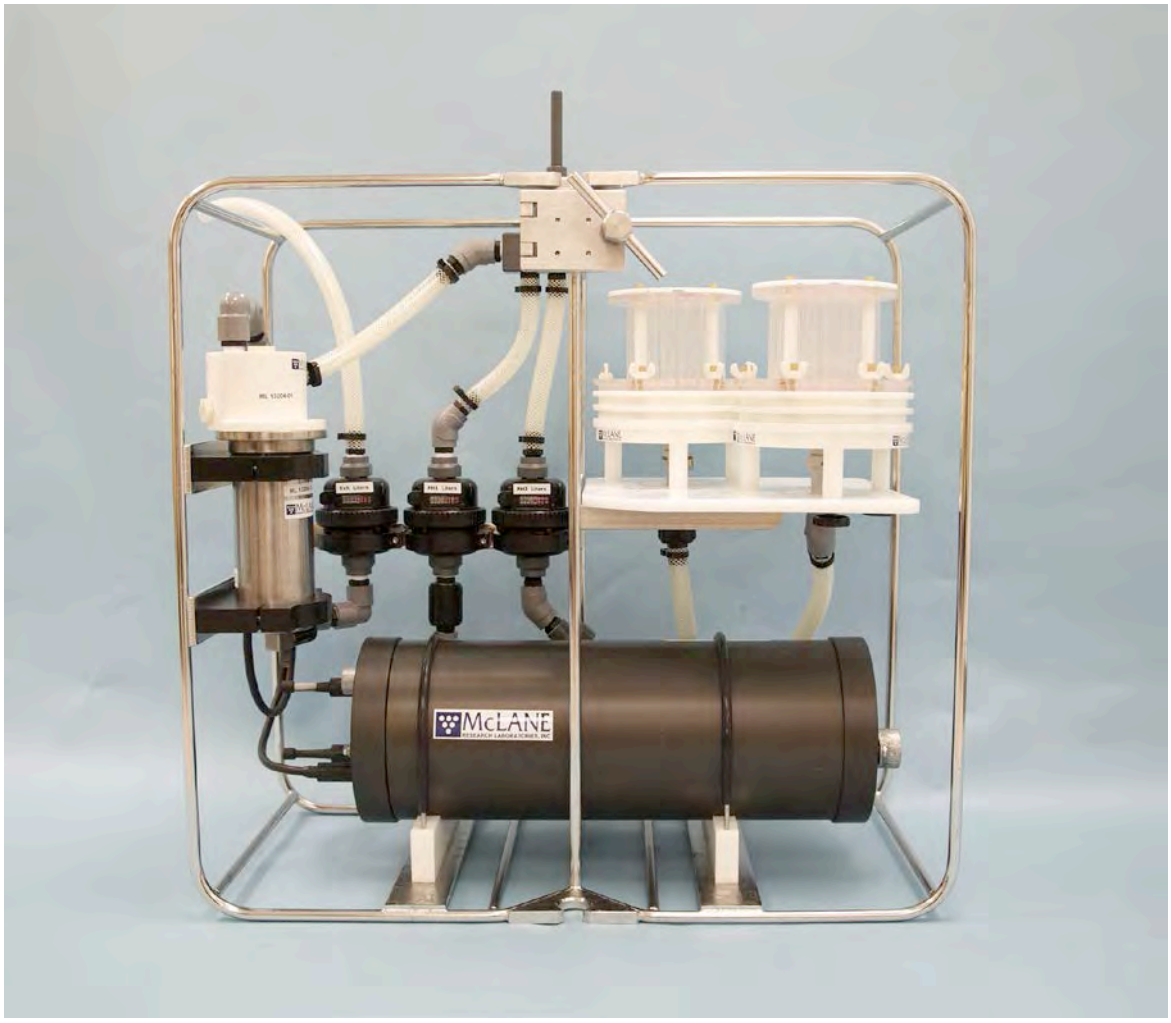
Profilers Samplers Flotation

mclanelabs.com

Water Transfer System

User Manual



Tel: +1 (508) 495-4000
mclane@mclanelabs.com

Skype: mclane_research
www.mclanelabs.com

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Chapter 1
WTS-LV Introduction

This manual describes the operation and maintenance of the McLane Large Volume Water Transfer Sampler (WTS-LV), a single-event sampler that collects large volume, in situ particles onto a mesh, GFF or membrane filter. The WTS-LV has a firmware controller and mechanical components. Several WTS-LV models are available to fit different sampling needs.

User Key

This User Manual contains the following symbols that call attention to information:

	**Note**	This symbol indicates information and tips that are helpful for operating the instrument.
	**Important**	This symbol indicates information that could affect key product operations.
	**Caution**	This symbol indicates information that must be followed to prevent instrument damage or user injury.

Mechanical Components

The WTS-LV mechanical components are detailed in Chapter 4 of this User Manual. These components are summarized in the section that follows.

Pump Assembly and Flow Rates

The pump motor is sealed in a titanium housing. Sampling flow rate is determined by the pump head size, filter porosity and filter load. Available pump heads and resulting flow rates are:

- 4L/min pump head – 0.5 to 4 liters per minute.
- 8L/min pump head – 3- 8 liters per minute.
- 30L/min pump head (WTS-LV Upright model) – 12 to 30 liters per minute.

Filter Holders

The standard radial filter holder is machined from black acetal stock and fits a 142mm mesh, GFF or membrane filter. The filter holder evenly distributes samples over the filter surface. Figure 1-1 illustrates all filter holder options available on the WTS-LV. Chapter 4, "Mechanical Description" and Appendix D "Optional Filter Holders" in this User Manual provide details about WTS-LV filter holder options.

Figure 1-1: WTS-LV Filter Holders

Filter Types

Filters are supplied by the user. Filter types and pump heads must be compatible for proper operation. Appendix E, "Pump Head Sizing" in this User Manual provides a chart of pump head and filter porosity compatibility.

Cable Clamps

Wire clamps attach the WTS-LV to a hydro wire without interrupting the cable (an in-line frame option is also available). Clamp inserts fit various wire sizes.

Electrical Components

Electrical components are located in a sealed pressure housing rated to a depth of 5,500m (Standard WTS-LV). An overview of these components is provided next. Details of the electrical components are provided in Chapter 5 of this User Manual.

The controller housing for the Standard WTS-LV contains a battery pack for drop-in alkaline batteries and a four board electronics stack. The controller contains the interface circuits that translate the signals and commands passing between the microcontroller, the peripheral components of the system, the system watchdog circuit and the independent power supply. The watchdog circuit is mounted on the motherboard to send periodic interrupt requests to the microcontroller, and a hardware counter, which can restart the microcontroller if acknowledgement is not received.

Deployment settings are entered on a computer connected via RS-232 COM cable (a USB to RS-232 connector is included in the toolkit).

Firmware and Pump Speed Algorithm

The firmware controls system testing, deployment settings and data offload. A pump speed algorithm in the firmware adjusts differential pressure across the active sample window as material collects on the filter. The firmware adjusts flow rate to prevent sample or mesh damage and lower battery drain. If rapid intake clogging occurs, pumping stops to protect the sample.

Trigger Option

A trigger feature allows the user to time synchronize and simultaneously deploy multiple WTS-LV samplers to obtain a profile of large volume water samples. For example, three samplers can be deployed to trigger sample collection at three different depths such as 500m, 1,000m and 1,500m. For WTS-LV samplers without the Trigger option, multiple samplers can be clock synchronized.

WTS-LV Line Drawing

The line drawing shown next illustrates the mechanical design of a Standard WTS-LV with standard 142mm filter holder and optional cartridge filter holder.

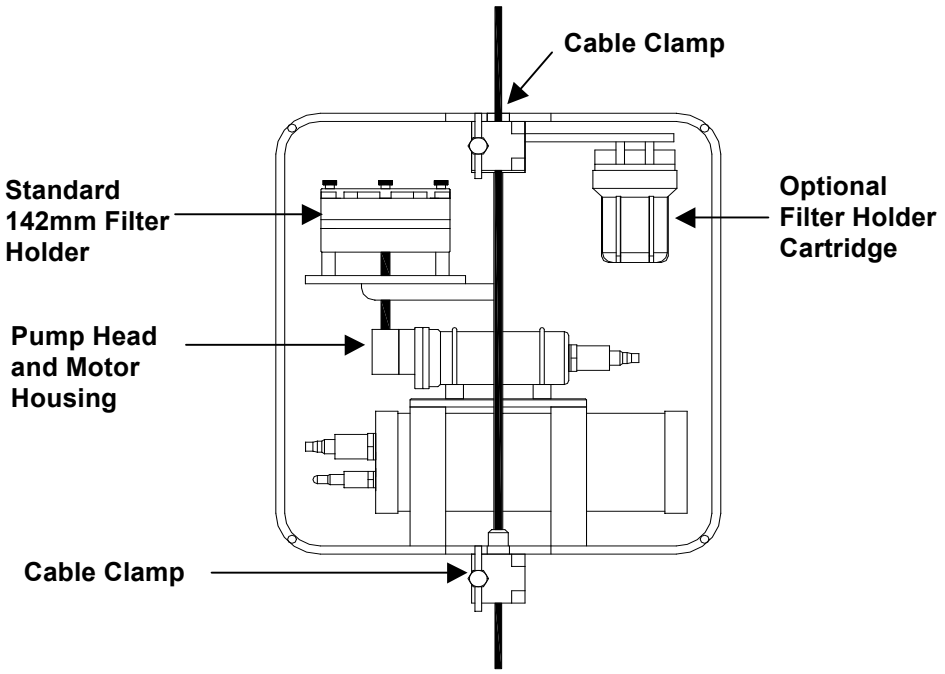

Figure 1-2: WTS-LV Line Drawing - Side View

Models

Available WTS-LV models are listed below. See Appendix C, "WTS-LV Models" in this User Manual for more about each model.

Examples in this User Manual use the Standard WTS-LV model unless otherwise specified.

