connection on pump drive). Only turn on turbidimeters, NOT pump drive yet. Switches are located on back of turbidimeters and front of pump drive. Turbidimeters will go through a startup routine and the LED display will show model number (“2100N”), a couple of other things, and then the turbidity value, which should be <1 NTU with just air in the cell. If you get an error message (sustained beeping), turn the system off and try again. Once the turbidimeter is properly displaying the turbidity, you can connect the null modem DB9 cable to the back of the instrument.

2.1.5 Test Pump operation and flow direction. To test the pump turn the selector for speed control source on the front panel of the stroke rate controller to **manual** and make sure direction selector is set to **forward**. Turn on pump drive and select 100% speed using up/down arrows. Place the free end of the tubing on the intake side of the pump in the replacement water carboy and hit the run button on pump stroke rate controller. Make sure water is flowing in the proper direction. Also you should periodically check the flow rate at 100% speed. The flow rate should be between 230 and 240 ml min⁻¹ and can be adjusted by moving the position of the pump head. The correct setting is typically around 4 on the pump head angle indicator. To increase the flow rate move it to a higher number on that side of the scale, or to decrease, a lower number. Once you have finished with the pump test **Turn off** the pump drive, and move the speed control selector to **0-5V**. You can leave the pump drive off until you are about ready to start the experiment.

2.1.6 Test motor operation. Typically testing motor operation will not be necessary. If it is deemed necessary the motor can be tested through the GM using the ComScript terminal emulator, or any other terminal emulator that supports serial devices. Contact SES if you need to test the motors manually through the GM for the required commands.

2.2 Software Set-Up

2.2.1 Software Overview. ComScript software, developed by Green Eyes, is supplied to run U-GEMS experiments. ComScript is written in C# using the .net platform. Latest version of ComScript software maybe downloaded at:

<http://gescience.com/ComScript.html>

A ComScript license is included with your UGEMS system. Your license key has already been registered with Green Eyes, LLC. However, if ever necessary you can receive a license key by starting the ComScript program (ComScriptGUI.exe), generate a license key under the help tab in the Desktop Utility, and provide to Green Eyes, LLC to receive activation key. The activation key to specific to the computer. For the Lenovo x140e notebook computer supplied with you system the activation key is;

EE6B-3262-CAC9-29BE

Version 3.5 or later of Microsoft .net platform must be installed on the host computer to run ComScript. Most newer computers come with .net pre-installed, but if required can be downloaded for free at from Microsoft website.

Presently ComScript is designed to run on PCs running Windows Operating Systems. It has been primarily tested on PC running Windows XP, Windows7, and most recently Windows8. ComScript includes both a terminal emulator and an automatic mode that runs a “profile” script that is written in a user friendly xml format. The xml command scripting language is a powerful tool to write applications for controlling external devices and collecting and storing data. The scripting language was used to write the “profile” and “config” xml files that run the erosion experiments. The open source shareware program, “gnuplot”, is also used to make the “on the fly plots” of turbidity during the experiments. Gnuplot must also be installed on the host PC. Gnuplot can be downloaded at:

<http://sourceforge.net/projects/gnuplot/files/>

2.2.2 Software installation. It is important to preserve the directory structure otherwise there will need to be some modifications to the programs for everything to function properly. ComScript should be installed in the root of the hard drive, if at all possible in “C:\ComScript\”. Contact SES or Green Eyes LLC to get registration key for ComScript (if not already registered) so that you will be using a licensed version (**included with U-GEMS**) otherwise trial version will expire in 30 days. To launch the ComScript application, start the application “ComScript GUI.exe”. Make a shortcut and paste onto the desktop for convenience. The “profiles” folder is located under “C:\ComScript\” and your project folder should be located in the “profiles” folder (e.g. “C:\ComScript\profiles\Erosion2p1s”). The gnuplot program executable should be located in the “C:\gnuplot\binary\” folder otherwise the .plt files in the erosion profile folder will need to be modified. The gnuplot program will be called directly from the erosion profile so users only need to make sure everything is in the right place. There is a file called “gnuplotkill.bat” that is called by the profile that needs to be in the erosion profile folder. If you would like to modify the plots the .plt files can be edited. A profile editor tool is built-in to the ComScript Desktop Utility, which has some useful tools to help build and edit profile and config xml files. A shareware program called “ConTEXT”, is also a useful text editor that recognizes xml tags and is helpful for editing the profile or config file for your erosion applications. ConTEXT can be downloaded at: <http://www.contexteditor.org/downloads/> .

2.2.3 Preparing to run program. Start the ComScript application and select the your “Erosion” profile from drop down box for your application; e.g. “Erosion”. Check “Open Data Interface when profile begins” box (see fig 2.2.1).

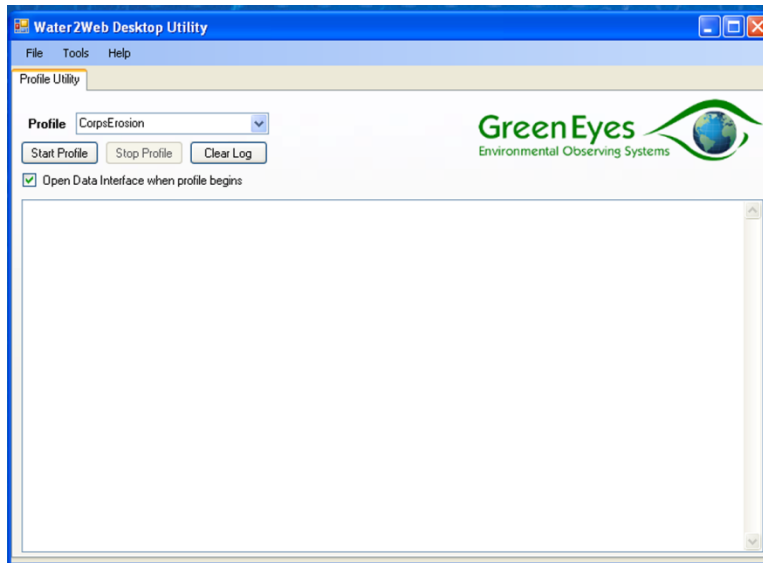


Figure 2.2.1 - W2W (predecessor to ComScript) Desktop Utility screen to open profile.

Hit “Start Profile” button. The profile will start, commands will scroll in Desktop Utility window, and the Data Interface (DI) will open. The DI shows the variables that are contained in the “config.xml” file. Variables in boxes with white backgrounds are user editable and those that have beige background are programmatically updated but not intended to be user updated. There is also a status indicator in the upper right of the DI that tells if the DI has an active connection to the running profile. Select the “Edit” button and make sure the editable variables are as indicated below;

Run = box unchecked

CollectData = box unchecked

tau = 0.01

temp1 = put in temp of replacement water for core 1 in degC

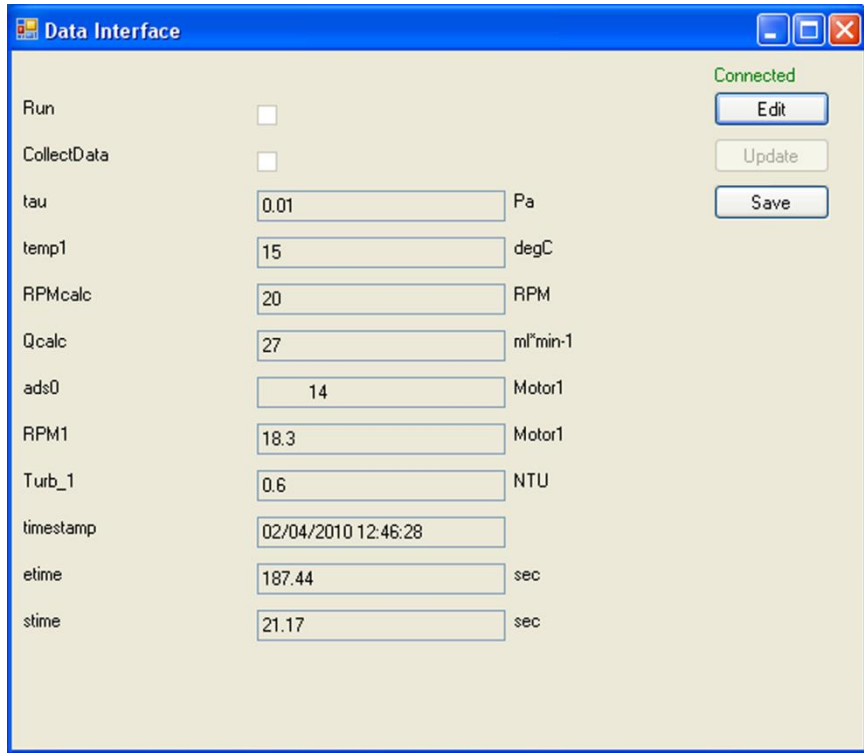


Figure 2.2.2- Data Interface window with sample of properly initialized values to begin erosion experiment.

Then hit “Update” to make changes take effect and then “Save” button (**important!**). This will save your parameters to the config.xml file. Next stop the profile, “Stop Profile” button in Desktop Utility and close the DI window. ComScript has been initialized.