Model	Description
Standard WTS-LV	Collects samples onto a *142mm membrane filter powered by 24 "D" cell batteries.
High Capacity WTS-LV	Collects samples onto a *142mm membrane filter, powered by a 30Ah battery pack with 3 times the capacity of the "D" cells.
Dual Filter WTS-LV	Collects samples onto dual, *142mm membrane filters that perform separately metered parallel filtration. Powered by a 30Ah battery pack with 3 times the capacity of the "D" cells.
Bore Hole WTS-LV	Collects samples onto a *142mm filter, body is configured to fit through a 30cm hole. Powered by 24 "D" cell batteries.

**The 142mm filter holder is standard. Appendix D "Optional Filter Holders", in this User Manual describes additional optional filter holders.*

Deployment Process

After the WTS-LV configuration is confirmed, the deployment time is programmed, and the bench test is completed, the following occurs:

1. The firmware enters Suspend mode and remains in that mode until the scheduled time of the pumping event.
2. At the scheduled time of the pumping event, the system automatically wakes and begins sampling.
3. Water flow moves through the horizontal intakes and then down into the filter holder through a titanium honeycomb baffle that straightens the flow and suppresses turbulence.
4. The water then passes through a 316SS wire pre-filter support.
5. The filter holder evenly distributes the sample flow over the entire filter surface. The filter is placed on a support frit approximately 5mm below the base of the baffle.
6. Filtered water passes through the frit, down a short length of tubing, and through the pump to the exhaust port.

WTS-LV Toolkit

Each WTS-LV comes with a toolkit that contains tools, software, and spare parts including:

- Backup batteries (AAA).
- Wrenches, screwdrivers, and hex drivers sized for the WTS-LV hardware.
- Spare o-rings, nylon and stainless steel screws and bolts.
- Spare polyurethane tubing.
- Priming hose plug.
- Communications cable for serial port connection to a computer.
- Media with the Motocross software and firmware documentation.
- USB to RS-232 connector.

Figure 1-3: WTS-LV Toolkit

The WTS-LV toolkit in Figure 1-3 is shown only as an example. Do not use the photo to compare with your actual toolkit contents.

Customer Support Resources

McLane Research Laboratories is on the Web at http://www.mclanelabs.com or via email at mclane@mclanelabs.com. The WTS-LV pages on the McLane website contain links to documentation including Technical Bulletins, and papers that describe the development and use of the WTS-LV.

```
Selection [] ? 7

               McLane Research Laboratories, Inc.
                    Falmouth Technology Park
               121 Bernard East Saint Jean Drive
               East Falmouth, MA 02536-4444  USA

                  Email: McLane@McLaneLabs.com
                 Web: http://www.McLaneLabs.com

              Tel: 508-495-4000  Fax: 508-495-3333

                    Configuration: LV-04M_TR
                    Source file: CF2-_07.c
                 Electronics S/N: ML12345-01

                  Compiled: Jan 15 2015 14:14
```

Figure 1-4: McLane Contact Information

Technical Support

When contacting McLane for technical support, please provide the following:

- Firmware version and instrument serial number. Serial number is printed on a silver label attached to the controller housing or on the Contact screen (Figure 1-4).
- A description of the problem.
- A text file of data created using the Motocross file capture utility.

Instrument Training

McLane also offers a 1-2 day instrument training course at our facility free of charge with the purchase of a new instrument. Participants conduct trial deployments and work directly with members of the McLane engineering staff. Conducting trial deployments is a beneficial way to learn system operations before actual field investigations. For more product training information refer to www.mclanelabs.com.

Notes

Chapter 2
Communicating with your McLane Instrument

The WTS-LV toolkit includes a COM cable for connecting the sampler to a host computer. You must also install the Motocross terminal emulation program (MotoCrossML.exe) on the computer. Once the COM cable is connected to the sampler and host computer, connecting the main instrument battery powers on the firmware. The following topics are part of instrument connection:

1. Cable and COM connectors
2. Configuring MotoCrossML.exe
3. Powering on the instrument (main battery connection)

Cable and COM Connectors

Locate the COM cable (in the instrument's toolkit) that connects the sampler and a computer. Determine whether the computer has a built-in serial port. Built-in serial ports are preferred for connection with your instrument. However, a USB to RS-232 adaptor is included in the toolkit for connection to computers without built-in serial ports. The adaptor is a DS_US232R-10(R-100/500) adaptor cable (manufactured by FTDI Ltd).

The COM bulkhead connector is a 5-pin MCBH style. Some instruments may have a 3-pin XSG style bulkhead connector (Figure 2-1). Both style cables have a serial connector. The serial connector either plugs directly into the computer or into the USB to RS-232 adaptor and then into the computer (Figure 2-2).

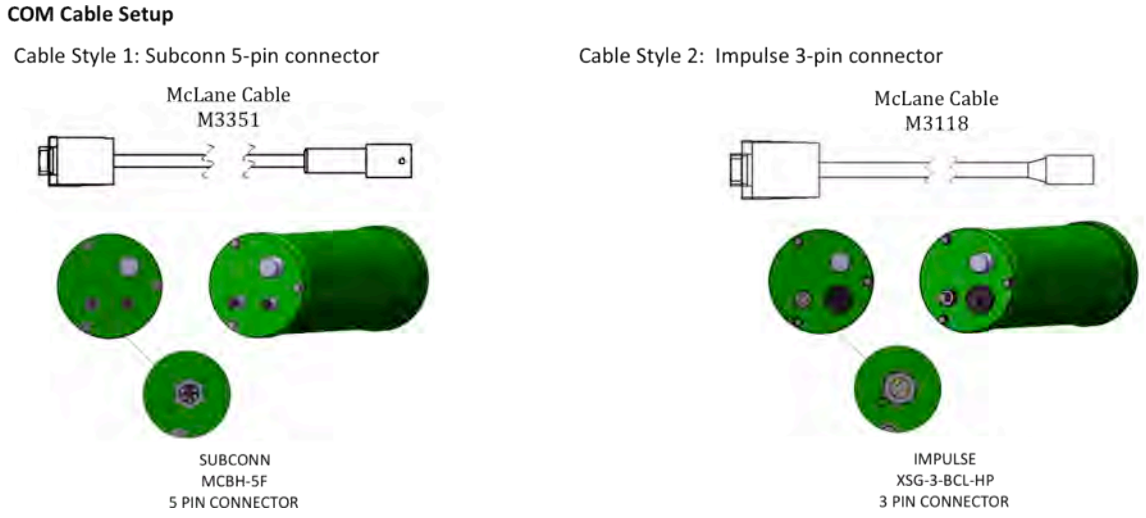

Figure 2-1: Cable Connector Styles

Figure 2-2: Computer COM Setup Styles

Motocross Terminal Emulator

Motocross is a terminal emulator for communicating with McLane samplers and profilers. McLane created a custom version of Motocross (MotoCrossML.exe), configured with the Motocross settings required by our instruments. Other Motocross considerations:

- A built-in Motocross feature can log communications with your instrument to a capture file located on the connected host computer. McLane recommends using capture file logging when running any bench tests or setting up a deployment.

McLane instruments require Motocross [CTRL]-C keystrokes to be configured as character transmissions for canceling operations, waking from Suspend mode, and navigating menus. The other Motocross Transmission mode, Standard Windows Editing mode, uses [CTRL]-C as a text copy function and is not recognized by McLane instrument operations.

- MotoCrossML.exe is included on the media shipped with a new instrument and is available at www.mclanelabs.com under Support > Software Utilities.

Configuring Motocross

1. Install MotocrossML.exe. (from the media included with your instrument) on a computer.
2. Open MotocrossML.exe. MotocrossML.exe is configured with the settings required by our instruments, however some setup is still needed.

Running a Motocross executable other than the program provided by McLane (MotoCrossML.exe) will not make the necessary configuration changes for using Motocross terminal emulation with McLane instruments.

3. Confirm that "Transmit Control Characters" (Figure 2-3) is enabled. From the top menu bar, select the Edit menu. Confirm Copy-Paste Options are set to transmit control characters (Figure 2-4), click OK.