2.2.4 Make sure the COM ports are set correctly. Open “profile.xml” file from the folder with your application; e.g. C:\ComScript\profiles\Erosion2p1s\profile.xml, in ComScript profile editor, ConTEXT or other editor. Make sure the COM ports are correctly assigned for the “GreenMachine”, “Turb1”, and “Turb2” (if dual core system). If they are not change “port” setting of the “device” command to the correct COM port assignment; e.g. “COM1”. If corrections are required be sure to save those corrections before running the ComScript profile. See section 2.1.2 and Appendix B for more information on testing COM port assignments.

2.2.5 Move/Rename/Delete old Datafile and log files. Data from the experiment will be written to the file “Datafile.txt” in the folder with the “profile” you are running. If the file exists the data will be appended to it, if it does not exist it will be created. So prior to starting an experiment, users are advised to either

Move/Rename/Delete the existing “Datafile.txt” to start with a fresh file. **Very Important!!!** Once experiment is complete, rename and archive “Datafile.txt” for your experiment to avoid accidentally deleting it when you start the next experiment. There is also a file called “log.txt” this file is a record of all the command processing of the ComScript profile, and is primarily a diagnostic tool. Normally writing to log file will be turned off. However if the set command in “startup” script in profile is set to “true” this file will be recorded and if left alone this file will becoming very large, so we **highly** recommend it be either archived or deleted after each experiment if it is recorded (not default).

2.2.6 Prepare the cores and start the experiment. See sections 2.3 & 2.4.

2.2.7 There is a ComScript profile command manual that is accessible from the help tab of the Desktop Utility.

2.3 Core Prep

- 2.3.1 Core selection and extrusion.** Try to select cores where the sediment surface is as even as possible. Carefully extrude cores using the pistons provided. It is helpful to apply silicone grease liberally to piston o-ring prior to pushing into the bottom of the core. Extrude the sediment surface to an average distance of 10 cm from the top of the core tube. Tighten nut on the piston such that the o-ring makes a seal with core tube. Install $\frac{3}{4}$ " threaded PVC rod extensions as needed, and thread the bottom plate until flange just touches the bottom of core tube. Install the diamond plate on $\frac{3}{4}$ " threaded PVC rod that is protruding below bottom plate (see fig 2.3.1).
- 2.3.2 Place core(s) in core holder.** Install the core into the core holder, level and secure the core using 4 positioning screws in each core holder position. Position the center block out disk (provided) in the center of the sediment, push pin into sediment, and make flush with the sediment surface. Needle nose pliers can be used to install the center block out disk. The water level should be at or near top of core tube. If the level is low carefully, add replacement water collected at coring site, taking care not to disturb the sediment surface.
- 2.3.3 Install erosion head.** Once the core is level and secure in core holder, install the erosion head. Make sure the erosion head is assembled correctly, such that the disk spins freely by hand (**Important!!**). Apply a small amount of silicone grease around top of core tube and position erosion head over core such that the o-ring in the erosion head contacts the top of the core evenly. Standing directly over the core and using your legs to secure the core holder, alternating pushing down on one side of the erosion head then the other with steady firm pressure. The erosion head should move down the core, and some water will come out of the ports as it moves into position. The divider plate in the middle of the erosion head should just contact the top of the core tube. Use gentle pressure to seat the erosion head to the core tube to avoid compromising the sealed perimeter of the divider plate to the erosion head sleeve.
- 2.3.4 Install motor on erosion head.** Now that the erosion head is in position, install the motor with the magnetic drive plate and erosion head top attached to the motor. Align one of the holes in the erosion head top plate and insert the nylon screw and hand tighten. The second nylon screw may be installed, but if the hole does not align properly it may be omitted.

2.3.5 Clamp erosion head/motor to core. Place clear clamp disk plate over erosion head and use the long 1/4-20 nylon all-thread rods to attach to diamond plate at the bottom of the core. Tighten using PVC nuts such that erosion head is clamped securely to core (see fig 2.3.1).

2.3.6 Connect the tubing to the erosion head. Install tubing connection #3 to the inlet port on erosion head (see system schematic and erosion head drawing) and connection #4 to outlet port (hint: you can see from the top of the core which port goes to center shaft by the drilled hole in the divider plate.)

2.3.7 Replacement water. Position the replacement water carboys on either side of core holder. Each core requires just over 20 liters of replacement water for a typical erosion experiment. This can vary with experiment duration, or if the higher stress levels are run for longer periods since the flow rates are higher for higher stress levels. Replacement water should be collected from the core site to minimize differences in salinity, temperature, chemistry, and biological composition.

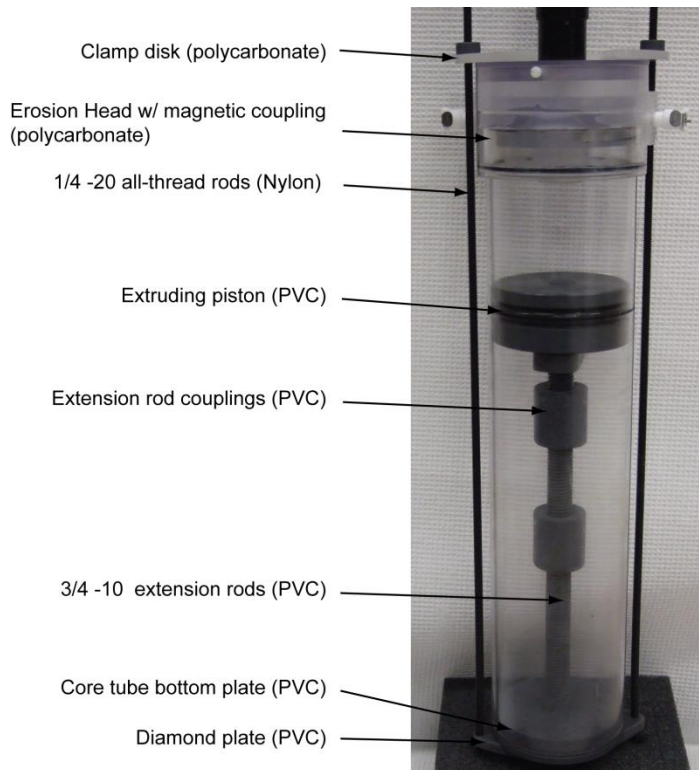


Figure 2.3.1- Photo of core assembly with UGEMS erosion head clamped to 10 cm core tube.

2.4 Running Erosion Experiment

- 2.4.1 System ready.** Make sure power is supplied to the Power/Control box (A/C cord plugged in, fuse good and installed). The turbidimeter(s) are on and displaying the turbidity value. The pump drive is on, the pump module connected, and the speed selector set to “0-5V”. The serial cable is plugged into the Power/Control box, null modem cables to turbidimeter(s), and each into the USB to Serial converter where port assignments have been verified.
- 2.4.2 Core Ready.** The core is extruded, the center block out is installed, the erosion head/ motor is installed and clamped to the core, the tubing connections are made and the replacement water is in place. Water level in core is at or near top of core. Intake tubing is in replacement water, and sample bottles are in place to collect effluent water.
- 2.4.3 ComScript ready.** Both ComScript and gnuplot are installed. The directory structure matches ComScript profile and plt files. Start the ComScript application (“ComScript GUI.exe”). Select the correct “profile” from the drop down menu for your application, e.g. “Erosion2p1s”. Check “Open Data Interface when profile begins” box (see fig 2.2.1).
- 2.4.4 Water temperature and sample.** Record the water temperature and take a sample of the replacement water for TSS analysis. Ready the sample bottles used for water collection during the experiment.
- 2.4.5 Start Profile.** Hit “Start Profile”. Make sure commands are scrolling in Desktop Utility window and that DI opens and shows status as “Connected”.
- 2.4.6 Start experiment.** In the DI window select “Edit”. Make sure $\tau = 0.01$, and the $temp1$ = measured water temp in degrees Celsius ($^{\circ}C$). (Note: for 2 core system there is both $temp1$ and $temp2$, and the program uses the average of the two to determine settings to achieve set shear stress (τ)). Check “Run” and “Data Collect” boxes, then select “Update” button. TURN on PUMP now! You have now initiated the experiment. The motors should start spinning slowly and the pump should start turning slowly. Verify this is happening. Also note the time of the start of the experiment. The data interface window will show the time stamp, the total elapsed time for the experiment (etime) in seconds, and the total elapsed step time (stime) in seconds. These times are helpful in determining step changes and noting times of observed events. Optional: hit the save button to write the data interface parameters to config.xml file (See fig 2.4.1).

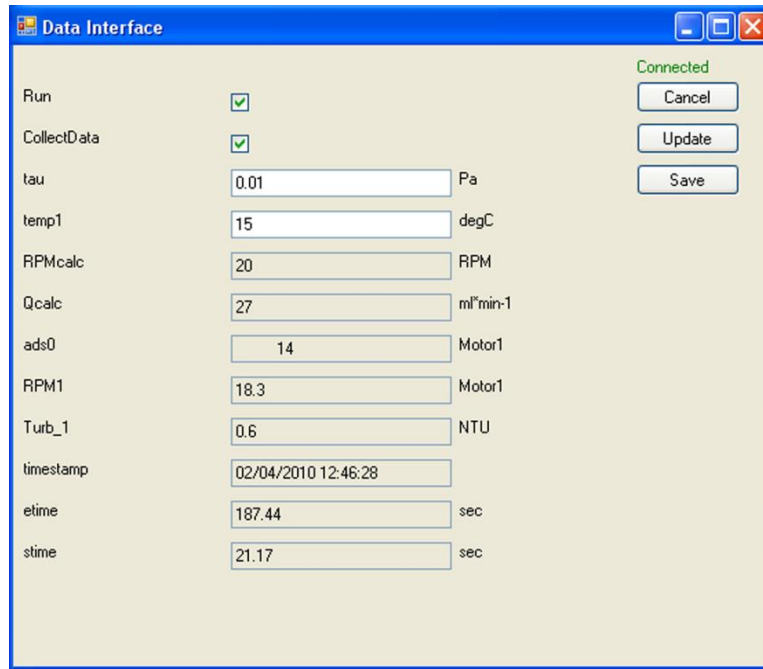


Figure 2.4.1 – W2W (similar for ComScript) erosion profile Data Interface when ready to start experiment. Select “Update” to initiate experiment.

2.4.7 Open Image Watcher. From the tools menu in the Desktop Utility select “Image Watcher”. In the Image Watcher window select “Choose Image” and then select image file “W2Wtest.png” from your profile directory (see fig 2.4.2). If you started with a fresh “Datafile.txt” file the plot should show the plot of turbidity and motor speed from the time the experiment was started by checking the “Run” and “Data Collect” boxes, see fig 2.4.3 (note: If the data file still contained data from a previous experiment then that data will also display on the plot). The x-axis range on the plot is 1800 seconds so that it will scroll to a new plot every 30 minutes of elapsed time during the experiment. If it becomes necessary to restart an experiment the elapsed time counter will be reset and will only reflect the time since the experiment was restarted and the plot will overlap the previous data. In this case be sure to use the time stamp (column 1) in the “Datafile.txt” to determine elapsed and step time for post-processing. Arrange the windows on your desktop so that you can see the data interface, image watcher, and ComScript desktop utility.

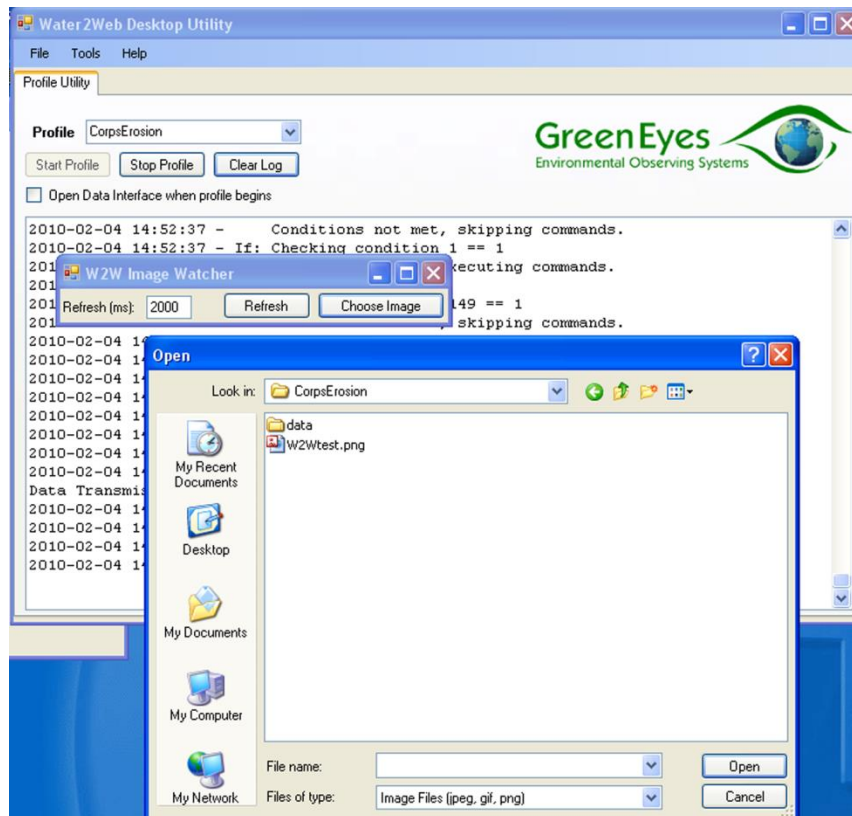


Figure 2.4.2 - Opening Image Watcher and selecting image file.

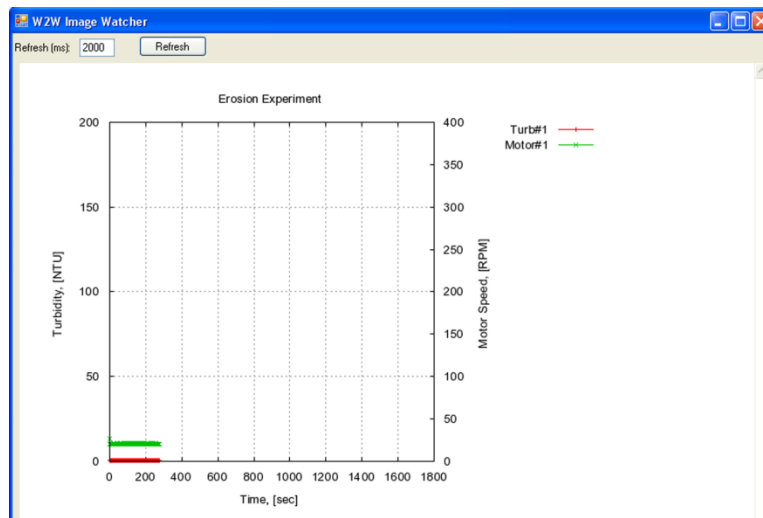
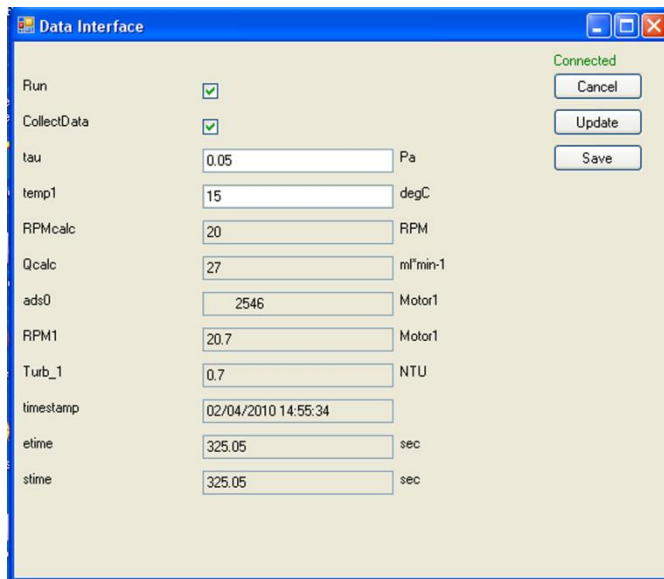


Figure 2.4.3 - Image Watcher plot for single core system near start of experiment.

2.4.8 Mark time of water into sample bottle. Mark the time that the water starts to flow into sample collection bottles. Use log sheets for each Core (see Appendix A). This first step is called the flushing step. No erosion is expected and there should be a general clearing of the water. Check the Image Watcher to view the time series of turbidity and keep an eye on the water level in the core tube. It should be up to near the top of the core tube and should never be allowed to fall as low as the bottom of the spinning disk. If the water level is low you can swap the tubing connections #3 & #4 on the erosion head to allow it to fill and then switch them back (**important!**) once the water level corrected.

2.4.9 Step Change. Generally the flushing step (0.01 Pa) is run for 30 minutes. To change to the next shear stress hit the “Edit” button on the data interface at about 10 seconds before the end of the step. Change the “tau” value to the shear stress for the next step, and hit the “Update” button at the desired step change time (see fig 2.4.4). The motor and pumping rate should increase to the next level by ramping up over several seconds; there may be a slight delay of a few seconds before the ramping begins. **Verify** that the motor and pumping increases, if the motors and pump did not respond then go through the above process again but this time changing the tau value a couple decimal places past the significant decimal (i.e. for desired tau = 0.1 use 0.101). **Important:** you will need to switch sample bottles at about 10 to 15 seconds after changing the step. Water collected for TSS analysis needs to be separated by step, i.e. sample bottle should contain water from one step only.



The screenshot shows a software window titled "Data Interface" with a blue title bar and standard window controls. The window is connected, as indicated by the "Connected" status in the top right. The interface contains several rows of parameters, each with a text input field and a unit label. On the right side, there are three buttons: "Cancel", "Update", and "Save".

| Parameter | Value | Unit |
|-------------|-------------------------------------|----------------------|
| Run | <input checked="" type="checkbox"/> | |
| CollectData | <input checked="" type="checkbox"/> | |
| tau | 0.05 | Pa |
| temp1 | 15 | degC |
| RPMcalc | 20 | RPM |
| Qcalc | 27 | ml*min ⁻¹ |
| ads0 | 2546 | Motor1 |
| RPM1 | 20.7 | Motor1 |
| Turb_1 | 0.7 | NTU |
| timestamp | 02/04/2010 14:55:34 | |
| etime | 325.05 | sec |
| stime | 325.05 | sec |

Figure 2.4.4 - Data Interface during step change. Update button will make the changes take effect and make the DI live again.