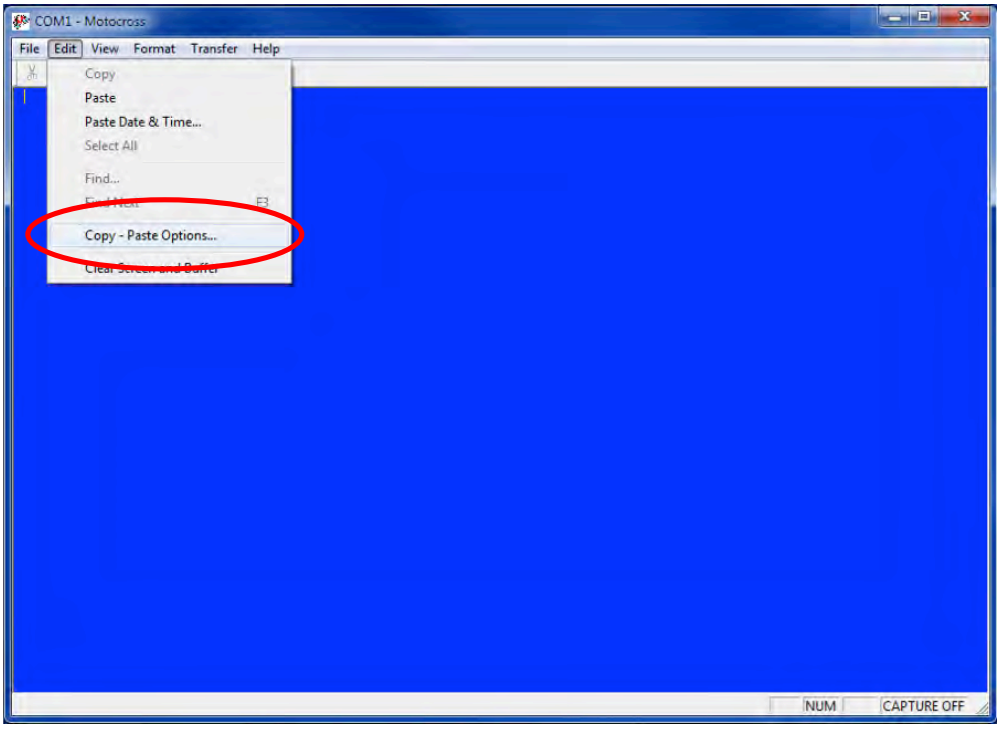

Figure 2-3: Change Default Settings for Sending Control Characters

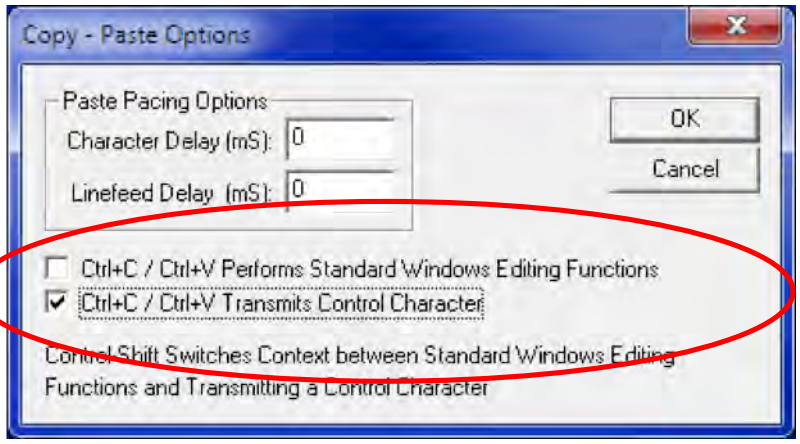

Figure 2-4: Ctrl+C/Ctrl+V Transmits Control Characters

4. From the File menu, select "Communication Settings" (Figure 2-5). Set parameters as follows and click OK:
    - Port # (the connected port).
    - Baud Rate: 9600 baud
    - Parity: None
    - Data Bits: 8
    - Flow Control: None

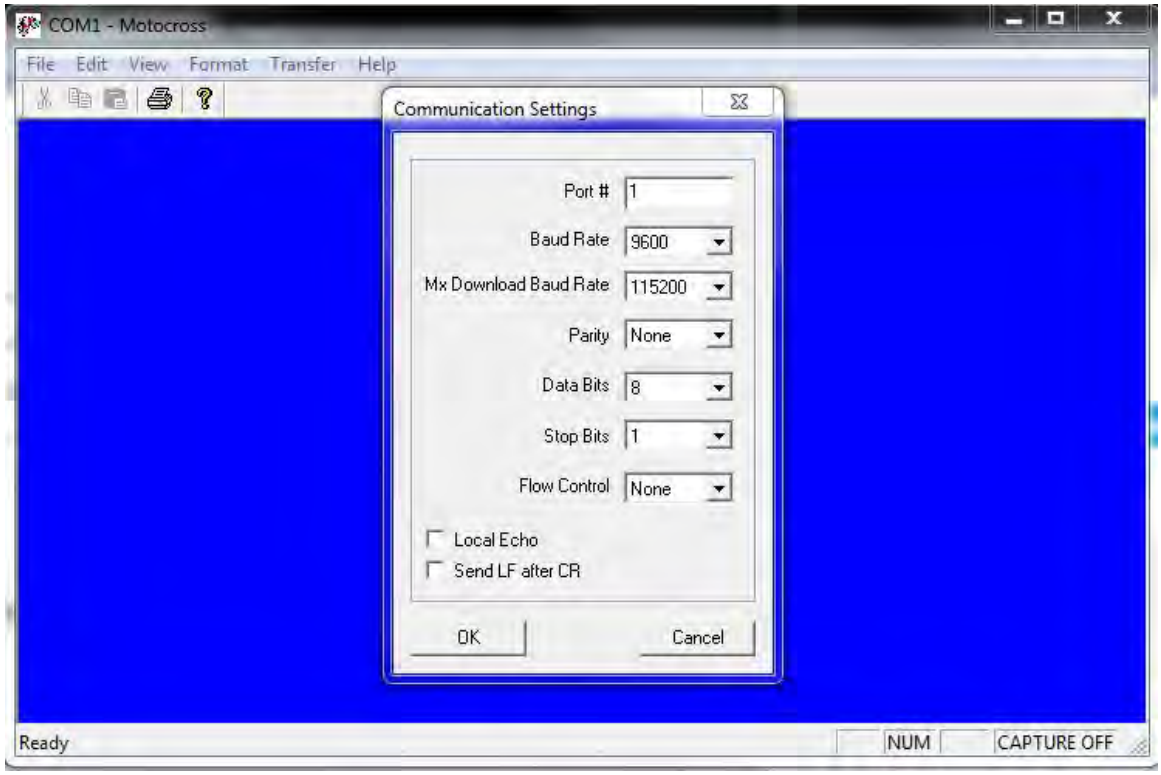

Figure 2-5: Communication Settings Configuration

Capturing instrument output to a text file

A built-in Motocross feature will log all communications to a capture file located on the connected host computer. This capture file is a very useful troubleshooting tool. McLane recommends setting up a capture file while running any bench tests or setting up a deployment.

1. Click the Transfer Menu.
2. Select “Capture Text”.
3. Enter a file name and location for the capture file.
4. Click “Start”.

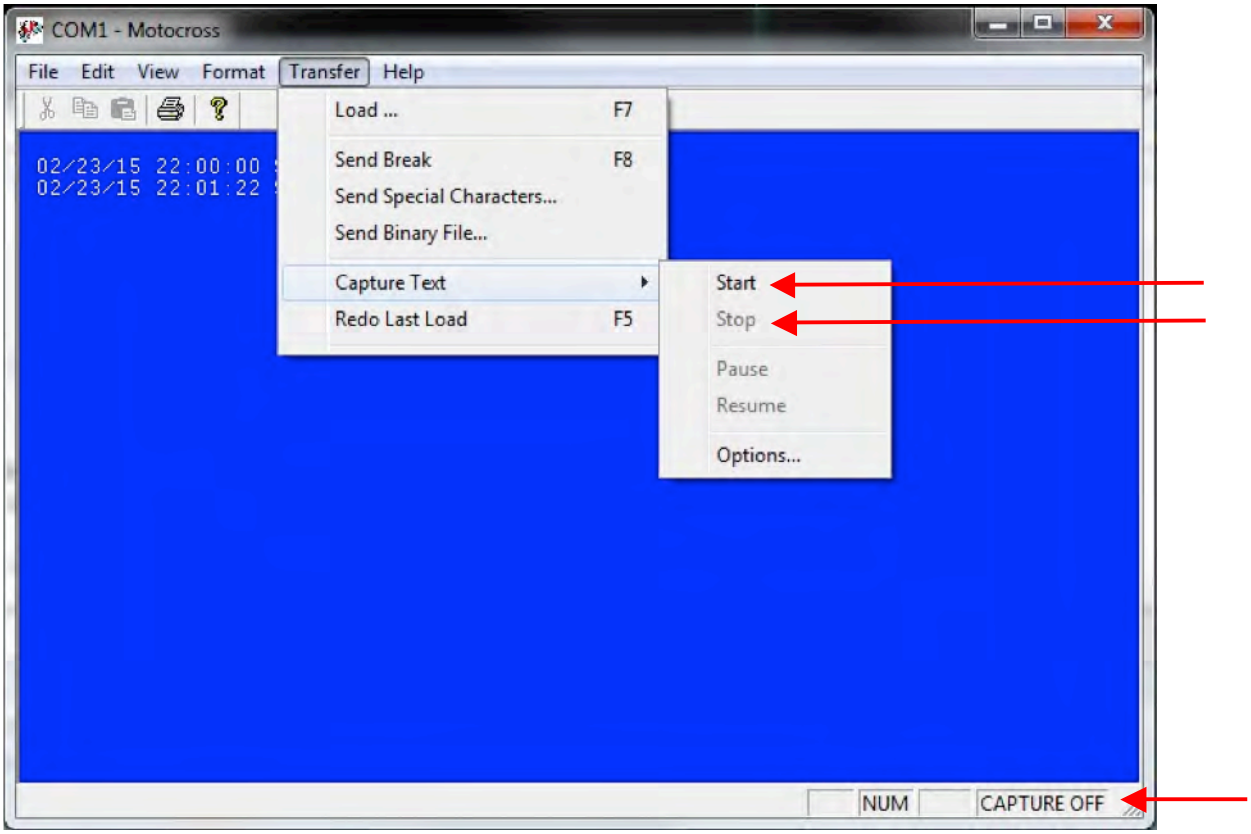

Figure 2-6: Start and Stop Capture File

5. Select whether to Append or Overwrite the file (Figure 2-7). Use caution when making this selection. Overwrite replaces any information in the log file. Append adds new information to the file.

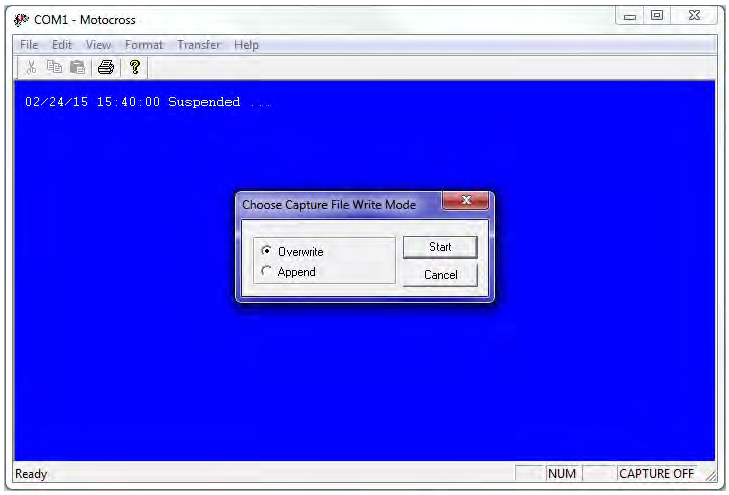

Figure 2-7: Overwrite or Append Capture File

6. Click "No" when prompted whether or not to include the Buffer text (Figure 2-8).

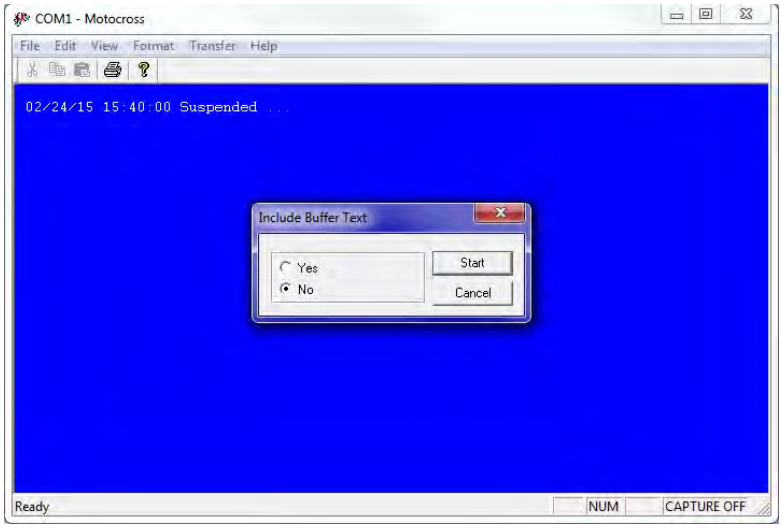

Figure 2-8: Include Buffer Text?

7. To finish capturing to file, select "Capture Text" from the Transfer menu (Figure 2-6) and then click "Stop" in the Transfer menu.

Connecting COM Cable and Battery, Starting Firmware

Connecting COM Cable

1. Place the sampler in a dry area.
2. With Motocross running, remove the dummy plug from the COM connector on the controller housing end cap.
3. Connect the COM cable to the computer serial communication port (use the USB to RS232 Adaptor, if the computer does not have a built-in serial port). Make this connection before connecting to the COM connector on the controller end cap.
4. Connecting to the COM bulkhead connector on the controller end cap.

Connecting Battery

1. Open the controller housing by unscrewing the three (3) bolts from the end cap (the cap on which the connectors are mounted).
2. Pull the end cap straight out from the cylinder (the electronics stack is mounted to this cap).
3. Grasp the main battery connector.

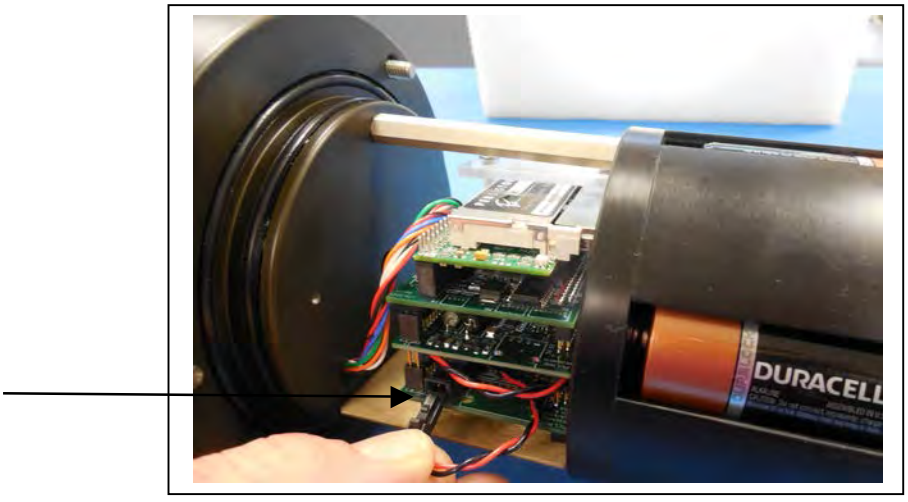

Figure 2-9: Connecting Main Battery to the Electronics Stack

4. Connect the main battery to the 2-pin connector on the middle board of the electronics stack.

5. Remove the cover from the back-up battery holder and insert two “AAA” alkaline batteries (included in the toolkit).

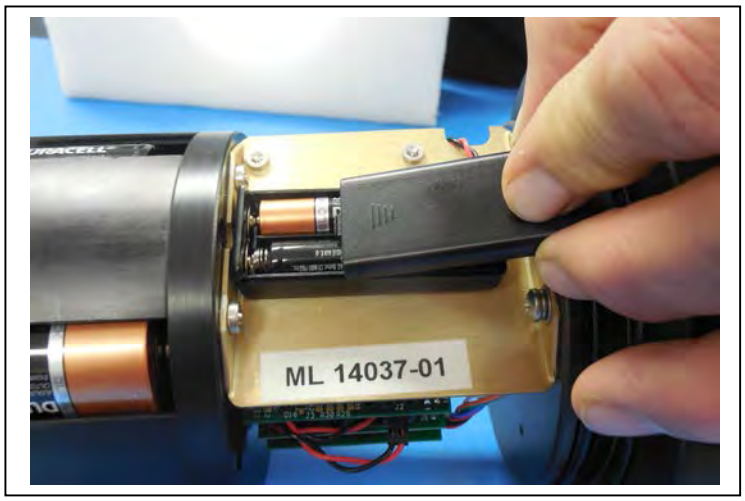

Figure 2-10: Connecting Main Battery to the Electronics Stack

6. The system initialization will begin (see Chapter 3, “User Interface” for details on the system initialization and firmware menus).

Activating the Firmware

1. After system initialization, the Main Menu displays.
2. Press [CTRL]-C three times (with one second pauses between each) to display the Main Menu. Only one [CTRL]-C is needed to control the firmware if the device is not in Suspend mode.

Disconnect the main battery before shipping to prevent electrical system damage during transit. Before disconnecting power, press [CTRL]-[C], to return to the Main Menu and put the sampler in Suspend mode.

Troubleshooting Communication with your Instrument

Troubleshooting: Confirm correct Port # defined

If the instrument firmware does not respond when connected to Motocross, use these steps to troubleshoot:

- Confirm the battery is connected to the instrument.
- Verify the correct Port # is defined (Figure 2-5).
- Ensure that character transmission mode is set (Figure 2-4).
- Read below for information on the toggle that changes Transmission mode.

Troubleshooting: Transmission Mode Toggle

It is possible to mistakenly switch between Control Character mode, and standard Windows Editing functions by holding down the [CTRL] key and pressing the Shift key. If Motocross does not respond as expected, press [CTRL]-Shift to toggle back to Character Transmission mode if needed.

Figure 2-11: Configured for Character Transmission Mode

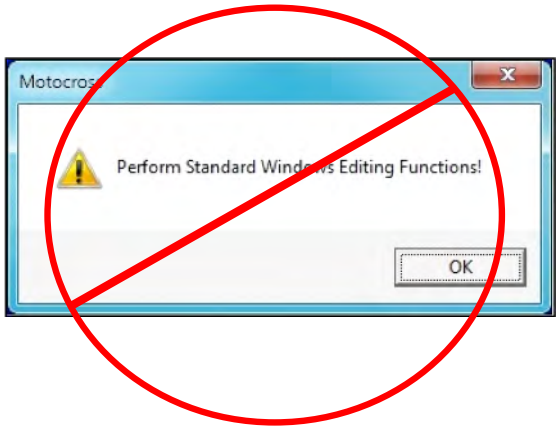

Figure 2-12: Configured for Windows Editing Mode – Do Not Use

Troubleshooting: USB Adaptor

The USB adaptor has LED indicator lights for transmitting and receiving data. Typing any key in Motocross terminal emulation should be indicated by the LED. If no LED light flashes on keystrokes, you may have selected the incorrect COM Port. Refer to the section that follows for instructions on Motocross setup.

Chapter 3
User Interface

This chapter describes the menu options and screens in WTS-LV firmware.

Powering On the WTS-LV

Connecting the main battery is the only way to power on the WTS-LV sampler. When the power-up sequence begins, a time and date prompt displays. Pressing [CTRL]-[C] three times (pausing three seconds between each keystroke) wakes the firmware if time/date do not display. If date/time still do not display, see Chapter 2 in this User Manual to troubleshoot operation with the Motocross terminal emulator.

```
CF2-LV-2.07 R1 L2.3 |  LV-2_07.c   compiled Jan 15 2015 at 14:14

          LV-04M  S/N ML?????-??  Large Volume Sampler
 © 1998-2015 McLane Research Laboratories. All rights reserved.
_____________________________________________________________

Clock reads 01/01/70 00:15:39.  Change [N] ? y

Format is mm/dd/[yyyy or yy] hh:mm:ss

Enter correct time [01/01/1970 00:15:41] ? 03/13/2015 08:32:19

Clock reads 03/13/15 08:32:19.  Change [N] ?
_____________________________________________________________
Configuration: LV-04M                  CF2 V2_07 of Jan 15 2015

               McLane Research Laboratories, Inc.
                      Large Volume Sampler
                           ML?????-??

               ____________________________
                           Main Menu

               ____________________________
                   Fri Mar 13 08:32:20 2015

          <1> Set Time          <5> Deploy System
          <2> Diagnostics       <6> Offload Data
          <3> Manual Operation  <7> Contacting McLane
          <4> Sleep             <C> Configure
```

Figure 3-1: System Power On

When the WTS-LV is powered on, using a file capture utility such as Motocross (www.Persistor.com) provides a complete record of deployment programming and is important during data analysis or troubleshooting.

Powering Off the WTS-LV

To power off the WTS-LV, complete the following steps:

1. Return to the Main Menu.
2. Select ‘Sleep’ from the menu.
3. Disconnect the main battery.

Firmware Control Menus

Sampler Menus provide firmware and controls for the deployment. Three settings menus are: Main Menu, Advanced Interface Menu and System Configuration Menu. These menus are explained in the section that follows.

Prompts and Key Combinations

Within the firmware some prompts and key combinations are frequently used:

- [CTRL]-[C] does the following: terminate the current operation and return to the Main Menu, terminate a deployment after Profiler recovery, wake from Suspend mode.
- Pressing [ENTER] selects the default choice for many prompts. If a default is available, the value is displayed at the end of the prompt in square brackets.
- Upper and lower case alphabetic characters display most prompts.
- Prompts for numerical values accept only numbers that fall within the displayed range.
- Prompts for alphanumeric input accept only characters from the displayed list.