2.4.10 Steps. Steps other than the flushing step are typically run for 20 minutes. A typical step series would be **0.01 (flushing), 0.05, 0.10, 0.15, 0.20, 0.30, and 0.45 Pa**. If desired additional step(s) up to 0.60 Pa can be run, but are outside of the range of the Gust calibrations presently. Select the "Edit" button about 10 seconds before the desired step change, edit tau, hit "Update" button at time of desired step change to initiate step change. Make sure the motor and pump speeds are increasing, and switch sample bottles. Optional: Hit "Save" button in the data interface, so in the event of a ComScript or PC failure you will be able to make a quick recovery and save your experiment.

2.4.11 Datafile. Data will be written to "Datafile.txt" when "Data Collect" box is updated to "checked". Check that the file size is increasing to verify data is being written, but **Do Not** open the file with MSEXcel or similar program while experiment is running or a file lock-up and ComScript crash may result. The format for the datafile.txt is;

```
"timestamp,etime,stime,RPM1,Turb_1,RPM2,Turb_2"
```

There is no header line written and the file is comma delimited.

2.4.12 Monitoring ComScript. Keep an eye on the Data Interface Window and to verify that it is "connected" and the numbers are changing as expected (e.g. etime). Although unlikely, should the profile stop, you will need to take the following actions:

- select the "save" button in the DI window
- select the "Stop Profile" button in the Desktop Utility
- close DI window
- make sure "Open Data Interface when profile begins" box is checked in Desktop Utility
- select "Start Profile" in the Desktop Utility
- In DI select "Edit" check "Run" and "CollectData" boxes and hit Update button.

The program should start running again. Make sure tau is set to the correct value and if Data Interface variables were not saved when it crashed tau must need to be reset. The etime and stime will be incorrect now since they will reflect the time

since the program was restarted. Reopen Image Watcher (see sec 2.4.7).

2.4.13 End of experiment. When the last step is completed, go to DI window and select “Edit” change “Run” and “Data Collect” to boxes to “unchecked”, and select “Update”. The system tau value will automatically change to 0.01 Pa and the motor and pump should wind down. The motor will automatically turn off, but the pump should be turned off manual at the V300 stroke rate controller. Experiment is over!!! Once the system has shutdown in the DI window select “Save” to write parameters to config file so that they will be set correctly for next experiment. In Desktop Utility select “Stop Profile”, the DI window should now be “disconnected” from the profile.

2.4.14 Archive datafile. Rename “datafile.txt” and move to location for archiving. Keep data safe and backed up. If recorded either rename, and move “log.txt” file for archiving or delete so the file will not grow too large.

2.4.15 Clean & Store. Disconnect tubing connections from the erosion heads. Run clean water through the pumps to clean pump heads for 2 minutes, using manual pump operation (see System Setup). Turn off all devices and disconnect A/C power. Remove motors and erosion heads from cores. Remove the center block out disk from sediment (may be covered over by sediment). Dump the sediment or dispose of it as required. Clean the erosion head with clean water and take apart spinning disk by removing polycarbonate nut. Be careful not to drop. Be sure to reinstall the flanged delrin bushing and make sure the nut is oriented correctly when reassembling so that the disk spins freely (see drawing section 7). Remove the flow cells from turbidimeters (Note: sometimes the bottom end cap will catch on the plastic holding arm in the sample chamber of the turbidimeter. If this happens you can try wiggling it around to get it free or sometimes it will be necessary to place a thin object straight down beside the flow cell on the front side of the flow chamber to hold the plastic arm back so that the flow cell can get by). Flush the tubing and flow cells with clean water (de-ionized if available). Allow to dry if possible. Wrap the flow cells in Kimwipes and put them back in styrofoam packaging for safe storage. Disassemble the system and put back in storage/travel case.

Section 3 System Maintenance

3.1 General

Any non-electronic parts of the system that comes in contact with salt water or sediment should be rinsed thoroughly after use with clean fresh water. Electronic parts should be wiped down carefully and/or gently cleaned with compressed air. Most of the components require little or no regular maintenance, just proper care.

3.2 Power/Control Box

The Green Machine and associated electronics should be stored away from extreme temperatures and high humidity. There is no regularly scheduled maintenance necessary of the components in the box other than making sure all components are well secured in the box especially when transporting (see Power/Control box layout drawing in section 7). The large power supply should be blocked in with foam when transporting. If an electrical component should fail, replacement of that component will likely be the best course of action. If an electrical connection should come loose or if a connector break then a simple repair or new connector would be required. There is a 4A fuse in the rear of the box. A replacement fuse is provided with the box, but if additional fuses are required they should be readily available (see parts list for info). When transporting the P/C box it should be protected from rough handling and it may be necessary to block in the larger power supply with foam blocks or padding to prevent it from bouncing on the electrical panel.

3.3 Motor

Maxon Precision motors require very little maintenance. If the motor contacts salt water during an experiment, the motor should be carefully wiped down with a damp (fresh water) cloth and gently blown dry with air while disconnected from the P/C box. If any major problem occurs with the motor, it should be sent to SES Consulting or Maxon for repair. Wiring connections on end of motor (inside PVC housing) are extremely fragile and if it becomes necessary to remove the PVC housing to expose the connections care must be taken as to not damage the solder tabs on the motor. Wiring problems involving the motor controller or the cord to the motor are fairly simple and can be repaired by someone with knowledge of electronics and soldering. Motors should be stored in the case provided and kept in a dry environment free of temperature extremes to provide longest the possible service life.

3.4 Pump

Maintenance of the FMI pump is simple but very important. **Always rinse the pump heads thoroughly after use by pumping fresh water through the system.** Never run the pump heads dry. If only one pump head is being used, a short loop of tubing filled with fresh water should be placed on the pump head not in use. When storing the pump, it is recommended to keep the pump heads moist. Short loops of tubing filled with fresh

water can be placed on the pump heads during storage. If this is not done, the pump heads may seize up. The best way to free a seized pump head is to rinse it with fresh water. The easiest way to do this is to remove the pump head from the pump (illustrated in pump manual) and soak the pump head in fresh water. If the seized pump head cannot be removed from the pump it may be necessary to squirt fresh water into the isolation gland (small ports on side of pump head) and anywhere else possible to rinse the seized piston within the pump head. With a little luck this should free the pump head enough to remove it from the pump and soak it. After reinstalling the pump head, the flow setting of the pump should be double checked (see section 2.1.5.). Pump calibrations should be checked periodically to insure proper settings are maintained. Normally, checking the flow rate at the 100% setting on the stroke rate controller will suffice. If a problem is suspected or verification is required it might be necessary to do a full calibration. One way this can be done is by setting up the system in the lab using clean water w/o sediment (using pistons as bottom and running through each step (shear stress) and checking the flow rate). This can be done relatively quickly since each step only needs to be long enough to test the pumping rate. You can use the equations in section 4 to determine what the pumping rate (Q) should be for each step using shear stress (τ_b) and temperature (T). If the pumping rate is off by more than 5% on average then this may indicate the need for a new calibration or a problem with the pump or a pump head that needs to be resolved. Contact SES for further assistance.

3.5 Turbidimeter

Any part of the turbidimeter sample chamber that comes in contact with salt water or sediment should be gently rinsed with fresh water, taking care to not splash any of the electrical parts of the unit. If this is necessary **be sure unit is unplugged from A/C power source**. Particular care should be taken with the flow through cell to keep it free of deposits, finger prints, and scratches. Periodically the flow cells should have silicone oil applied with the cloth provided following the instructions in the Hach manual. Calibration standards are provided with the turbidimeters if a NTU calibration is needed. Typically, this is not required for the erosion system because a calibration to Total Suspended Solids (TSS) is normally made from the filter data of the collected sample water; however, consult the Hach manual for the calibration procedure if a NTU calibration is deemed necessary. When not in use, the turbidimeter should be stored away from temperature extremes and high humidity.

3.6 Erosion Head

The erosion head should be taken apart and rinsed thoroughly between erosion experiments and before long term storage. The o-ring that provides the seal between the erosion head and the core tube may need replacement periodically. This o-ring is a Dash No. 242 (for 4" core tube size), standard buna o-ring, which is readily available from industrial suppliers (e.g. McMaster-Carr). It is likely that the neodymium magnets on the spinning disk/spool will start to show some rust. Small amounts of rust should not be a

problem, however if the rust gets heavy and there is the potential for the rust to flake off during an experiment and get sucked in through the turbidimeter, it should be sanded lightly and recoated with an epoxy or urethane coating, if necessary you can send them back to SES to replace/ re-seal magnets. The glued on pieces on the sides of the erosion heads (side plates), where the quick connect fittings screw in, should be inspected for leaks periodically. If a leak is detected the piece should be re-glued/sealed. The divider plate that separates the wet-side of the magnetic coupling from the dry could also develop a leak, where water from the core tube would get above the plate on the motor (dry) side. If water is getting on top of this plate this indicates a leak either around the perimeter of the divider plate or around the spindle shaft for the spinning disk. If there is a leak re-seal the offending area. Except for the bushing (acetal/Delrin) the erosion head is made of durable polycarbonate and should provide a long service life. Note: When re-assembling erosion heads be sure bushing, nut, and spinning disk are installed correctly, and disk spins freely (see Erosion Head drawing in section 7). The delrin bushing may need replacement during the service life of the erosion head(s). If this becomes necessary contact SES Consulting or have a bushing fabricated to replace (see drawing in Section 5).