Main Menu

The Main Menu automatically displays after firmware initialization. The pump head, enabled options, firmware version and compile date display at the top of each firmware screen. The options on this menu are explained in more detail at the end of this chapter.

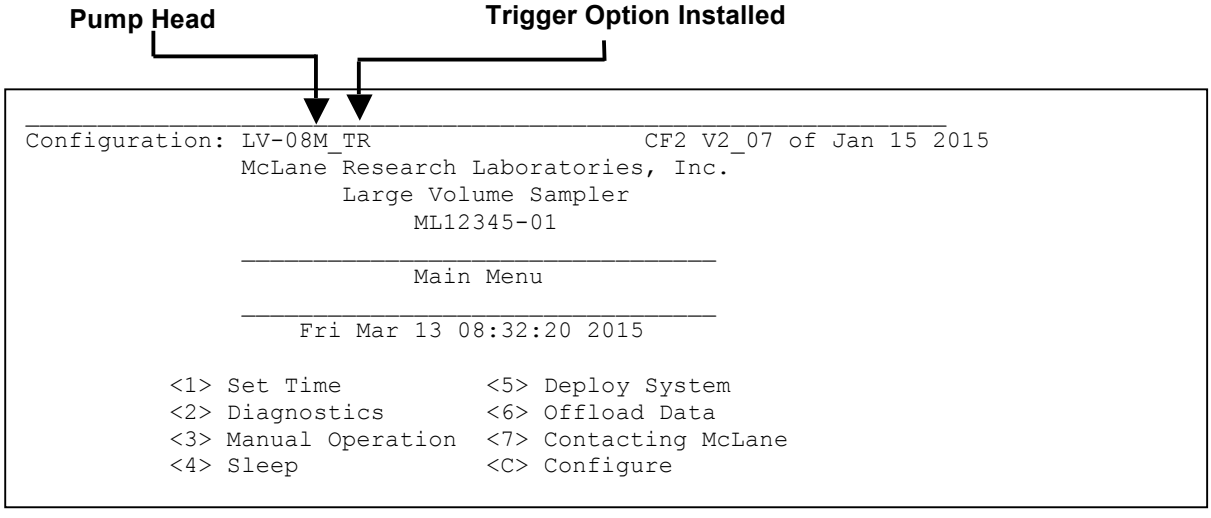

Figure 3-2: WTS-LV Main Menu

System Configuration Menu

The Configuration menu sets the controls for the pressure sensor, pump type, rechargeable battery, and trigger. A new WTS-LV sampler ships with these settings complete. Using the Configuration menu could be necessary if hardware changes are made or if the firmware is upgraded.

From the Main Menu, type *C* and enter the password *configure*.

```
Selection [] ? c  Password: ***

_____________________________________________________________________
Configuration: LV-04M_TR                CF2 V2_07 of Jan 15 2015

                 _____________________________
                         Configuration Menu
                 _____________________________
                     Mon Apr  6 13:52:40 2015

           <A> Pressure Sensor               [No]
           <B> Pump                          [Maxon   4 L/Min.]
           <C> Rechargeable Battery          [No]
           <D> Trigger                       [Enabled]

           <X> Save & Exit          <^C> Cancel & Exit

           Selection [ ] ? x

Configuration successfully stored
```

Figure 3-3: WTS-LV System Configuration Menu

Option <A> Pressure Sensor

Option <A> Pressure Sensor sets whether or not the integral pressure sensor is installed.

Option <B> Pump

Option B allows the operator to change the pump motor and pump capacity. Both Maxon and Pittman motors are supported.

The firmware settings must match the installed pump head. Contact mclane@mclanelabs.com with your instrument serial number if you have questions about your WTS-LV pump parameters.

Option <C> Rechargeable Battery

In firmware v2.00 and above, WTS-LV samplers with drop-in battery holders can use 24 "D" alkaline batteries or 24 rechargeable nickel-metal hydride (NiMH) batteries. The NiMH cells require 6-8 hours to charge and provide 2/3 of the 24 "D" cells capacity. McLane has performed testing using Tenergy rechargeable batteries. Any equivalent 10Ah batteries can be used.

The voltage thresholds for NiMH batteries differ and trigger battery warnings at different voltages than the alkaline "D" cells. Contact mclane@mclanelabs.com for more information about this option.

```
Configuration: LV-04M_TR                CF2 V2_07 of Jan 15 2015

                        Configuration Menu

                    Mon Apr  6 13:52:40 2015

          <A> Pressure Sensor               [No]
          <B> Pump                          [Maxon   8 L/Min.]
          <C> Rechargeable Battery          [No]
          <D> Trigger                       [Disabled]

          <X> Save & Exit          <^C> Cancel & Exit

          Selection [ ] ? c

    NOTE: Configured for Alkaline pack or drop-in cells
    Battery Warning at 32.0V, Battery Minimum is 20.0V

Is there a rechargeable battery installed? [N] ? y

    NOTE: Configured for Nickel-metal hydride drop-in cells
    Battery Warning at 28.0V, Battery Minimum is 24.0V
```

Figure 3-4: Rechargeable Batteries Configured

Option <T> Trigger

A trigger start provides a way to time synchronize multiple instruments. If the Trigger option is configured, the WTS-LV sampler must have the trigger plug installed. For more information about the trigger see the section “Trigger Start” in this Chapter.

The firmware does not check to verify whether the trigger is installed regardless of the setting on the Configuration menu.

```
_____________________________________________________________________
Configuration: LV-04M_TR                CF2 V2_07 of Jan 15 2015
                 _____________________________
                         Configuration Menu
                 _____________________________
                     Mon Apr  6 13:52:40 2015

           <A> Pressure Sensor                [No]
           <B> Pump                           [Maxon   8 L/Min.]
           <C> Rechargeable Battery           [No]
           <D> Trigger                        [Disabled]

           <X> Save & Exit           <^C> Cancel & Exit

           Selection [ ] ? d

Is there a trigger installed? [N] ? y
```

Figure 3-5: Trigger Configured

Main Menu Detailed Option Descriptions

```
_____________________________________________________________________
Configuration: LV-08M_TR                  CF2 V2_07 of Jan 15 2015
               McLane Research Laboratories, Inc.
                      Large Volume Sampler
                           ML12345-01
               ___________________________________
                           Main Menu
               ___________________________________
                   Fri Mar 13 08:32:20 2015

          <1> Set Time          <5> Deploy System
          <2> Diagnostics       <6> Offload Data
          <3> Manual Operation  <7> Contacting McLane
          <4> Sleep             <C> Configure
```

This section describes the WTS-LV Main Menu in detail.

Figure 3-6: WTS-LV Main Menu

Main Menu <1> Set Time

This option sets the real time clock (RTC).

McLane recommends that the RTC be set during the power-up sequence. When the RAS is powered on, the clock defaults to January 1,1970, 00:00:00. The clock can be set to any date and time in the allowed range and the count will continue from the new value.

```
Clock reads 01/01/70 00:15:39.  Change [N] ? y

Format is mm/dd/[yyyy or yy] hh:mm:ss

Enter correct time [01/01/1970 00:15:41] ? 03/13/2015 08:32:19

Clock reads 03/13/15 08:32:19.  Change [N] ?
```

Figure 3-7: Set Time

Main Menu <2> Diagnostics

Diagnostics scrolls a display of system status including date, time, battery voltage (in Vb), and temperature (in °Celsius). To exit Diagnostics and return to the Main Menu type *X* or or [CTRL]-[C]. Toggle the scrolling on and off without exiting by pressing any other alphanumeric key.

```
Selection [] ? 2

 Press any key to pause/continue display, or ^C to exit

03/13/15 08:33:16  35.8 Vb  21∞C
03/13/15 08:33:17  35.8 Vb  21∞C
03/13/15 08:33:18  35.8 Vb  21∞C
03/13/15 08:33:19  35.8 Vb  21∞C
03/13/15 08:33:20  35.8 Vb  21∞C
03/13/15 08:33:21  35.8 Vb  21∞C
03/13/15 08:33:22  35.8 Vb  21∞C
03/13/15 08:33:23  35.8 Vb  21∞C
```

Figure 3-8: Diagnostics

Low Battery Messages

Low battery voltage triggers warning messages during the exit from the Diagnostics display. If the main battery falls below 32 V, a message displays suggesting battery replacement before deployment.

```
Battery voltage is abnormally low.  Check/replace main battery pack before
deploying system.

Press any key to continue.
```

Figure 3-9: Low Battery Voltage

If the main battery falls below 20 V, the message shown below displays, the Diagnostic routine terminates, and the program returns to the Main Menu.

```
Main battery is extremely low and should be replaced before running
diagnostics.
```

Figure 3-10: Critically Low Battery Voltage

If critically low battery voltage (under 20 V) is detected and a data file has not been offloaded, the additional warning shown next displays before the system returns to the Main Menu.

```
A data set exists in memory that has not been offloaded.  Offload the data now,
before replacing battery, or the data may be lost.
```

Figure 3-11: Critically Low Battery Voltage – Offload Data

Confirm that offloaded data is accurate before disconnecting the battery. The firmware detects only the successfully execution of the Offload Data option and not whether the data file was successfully logged by Motocross.