Section 4 Calibrations and Settings

4.1 Gust Calibrations. A key feature of this system is the combination of the rotating disk and central suction that generates a quasi-uniform shear stress across the surface of the sediment. These calibrations were made in Dr. Gust's laboratory and he has patented this concept (US patents 4,884,892 and 4,973,165). The calibrations were made using the standard 10cm core erosion head, with spinning disk 10 cm above the sediment surface.

To obtain the desired applied shear stresses, specific combinations of motor RPM and pumping rate must be applied. These combinations are determined from calibration equations derived from experimental testing in the laboratory of Dr. Gust in Germany. The calibration equations are expressed in terms of the shear velocity at a water temperature of 15 °C, where the shear velocity is defined by $u_* = \sqrt{\tau_b/\rho}$, τ_b is the bottom shear stress and ρ is the water density. The most recent calibration equations for the 10 cm microcosm are:

$$u_{*15} = 0.0318 \cdot n^{0.763}$$

$$Q = -28.31 \cdot u_{*15}^2 + 170.2 \cdot u_{*15} - 23.85$$

Where u_{*15} is in cm sec^{-1} , n is the disk rotation rate in rotations per minute (RPM), and Q is the pumping rate in ml min^{-1} . To convert to shear velocity at temperature T to equivalent u_{*15} , Dr. Gust's lab recommends

$$u_{*15} = u_{*T} \cdot (1 + 0.006 \cdot (T - 15))$$

and then the stress is $\tau_b = u_{*T}^2 \cdot \rho$. The maximum calibrated shear stress at present is 4.5 dynes cm^{-2} (0.45 Pa), though we have pushed the system to 6.0 dynes cm^{-2} (0.60 Pa) by extrapolation.

These calibrations have been programmed into the W2W profile.xml program so that when the user sets the shear stress (units of Pascals [Pa]) and temperature the required RPM and pumping rate (Q) are calculated

4.2 Maxon Motors. The Maxon motor controller (LSC 30/2) has been set for the proper operation in the erosion system and a speed calibration was performed so that the relationship of the motor output speed and the encoder counts could be established. These setting should not require change unless a new motor controller is installed and needs to be configured or the settings have inadvertently changed on the existing units.

The motor calibration was performed using visual count of 10 revolutions of the magnetic drive plate attached to the motor output shaft and recording the time. The reading of the encoder counts of ChanA on a digital input on the Green Machine (GM) was also recorded. This visual calibration was possible up to an output shaft RPM of just under 100, above which visually counting RPM was not reliable. The results of the calibration of the motor can be found in figure 4.1.1.

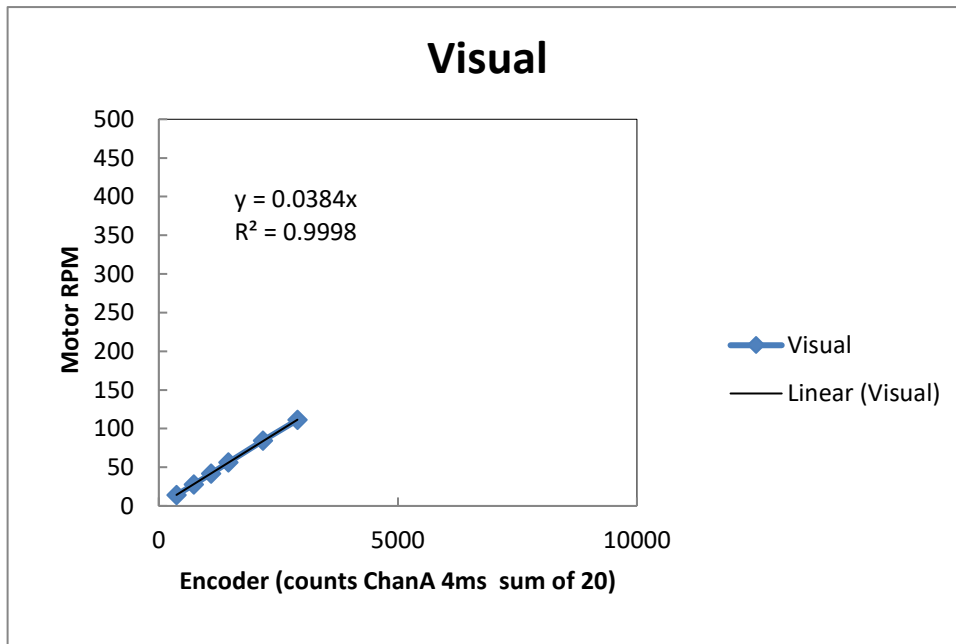


Figure 4.2.1- Maxon motor calibration for GMariotti_LSU single core system. Calibration date was 7 June 2015.

The encoder is attached to the motor on the opposite end of where the gearhead is attached. The encoder therefore spins at the motor base speed and not at the same speed as the gearhead output shaft which the magnetic drive disk is mounted. Parameters of how the encoder counts were collected and the motor configuration are shown below;

- Encoder is 500 counts per turn with 2 channels (A & B). Each channels has 1,000 transitions (state changes) per turn.
- Only Channel A was used.
- Counts were collected nearly continuously using 4 millisecond duration.
- Running sum of 20, 4 ms samples were used for reported encoder reading.
- Gear reduction for output shaft of motor = 18:1

These calibration yield the following result which is confirmed by the visual calibration result;

$$RPM (output) = 0.0384 \cdot ENC$$

To configure the motor controller the dip switches need to be set for encoder operation and for external speed control of +/- 3.9 Volts, and the potentiometers (P1 – P5) need to be adjusted so that the motor does not spin at 0 reference voltage and that the maximum desired motor speed is achieved at max reference voltage. See Maxon Motor Controller (LSC 30/2) manual for more information and location of dip switches and potentiometers. Please note this is not a routine requirement, but only when configuring a new controller or when reconfiguration is required. The maximum motor output shaft speed for this motor assembly (p/n# 333189) is **376 RPM** (ENC = 9800).

- 4.3 **FMI Pump.** The FMI pump (QV w/ Q1CKCW pump head) was calibrated so that the maximum flow rate could be achieved and the relationship of DAC setting to pumping rate could be found. This relationship was programmed into the ComScript profile.xml file so that the GM would send the proper analog reference voltage to the V300 stroke rate controller that controls the pumping rate. The calibration yielded the following results;

$$Q = DAC \cdot 0.065$$

First the pump heads were set to achieve maximum desired flow rate ($Q = 240 \text{ ml} \cdot \text{min}^{-1}$) when the stroke rate controller was set to 100%. This was achieved with pump head angle at 4 on the angle indicator plate. Then a flow calibration was performed over a complete range of DAC settings on the GM where the corresponding flow rate was measured by collecting water over a 1 minute interval and measuring the volume.

The DAC setting has a range of 0 to 4095 which converts to an analog output voltage range of 0-5 volts. This gives a DAC setting to voltage ratio of 4095:5.

The DAC set value is calculated in the ComScript profile.xml, based on the shear stress setting and is sent to the GM which sends the appropriate reference voltage to the V300 Stroke Rate Controller, which controls the pumping rate.

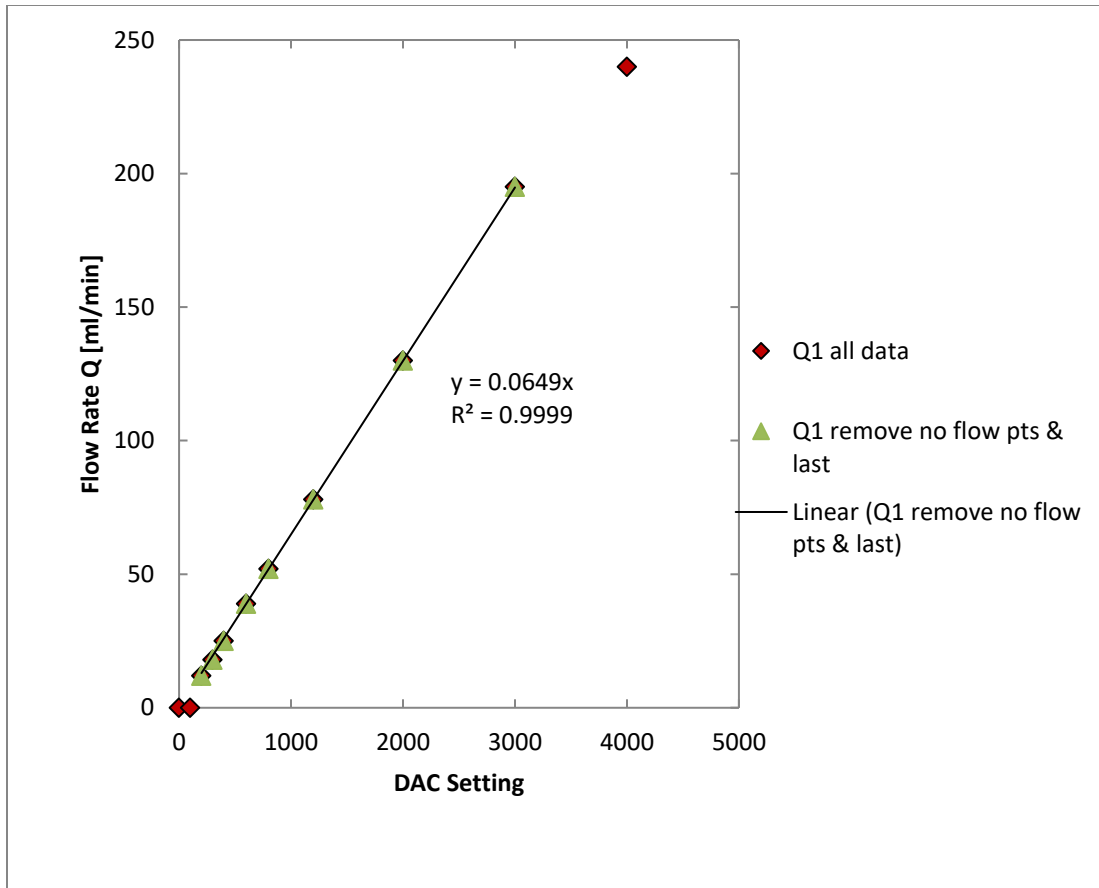








Figure 4.3.1- GMariotti_LSU pumping rate calibration. Calibration date was 7 June 2015. Pump head angle was approximately 4. First two points and last point was removed to make this fit because pumping rate was below threshold value at first 2 DAC settings and was beyond linear range for the last.