Main Menu <3> Manual Operation

Manual Operation provides direct control of the pump for bench testing, system assessment, and deployment preparation (the examples that follow show a 4L/min pump).

```
         Selection [M] ? 1

  2500 h  211 I_Hz   52 A_Hz    0.1 L   4.7 L/min     1 sec  35.7 V   71 mA
  2441 h  212 I_Hz  105 A_Hz    0.1 L   4.7 L/min     2 sec  35.7 V   66 mA
...
2185 h  182 I_Hz  182 A_Hz    4.9 L   4.0 L/min   101 sec  35.7 V   63 mA


  2184 h  180 I_Hz  181 A_Hz    4.9 L   4.0 L/min   102 sec  35.7 V   65 mA
  2186 h  181 I_Hz  181 A_Hz    5.0 L   4.0 L/min   103 sec  35.7 V   61 mA

Volume reached
Total volume pumped     = 4992 ml

 Elapsed time of event   = 104 sec
 Lowest battery detected = 35.7 V

 Press any key to return to pump menu.
```

Figure 3-12: Manual Operation Menu – Configured for 4L/min Pump head

Option <1> Run pump: forward

This option pumps 5 liters of water in the forward direction at 4L/min, 10 liters of water in the forward direction at 8L/min. Press [CTRL]-[C] to stop the pump before the operation is complete.

```
_____________________________________________________________________
Configuration: LV-04M_TR                CF2 V2_07 of Jan 15 2015

                 ___________________________________
                          Manual Operation
                 ___________________________________

                      Fri Mar 13 08:33:40 2015

           <1> Run pump forward (5 liters @ 4 L/min)
           <2> Run pump reverse (5 liters @ 4 L/min)
           <3> Run pump programmable

           <M> Main Menu
```

Figure 3-13: Run Pump Forward – Configured for 4L/min Pump head

Option <2> Run pump: reverse

This option pumps 5 liters of water in the forward direction at 4L/min, 10 liters of water in the forward direction at 8L/min. Press [CTRL]-[C] to stop the pump before the operation is complete.

```
Selection [M] ? 3

Current value of volume per sample: 100
Enter volume per sample [liters] (1-10000) [100] ?
Current value of initial flow rate: 4000
Enter initial flow rate [mL/min] (1000-5000) [4000] ? 2000
Current value of minimum flow rate: 1000
Enter minimum flow rate [mL/min] (500-2000) [1000] ?
Current value of pumping time limit: 101
Enter pumping time limit [minutes] (1-101) [101] ?
Forward or Reverse pumping (F|R) [F] ?
```

Figure 3-14: Run Pump Reverse - Configured for 4L/min Pump head

Option <3> Run pump: programmable

This option allows the operator to enter pumping flow rate, minimum flow rate, volume, and time limit. Press [CTRL]-[C] to stop the pump before the operation is complete. A sample screen is shown next.

```
          Selection [M] ? 2

  2500 h  215 I_Hz   53 A_Hz    0.1 L   4.7 L/min     1 sec  35.7 V   70 mA
  2433 h  214 I_Hz  107 A_Hz    0.1 L   4.7 L/min     2 sec  35.7 V   70 mA
. . .

  2175 h  182 I_Hz  181 A_Hz    4.9 L   4.0 L/min   102 sec  35.7 V   59 mA
  2173 h  180 I_Hz  180 A_Hz    5.0 L   4.0 L/min   103 sec  35.7 V   62 mA

Volume reached

 Total volume pumped     = 4994 ml
 Elapsed time of event   = 104 sec
 Lowest battery detected = 35.7 V

 Press any key to return to pump menu.
```

Figure 3-15: Run Pump Programmable

Each row in the Real-time Pump Data display shows (from left to right) the pump speed control value, the instantaneous hall counts in Hertz, the average pump hall counts in Hertz, the cumulative volume pumped in liters, the instantaneous flow rate in L/min, and the elapsed time in seconds, battery voltage (Vdc), and system current draw (mA).

Main Menu <4> Sleep

Use this option to place the WTS-LV in Suspend mode to conserve battery power. When the sampler is not sampling, Suspend mode automatically triggers after 20 minutes of inactivity.

Prior to Suspend mode, the current time will display. During Suspend mode, the system will wake every 20 minutes to check system status, display the time and then return to Suspend mode. This is also the operation mode after the sample is completed. To wake the system and return to the Main Menu, press [CTRL]-[C] three times (with three second pauses between each keystroke).

```
Selection [] ? 4

03/04/15 11:40:10 Suspended ...
```

Figure 3-16: Suspend Mode

Main Menu <5> Deploy System

Deploy System does the following:

- Checks EEPROM and requires a reboot if data is stored there.
- Warns if there is data ready to be offloaded.
- Confirms the date and time.
- Check and reset the scheduled or count-down start mode
- Displays a final sampling parameter check with options to make changes.

After the date, time and sampling parameters are confirmed, the final check is performed and a final prompt is displayed.

In firmware v2.08 and above, if backup batteries are not detected during the check, the firmware will not accept the 'Y' entry to start the deployment.

Typing *Y* at the final prompt commits the firmware to the deployment. The firmware enters Suspend mode and only a [CTRL]-[C] entry is allowed.

Specific steps for using this option to program a WTS-LV deployment are provided in Chapter 6, "Operations" in this User Manual

Main Menu <6> Offload Data

This option works with the "Capture to file" feature of Motocross. After recovering the WTS-LV, and re-establishing the communications link with the computer, select <6> Offload Data to capture data to a text file. Confirm that Motocross "Capture to File" is ON during offload. Offload data before disconnecting the battery to prevent data loss. For detailed information about data offload see Chapter 7, "Deployment and Recovery" in this User Manual.

Figures 3-17, and 3-18 show the screens when the offload for All Data is selected.

```
Configuration: LV-04M_TR                CF2 V2_07 of Jan 15 2015

                 ____________________________________
                     Offload/Display Data File
                 ____________________________________
                     Mon Apr  6 13:49:15 2015

       <1> Display ALL data
       <2> Display event summary data
       <3> Display pump data
       <4> EEPROM data backup cache

       <M> Main Menu

       Selection  [] ? 1

 To copy the instrument data file to a disk file, initiate
 your communication program's file logging command now and
 then Press any key to start the transfer.  The instrument
 data file will remain resident and is not deleted by this
 procedure.

 Software version:  LV-2_07.c
 Compiled:          Jan 15 2015 14:14:53
 Electronics S/N:   ML13344-02

 Data start:        04/06/15 11:58:41
 Data stop:         04/06/15 13:36:15
```

Figure 3-17: Display All Data (1 of 2)

```
HEADER
 ______

 tank test deployment
 12345-02

 SAV

 Sample volume:           125 liters
 Initial flow rate:      3000 ml/min
 Minimum flow rate:      1000 ml/min
 Time limit:              126 minutes
 Pump data period:          1 minutes
 Trigger delay:      00:30:00  [HH:MM:SS]

 DEPLOYMENT DATA
 _______________

 Event start:  04/06/15 12:29:09   36.3 Vb   17 ∞C
  124.99 L delivered in 4025 seconds : Volume reached
 Event end:    04/06/15 13:36:15   33.5 Vb   23 ∞C

 Normal shutdown.

PUMPING DATA
 ____________
 Sample interval = 1 [minutes]

   [L/min]    [liters]   [Vbat]
      3.00        1.83    34.5
      3.00        3.70    34.4
      3.00        5.56    34.3
      3.00        7.42    34.2
      2.98        9.29    34.2
      3.00       11.15    34.1
      3.02       13.02    34.0
      3.00       14.88    34.0
      2.98       16.74    33.9
      3.02       18.61    33.9
      3.00       20.47    33.9
.  .  .  <-- Display shortened to save space
      2.98      121.13    32.5
      2.98      122.99    32.5
      3.00      124.85    32.5

Lowest battery voltage measured while under load: 32.5
```

Figure 3-18: Offload/Display Data File – Display All (2 of 2)

Option <4> EEPROM Data Backup Cache

Option 4 accesses a back-up copy of critical data written to non-volatile memory during deployment. In an unlikely system malfunction, EEPROM provides limited data recovery. Make backup copies of the capture file.

```
        Selection  [2] ? 4

 During deployments a backup copy of the most important
 information stored in the instrument datafile is also written
 to a small EEPROM.  The EEPROM provides non-volatile data
 storage, allowing data recovery in the unlikely event the
 instrument datafile is no longer resident in active memory.

 The cache file remains resident in the EEPROM until
 it is overwritten during the next deployment.

 The EEPROM data cache contains:
  - The start and stop time for the sampling event.
  - The volume of water pumped through the filter for the event.
  - The elapsed time for the event.
  - The lowest battery voltage encountered during the event.

 To copy the EEPROM cache file to a disk file, initiate your
 communication program's file logging command now, and then
 press any key to start the transfer.


  Scheduled for:  04/06/15 12:29:08
     Start time:  04/06/15 12:29:09

  Start battery:  36.3 V
  Start Celsius:  17 ∞C
  Volume pumped:  124.99 L
  Elapsed time:  4025 sec
  Lowest battery:  32.4 V

  End Celsius:  23 ∞C
  End battery:  33.5 V
  End time:  04/06/15 13:36:15

  Status:  Volume reached

 End of EEPROM data backup cache.

Press any key to continue.
```

Figure 3-19: EEPROM Data Backup Cache

Main Menu <7> Contacting McLane

This option displays McLane Contact information and includes the software version and serial number of your instrument.

```
Selection [] ? 7

               McLane Research Laboratories, Inc.
                    Falmouth Technology Park
               121 Bernard East Saint Jean Drive
               East Falmouth, MA 02536-4444  USA

                  Email: McLane@McLaneLabs.com
                 Web: http://www.McLaneLabs.com

              Tel: 508-495-4000  Fax: 508-495-3333

                    Configuration: LV-04M_TR
                    Source file: CF2-_07.c
                  Electronics S/N: ML12345-01

                  Compiled: Jan 15 2015 14:14
```

Figure 3-20: McLane Contact Information

Deployment Programming - Count-Down or Timer

This section provides steps for programming a WTS-LV deployment. Use the file capture utility available in Motocross to log all communication with the WTS-LV. Chapter 2 in this User Manual has more information about using Motocross.

Sample Start Parameters

The system can be programmed to begin via a scheduled start (specific date and time) or a count-down timer. If the trigger option is installed, the trigger delay must also be set (see the section that follows for Programming a Deployment with the Trigger Start).