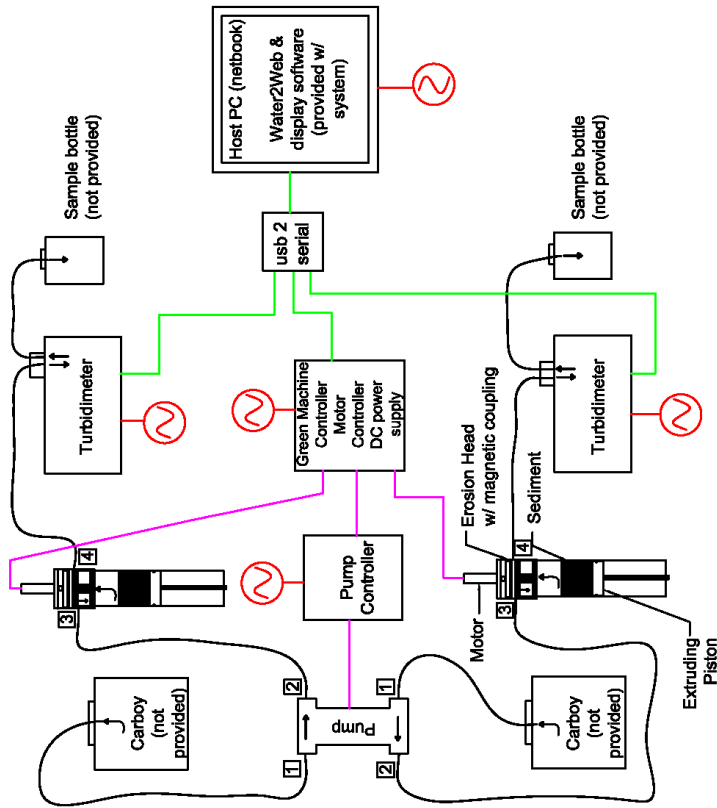
4.4 Turbidimeter. Normally calibration of the Hach 2100N turbidimeters is not necessary for use in U-GEMS because the turbidimeter output will be directly calibrated to Total Suspended Solids (TSS) in the analysis. If calibration to NTU is required however, there are sample standards provided and there are instructions to make the calibration in the Hach 2100N manual which was provided with your system.

Section 5. Drawings

| REVISIONS | | DATE | APPROVED |
|-----------|-------------|------|----------|
| ZONE | DESCRIPTION | | |

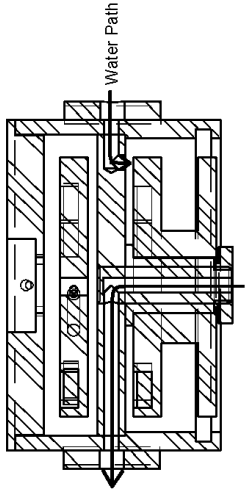
Legend:

-  Tubing
-  Water Flow
-  tubing connection number
-  A/C Power Input
-  RS232 Comms
-  Control & Signal comms

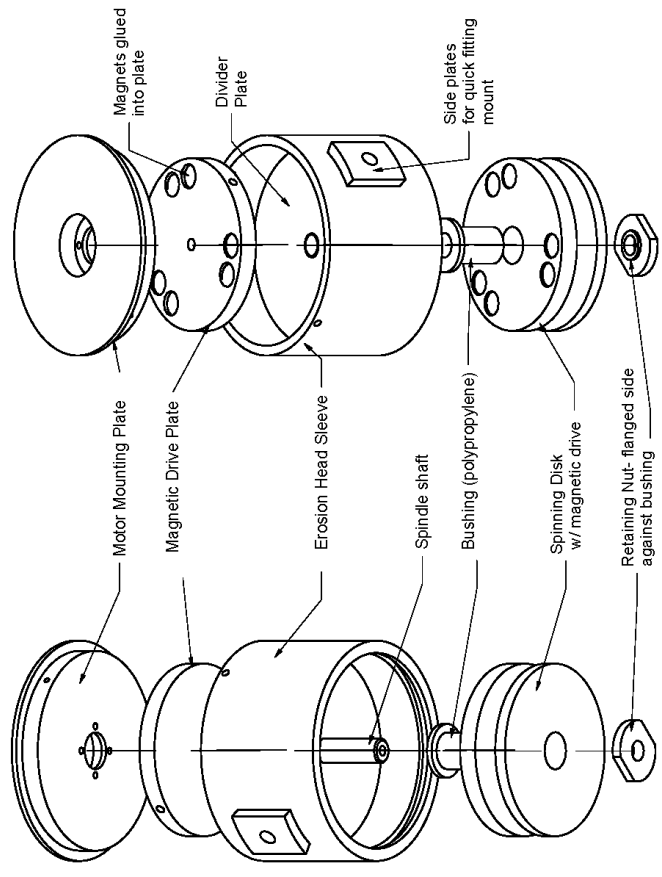


| | | | | | | | | | | | | | |
|---|----------|--------|--------|-------|-----|------|------------|-----------|-------------------------|---------|--------|-------|--------|
| SES Consulting 118 West Erie Ave Channahon, IL 61114 Phone: (815) 200-0734 | MATERIAL | FINISH | smooth | DRAWN | SES | DATE | 12/30/2009 | TITLE | U-Gems 2-Core Schematic | DWG NO. | 1000 | REV | B |
| | | | | | | | | TOLERANCE | SCALE | PROJECT | U-GEMS | SHEET | 1 OF 1 |
| | | | | | | | | | Not to scale | | | | STATUS |

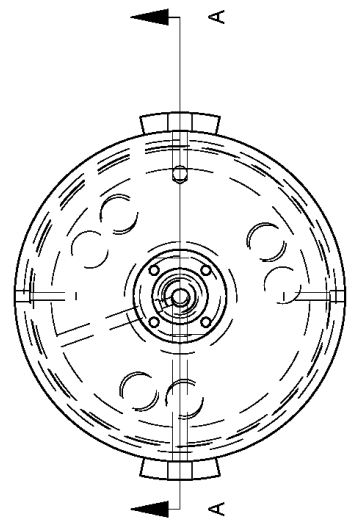
| REVISIONS | | DATE | APPROVED |
|-----------|-------------|---------|----------|
| ZONE | DESCRIPTION | REVISED | APPROVED |
| ZONE | CHANGE | | |



Section A-A:

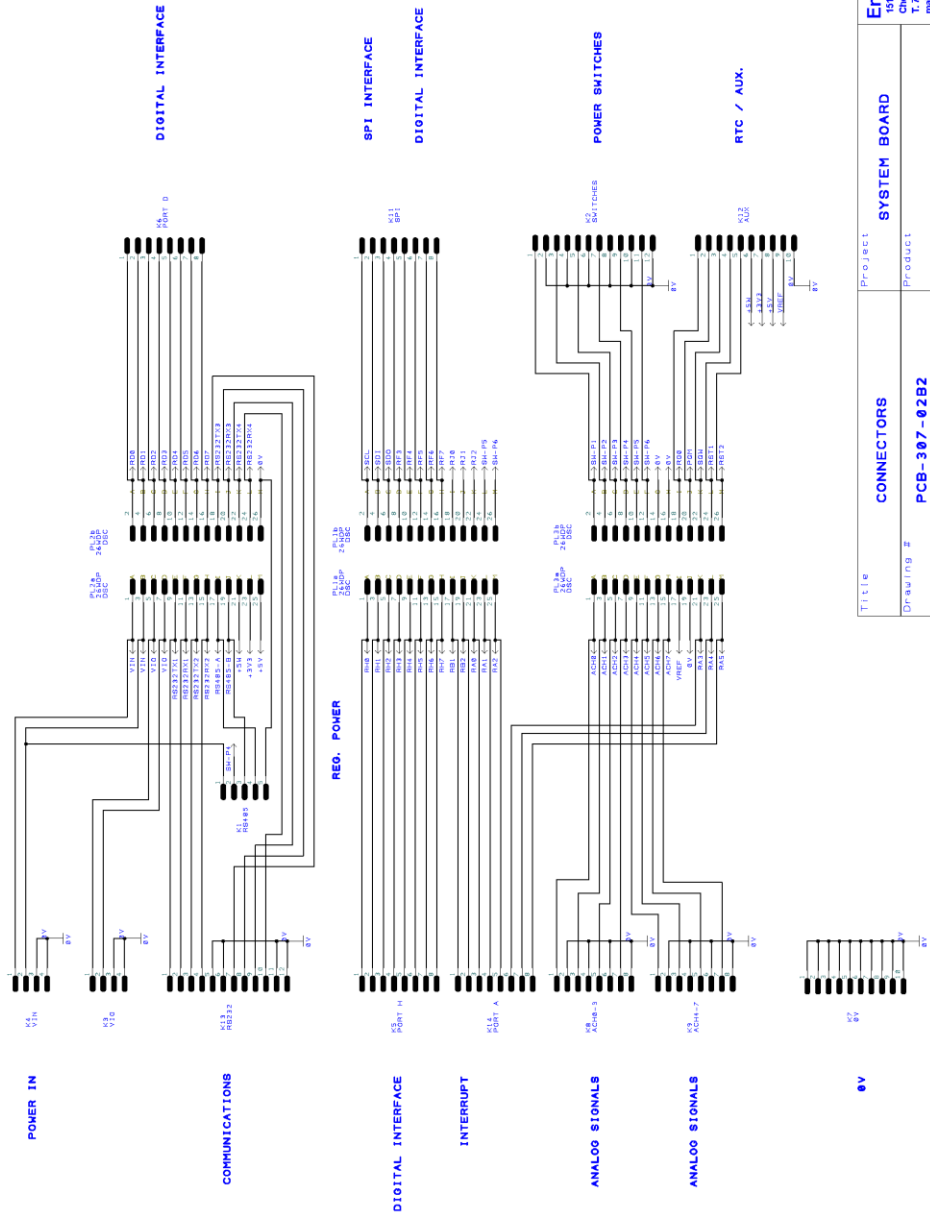


Exploded Views:



Top View:

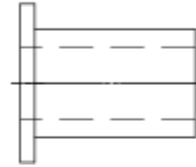
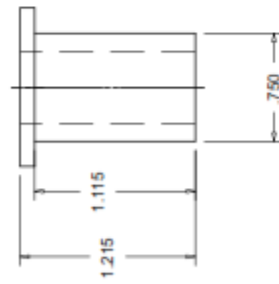
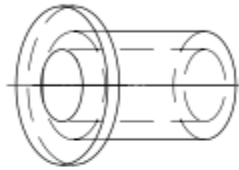
| | | | | | |
|---|--|---------------------------|---|--|------------------|
| SFS Consulting 118 West End Ave Cambridge, MD 21613 T. 410 200 0734 steven.suttles@verizon.net | MATERIAL | DRAWN | TITLE | DWG NO. | REV |
| | POLYCARBONATE (U.O.N.) FINISH: SMOOTH | SES DATE: 2 March 2010 | EROSION HEAD EXPLODED VIEW TOLERANCE: NONE | 1002 PRODUCT: U-GEMS SHEET: 1 OF 1 | B STATUS: MFG |



| | | | |
|--------------|-------|--------------|------------|
| Title | | Project | |
| CONNECTORS | | SYSTEM BOARD | |
| Drawing # | | Product | |
| PCB-307-02B2 | | | |
| Rev. | Drawn | Date | Change |
| MBR | MBR | 05/05/09 | TO SUIT GM |
| Reason | | | Sheet |
| | | | 2 of 2 |

EnviroTech Instruments LLC
 1577 Technology Drive, Suite 101
 Chesapeake, VA, 23026, USA
 T: 757 549 8174 / F: 757 419 2382
 mail@envirotechinstruments.com

| ZONE | | REVISIONS | | DATE | | APPROVED | |
|------|-------------|-----------|-------|------|---------|----------|----------|
| ZONE | DESCRIPTION | DATE | REVIS | DATE | REVISED | DATE | APPROVED |
| | CHANGE | | | | | | SES |



| | | | | | | | | | | | |
|---|----------|----------------|-------|------------|-----------|------------------------------|--------|----------|---------|--------|-----|
| SES Consulting 118 West End Ave Cambridge, MD 21613 T. 410 200 0734 steven.suttles@vertzon.net | MATERIAL | Delrin (black) | DRAWN | SES | TITLE | EROSION HEAD SPINDLE BUSHING | DWGNO. | 400-007B | REV | B | |
| | FINISH | SMOOTH | DATE | 09/22/2014 | TOLERANCE | +/- 0.008 in | DIMS | in | PRODUCT | U-GEMS | |
| | | | | | | | | SHEET | 1 | OF | 1 |
| | | | | | | | | | | STATUS | MFG |

Section 6. Parts List

| Corps UGEMS Parts List: | | | | | |
|--|-----------------|--------------|-----------------|--------------|--|
| Description | Vendor | Part# | Mfr | Mfr# | Website |
| Pumps: | | | | | |
| Pump motor drive- QV-2 core | FMI | Q2V | FMI | | www.fmipump.com |
| Pump motor drive- QV- 1 core | FMI | QV | FMI | | www.fmipump.com |
| Pump Heads | FMI | Q1CKCW | FMI | | www.fmipump.com |
| Tubing adapters | FMI | R412-1K | FMI | | www.fmipump.com |
| Motors: | | | | | |
| motor (#268214) ,gearbox (#166159) , & encoder (#228452)- assembly # | Maxon | 333189 | Maxon | | www.maxonmotorusa.com |
| motor controller | Maxon | 250521 | Maxon | | www.maxonmotorusa.com |
| Motor Connector- Cable | Allied | 70099215 | Bulgin | PX0728/S | www.alliedelec.com |
| Motor Connector- cable support | Allied | 70099263 | Bulgin | 12237 | www.alliedelec.com |
| Turbidimeters: | | | | | |
| turbidimeter 2100N | Hach | 4700000 | Hach | | www.hach.com |
| flow through cells | Hach | 4709500 | Hach | | www.hach.com |
| flow through cell kit | Hach | 4744800 | Hach | | www.hach.com |
| Null Modem cable for Turbidimeters | Cables To Go | 3044 | | | www.cablestogo.com |
| Null Modem cable for Turbidimeters | PC Cables | 2004 | | | www.pccables.com |
| Power Control Box: | | | | | |
| Relay- Motor OnOff | Allied | 814-0736 | IDEC | RH1B-ULDC12V | www.alliedelec.com |
| Relay Mount | Allied | 814-0333 | IDEC | SH1B-05C | www.alliedelec.com |
| Din Rail | Allied | 814-3103 | IDEC | BNDN-1000 | www.alliedelec.com |
| Din Rail End Stop | Allied | 814-3024 | IDEC | BNL-5 | www.alliedelec.com |
| Din Rail Spacer | Allied | 814-3078 | IDEC | SA-406 | www.alliedelec.com |
| Motor Connector- Panel | Allied | 70099236 | Bulgin | PX0727/P | www.alliedelec.com |
| Power Supply- 24 VDC | Allied | 70151687 | SL Power/Condor | HD24-4.8-A+G | www.alliedelec.com |
| BNC adapter- pump control | Allied | 510-7510 | Emerson | 25-7510 | www.alliedelec.com |
| Phone Jack | Allied | 932-0256 | Switchcraft | 3501FPX | www.alliedelec.com |
| RCA cable | Allied | 510-0180 | Emerson | 73-7414-3 | www.alliedelec.com |
| Fuse holder | Allied | 740-0817 | Cooper Bussmann | HKP-R | www.alliedelec.com |
| Fuses | Allied | 740-0505 | Cooper Bussmann | AGC-4-R | www.alliedelec.com |
| Receptacle | Allied | 932-0099 | Switchcraft | EAC309 | www.alliedelec.com |
| Power Cord | Allied | 626-3520 | Volox | 17249 10 B1 | www.alliedelec.com |
| DC/DC power supply- 12 VDC | TRC Electronics | SD-25B-12 | | | www.trcelectronics.com |

| | | | | | |
|--|-------------------|--------------------|---------|------------|--|
| Enclosure-QR Latch OPQ CVR GRY 4x Hinge 14x12x6in | AutomationDirect | HW- J141206CHQR | Hubbell | | www.automationdirect.com |
| SUB-PANEL Aluminum FITS 14X12IN2 | AutomationDirect | HW-MP1412A | Hubbell | | www.automationdirect.com |
| | | | | | |
| ErosionHead/Plumbing/etc: | | | | | |
| Inline Tube connection- straight, insert-barb 3/16" I.D. tubing | QuickCouplings | PMC2203 | CPC | PMC2203 | http://quickcouplings.net/ |
| Quick Disconnect- 1/8" NPT fitting, 1/8" flow straight | QuickCouplings | PMC1002 | CPC | PMC1002 | http://quickcouplings.net/ |
| Inline Tube connection- straight, insert-barb 3/16" I.D. tubing | US Plastics | 64622 | CPC | | www.usplastic.com |
| Quick Disconnect- 1/8" NPT fitting, 1/8" flow straight | US Plastics | 64601 | CPC | | www.usplastic.com |
| Tygon tubing- 3/16" I.D. x 7/16" O.D. | US Plastics | 57108 | Tygon | | www.usplastic.com |
| Tygon tubing- 1/8" I.D. x 1/4" O.D. | US Plastics | 57105 | Tygon | | www.usplastic.com |
| 3/4" -10 threaded PVC rod | Piedmont Plastics | | | | www.piedmontplastics.com |
| 1/4"- 20 nylon threaded rods | McMaster-Carr | 98743A230 | | | www.mcmaster.com |
| 3/8"- 16 treaded studs (pkg of 10) | McMaster-Carr | 92412A640 | | | www.mcmaster.com |
| erosion head o-ring (Dash No. 242, buna std) | McMaster-Carr | 9452K192 | | | www.mcmaster.com |
| | | | | | |
| Neodymium disc magnets .500 x .200 | Magnet Source | ND-140N-35 | | | www.magnetsource.com |
| USB to Serial converter | Moxa | UPort 2210 | MOXA | UPort 2210 | http://www.moxa.com/ |
| Carry Case | CarryCasesPlus | iM3075-F | Storm | iM3075-F | www.carrycasesplus.com |
| | | | | | |
| | | | | | |