To program the WTS-LV deployment, complete the following steps:

1. Power on the computer and start Motocross.
2. Remove the dummy plug from the COM connector on the end cap and connect the COM cable to the computer.
3. Connect the COM cable to the computer serial port.
4. Connect the battery.
5. From the Main Menu, select < 5>, Deploy System. If data exists in memory and the data offload procedure has not been run a prompt to continue displays. Previous data will be erased.

```
A data set exists in system memory that has
 not been offloaded.  Existing data will be lost
 if deployment continues.

 Continue [N] ? y

 Previous deployment records will be erased.


 Continue [N] ? y
```

Figure 3-21: Existing Data File will be Erased

6. Confirm the date and time.

```
Clock reads 05/14/15 15:31:45.  Change [N] ?
```

Figure 3-22: Confirm Date and Time

7. Select the method for starting the system (both start options are referenced to the system real-time clock).

```
 Header 1|
        2|
        3|
 Sample 4| Sample volume     =      100  [liters]
        5| Initial flow rate =     4000  [ml/min]
        6| Minimum flow rate =     1000  [ml/min]
        7| Time limit        =      100  [minutes]
 Data   8| Pump data period  =        1  [minutes]
 Start  9| Countdown timer:    01:00:00  [HH:MM:SS]
        D| Done.  Continue pre-deployment set-up.
Selection [] ? 9
Scheduled, Countdown, or Trigger (S|C|T) [C] ? t
 Enter HH:MM:SS for trigger delay
 Hours   ( 0-24) [ 1] ? 0
 Minutes ( 5-59) [ 5] ? 30
 Seconds ( 0-59) [ 0] ? 0
```

Count down set for 30 minutes

Figure 3-23: Sample Parameters

A Quick Reference overview of each sampling parameter is provided in Appendix A of this User Manual.

Count-down Timer

- The count-down timer start begins counting when the deployment is confirmed, and begins pumping when the timer reaches zero. The count-down timer can be set in 1 minute increments from 5 minutes up to 24 hours.

If the count-down delay is set to 0 hours a setting of at least 5 minutes will be required.

The count-down begins when *Y* is selected at the 'Proceed with Deployment' prompt.

Scheduled Start

- A scheduled start requires entering the date and time for pumping to begin. The scheduled start timer should be used to program longer delays.

Deployment Programming -Trigger Start

This section provides steps for programming a WTS-LV deployment with a Trigger Start. Use the file capture utility available in Motocross to log all communication with the WTS-LV. Chapter 2 in this User Manual has more information about using Motocross.

Setting and Activating the Trigger

The trigger start is included on the WTS-LV Upright and WTS-LV Dual Filter models. The trigger is available as an option on the Standard and Bore Hole WTS-LV models. The trigger provides a way to time synchronize multiple instruments.

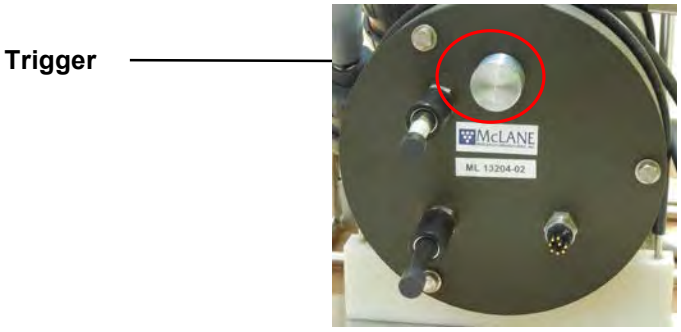

Figure 3-24: Trigger Plug

When the trigger is installed, the WTS-LV firmware displays additional options for timing the trigger countdown (see Figure 3-25). The steps that follow explain how to activate the trigger. During the deployment, the trigger delay count-down begins when the trigger is activated (the trigger plug is disconnected and reconnected). Until the trigger plug is disconnected, the system remains awake.

When the trigger is activated, the WTS-LV goes into Suspend mode and waits for the Trigger Delay time to count down. Do not press [CTRL]-[C] after the trigger is activated, or the deployment will be stopped (the message in Offload data will read 'Deployment Stopped by User').

Sample Start Parameters

The system can be programmed to begin via a scheduled start (specific date and time) or a count-down timer. If the trigger option is installed, the trigger delay must also be set (see the section that follows for Programming a Deployment with the Trigger Start).

To program the WTS-LV deployment, complete the following steps:

1. Power on the computer and start Motocross.
2. Remove the dummy plug from the COM connector on the end cap and connect the COM cable to the computer.
3. Connect the COM cable to the computer serial port.
4. Connect the battery.
5. From the Main Menu, select < 5>, Deploy System. If data exists in memory and the data offload procedure has not been run a prompt to continue displays. Previous data will be erased.

```
A data set exists in system memory that has
 not been offloaded.  Existing data will be lost
 if deployment continues.

 Continue [N] ? y

 Previous deployment records will be erased.


 Continue [N] ? y
```

Figure 3-25: Existing Data File will be Erased

6. Confirm the date and time.

```
Clock reads 05/14/15 15:31:45.  Change [N] ?
```

Figure 3-26: Confirm Date and Time

7. Select *9* for the start function.

8. Type *T* and program the trigger delay time.

```
 Header 1|
        2|
        3|
 Sample 4| Sample volume     =      100  [liters]
        5| Initial flow rate =     4000  [ml/min]
        6| Minimum flow rate =     1000  [ml/min]
        7| Time limit        =      100  [minutes]
 Data   8| Pump data period  =        1  [minutes]
 Start  9| Countdown timer:    01:00:00  [HH:MM:SS]
        D| Done.  Continue pre-deployment set-up.
Selection [] ? 9
Scheduled, Countdown, or Trigger (S|C|T) [C] ? t
 Enter HH:MM:SS for trigger delay
 Hours   ( 0-24) [ 1] ? 0
 Minutes ( 5-59) [ 5] ? 30
 Seconds ( 0-59) [ 0] ? 0
```

Trigger

Figure 3-27: Sample Parameters

A Quick Reference overview of each sampling parameter is provided in Appendix A of this User Manual.

9. Plug in the trigger. The system will perform a test of the trigger circuit and display “Trigger is functioning” to confirm the trigger function (Figure 3-28).

```
 Header 1|
        2|
        3|
 Sample 4| Sample volume     =      300  [liters]
        5| Initial flow rate =     7000  [ml/min]
        6| Minimum flow rate =     5000  [ml/min]
        7| Time limit        =       60  [minutes]
 Data   8| Pump data period  =        1  [minutes]
 Start  9| Countdown timer:    01:00:00  [HH:MM:SS]
        D| Done.  Continue pre-deployment set-up.
        Selection [] ? 9
 Scheduled, Countdown, or Trigger (S|C|T) [C] ? t      <-- Set Trigger Time
 Enter HH:MM:SS for trigger delay
 Hours   ( 0-24) [ 1] ? 0
 Minutes ( 5-59) [ 5] ? 5
 Seconds ( 0-59) [ 0] ? 0
_____________________________________________________________
 Header 1|
        2|
        3|
 Sample 4| Sample volume     =      300  [liters]
        5| Initial flow rate =     7000  [ml/min]
        6| Minimum flow rate =     5000  [ml/min]
        7| Time limit        =       60  [minutes]
 Data   8| Pump data period  =        1  [minutes]
 Start  9| Trigger delay:      00:05:00  [HH:MM:SS]
        D| Done.  Continue pre-deployment set-up.
        Selection [] ? d
 Trigger test:                                         <-- Trigger Test
 Disconnect and reconnect trigger plug, or press ^C to abort...
Trigger is functioning.                                <-- Trigger Functioning
System status: 11/10/14 13:59:39  36.0 Vb  25∞C
CAUTION: Deployment will ERASE all EEPROM data backup entries.
```

Figure 3-28: Setting Trigger Delay and Performing Trigger Test

10. Remove the trigger plug and set aside. The trigger delay time begins a countdown when the trigger is activated. The deployment delay countdown begins when 'Y' is selected at the 'Proceed with Deployment' prompt

11. Type *Y* to proceed with the deployment.

```
 Proceed with the deployment [N] ? y
 Trigger delay: 00:05:00  [HH:MM:SS]
 Disconnect and reconnect trigger plug, or press ^C to abort...
Trigger received.
 Waiting for scheduled event @ 11/10/14 14:06:29
 Remove communication cable and attach dummy plug.
System is ready to deploy...
```

Figure 3-29: Proceed with Deployment, Trigger Activated

12. The system will stay awake and wait for the trigger time.

13. To activate the trigger delay for deployment, install the trigger plug.

To run the trigger test, before selecting *D* 'done', remove the trigger plug then re-connect the plug.

Deploy

The steps that follow explain how to complete the deployment.

1. Select *D* to proceed with the deployment when the sample parameters are complete.
2. One line of system status information displays followed by a message reminder to offload data written to the EEPROM backup during a previous deployment. Disregard the message if the data has already been recovered.

```
Selection [] ? D

System status:

   Date     Time    Battery    Temp Port
 03/17/15 13:18:27  30.8 Vb  18.0∞C 00 (home)

Caution: Deployment will overwrite the EEPROM data backup cache.

Performing 6 second Backup Battery test...

!!! CANNOT CONTINUE - CHECK BACKUP BATTERY !!!
```

Figure 3-30: System Status

In firmware v2.08 and above, the pre-deployment process checks to confirm that backup batteries are correctly installed. If backup batteries are not detected, the firmware will not accept the 'Y' entry to start the deployment.

3. The data offload reminder and battery check will be followed by a prompt to proceed with or terminate the deployment (a final chance to check the settings prior to deployment).

4. The firmware performs a consistency check. If the main battery voltage is too low to support the deployment, warnings will display (see Chapter 3 for battery voltage warnings).

5. Once the system is ready to deploy, remove the communications cable, replace the dummy connector, and connect to the wire. The system will remain in the Suspend mode until the scheduled time of the pumping event. At that time the system will automatically wake up and begin sampling.

```
CAUTION: Deployment will ERASE all EEPROM data backup entries.

 Proceed with the deployment [N] ? y

 Trigger delay: 00:30:00  [HH:MM:SS]

 Disconnect and reconnect trigger plug, or press ^C to abort...

Trigger received.

Waiting for scheduled event @ 04/06/15 12:29:08

Remove communication cable and attach dummy plug.

System is ready to deploy...

04/06/15 11:59:08 Suspended until 04/06/15 12:29:08 ...
```

Figure 3-31: Deploy System – Trigger Installed

Pumping begins whether or not the WTS-LV is on station. Reconnecting the COM cable and typing [CTRL]-[C] will terminate the deployment.