Appendix A:

Sample Erosion Experiment Log Sheet

Appendix B:

COM Port Assignment Test w/ ComScript Terminal Emulator

Procedure for testing COM Port Assignments using ComScriptTerminal Emulator:

1. Start ComScript and Open Terminal Emulator Program from Menu.

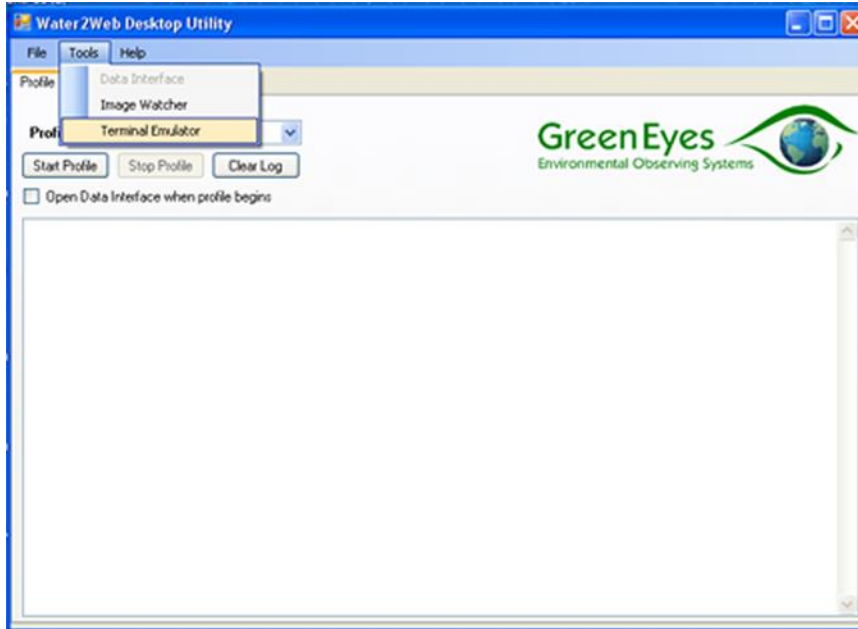


Figure B.1- Opening Terminal Emulator in W2W (predecessor to ComScript) Desktop Utility.

2. Configure Connection for Green Machine and Connect.

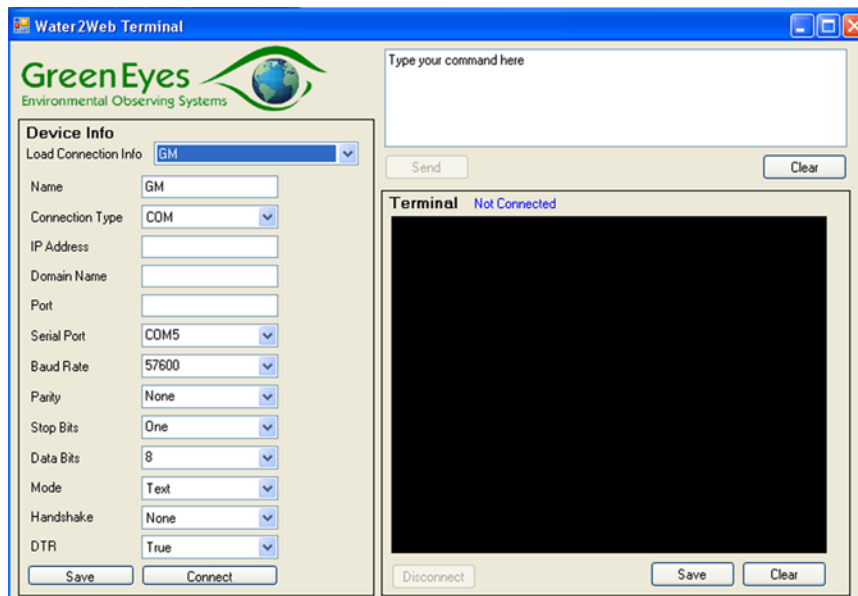


Figure B.2- GM connection. BaudRate = 57600, Parity = None, Stop Bits = One, Data Bits = 8, Mode = Text. Select Serial Port that you think the GM is on.

3. Send Command to GM and check for response.

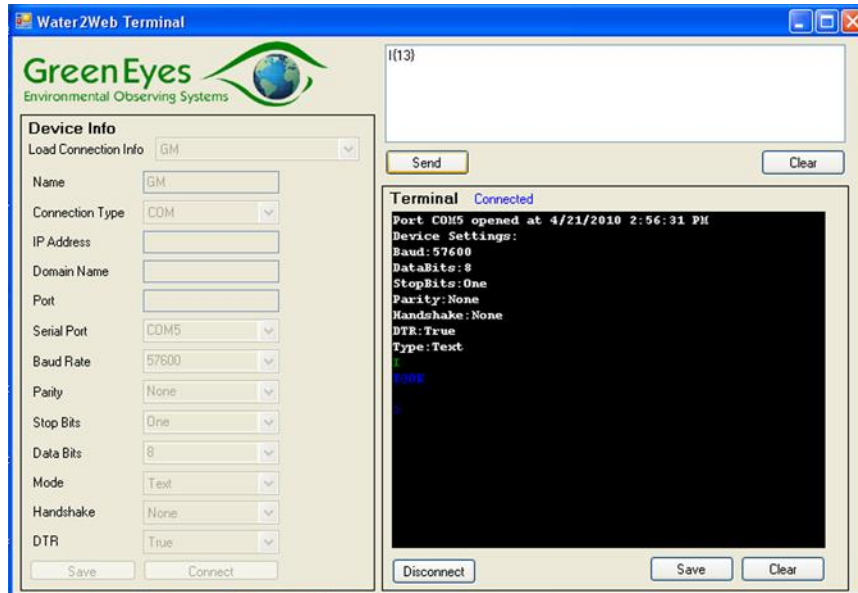


Figure B.3- Type "I(13)" in send box and send. Look for response from GM in black box below. Response should be "@OK" in blue.

4. If do not get the proper response. Make sure GM is powered and serial cable is connected. Disconnect, change Serial Port, and try another COM port.

5. Check Turbidimeter(s) COM port(s).

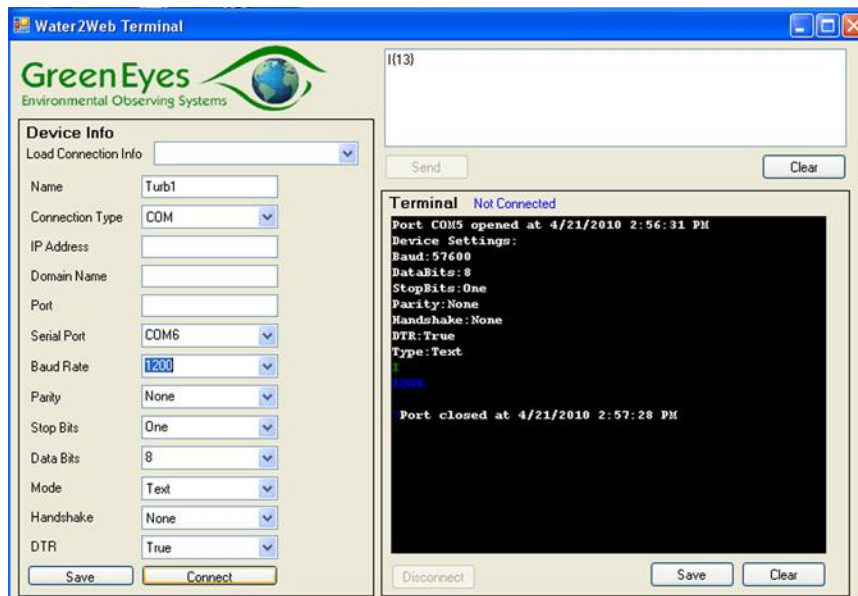


Figure B.5- Setup connection to turbidimeter and connect. Baud Rate = 1200!!!

- 6. Test Turbidimeter connection. Make sure turbidimeter is on and displaying value and null modem cable is connected. Connect to turbidimeter using ComScript Terminal Emulator. In send box type “VAL{13}” and send. Should get response from turbidimeter “VAL = #### NTU”. If you do not try a different serial port!**
- 7. If serial port assignments are not in agreement with profile then “device” commands in profile need to be changed to correct serial port assignment for each device otherwise profile will fail.**