Chapter 4
Mechanical Description

Frame

The WTS-LV frame is an electro-polished 316 stainless steel welded frame designed to protect the pump and provide easy access to the filter holder. CTD's, fluorometers and other sensors can also be attached to the frame.

Unless otherwise noted, the examples in this chapter are for the Standard WTS-LV model. Other WTS-LV models are described in Appendix C "WTS-LV Models", at the end of this User Manual.

Cable Clamps and Insert Sizes

Top and bottom 316 stainless steel cable clamps attach the WTS-LV frame to the wire for deployment. The clamps fasten to the wire with a threaded bolt and a T-handle nut that compress the stainless steel clamp around the wire. The bottom clamp attaches to the wire first (supporting the full system weight). The top clamp is secured second.

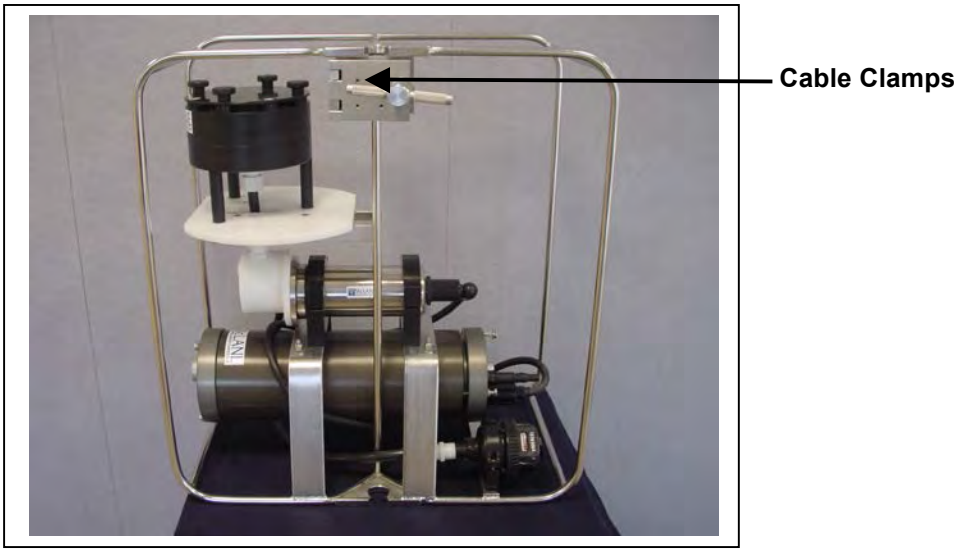

Figure 4-1: WTS-LV Full View

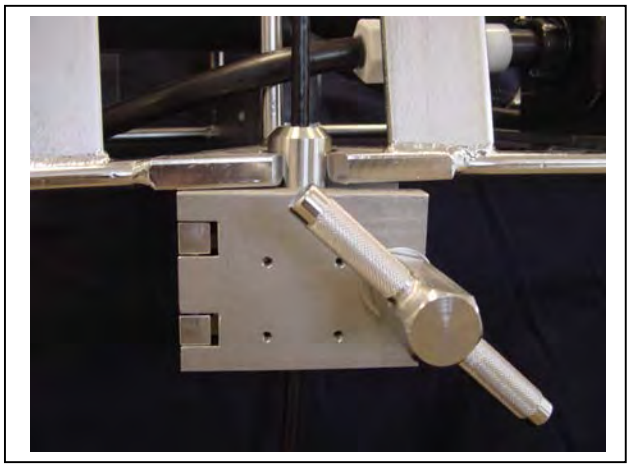

Figure 4-2: Bottom Clamp

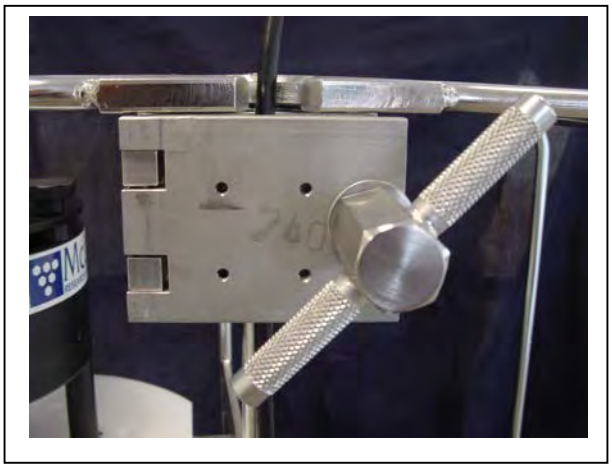

Figure 4-3: Top Clamp

Clamp Insert Sizes

Wire clamps are designed for typical jacketed wire sizes. See the table shown next for the nominal wire sizes and jacket OD. A new WTS-LV includes two sets of clamp inserts. Unless otherwise specified, 5/16” and 1/2” inserts are the sets provided with a new WTS-LV.

Wire OD (in)	1/4”	5/16”	3/8”	7/16”	1/2”	5/8”
Jacket OD (in)	5/16”	3/8”	7/16”	1/2”	9/16”	11/16”

Unless otherwise specified at the time of order, a new WTS-LV includes one set of 5/16” and one set of 1/2” wire OD inserts.

Controller Housing

The WTS-LV controller housing is a 6061-T6 aluminum housing, pressure resistant to depths of 5,500m. The controller housing holds the battery pack and electronics assembly (micro-controller, 3-phase pump motor driver and stepper motor driver). The controller housing is fastened to the frame by two latex rubber-insulated, 316 stainless steel U-bolts. Both the electronics assembly and batteries can be accessed without removing the controller housing from the frame.

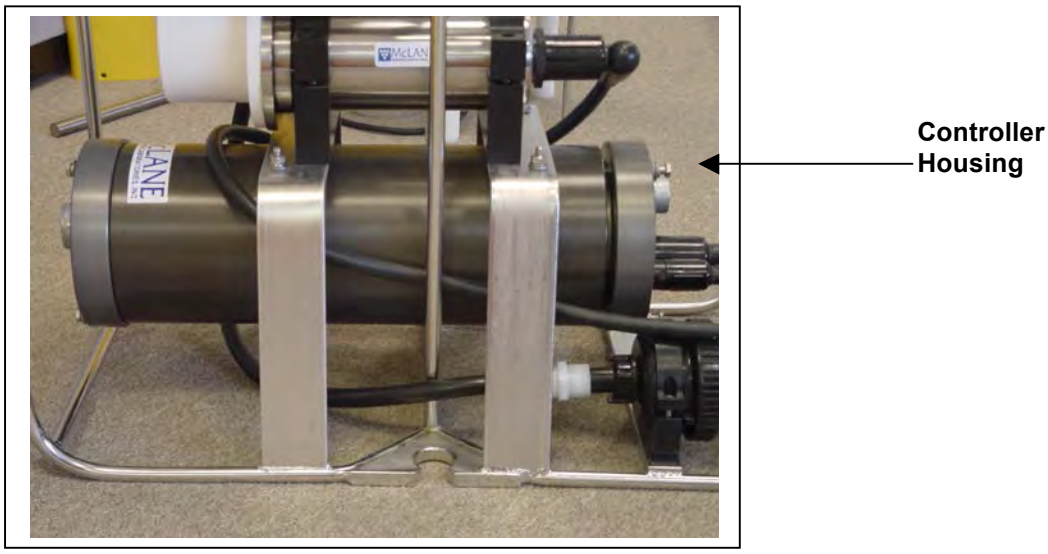

Figure 4-4: Controller Housing

Top and Bottom End Caps

Top and bottom end caps seal the controller housing from water intrusion with a face o-ring seal and a radial o-ring seal (with a backup ring). Each end cap includes two 70 durometer round section o-rings (2-246 and 2-242) and one 90 durometer backup ring (8-242).

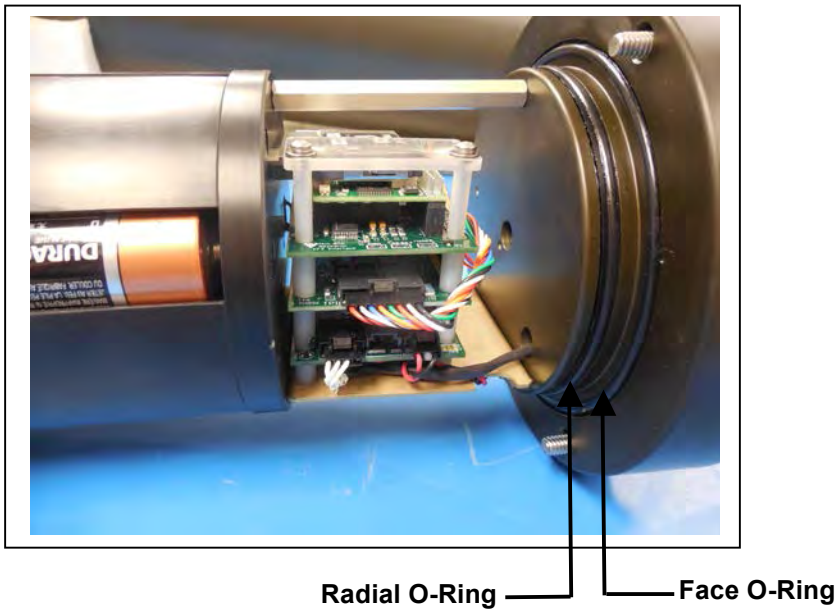

Figure 4-5: Controller Housing Top End Cap, with O-Ring Seals

O-ring maintenance is important to keep the controller housing end caps from water intrusion. See Chapter 8 “Maintenance and Storage”, for details about o-ring maintenance.

End Cap Bulkhead Connectors

The controller housing end cap has bulkhead connectors for the Pump and the COM Port. The connectors are labeled “P” (Pump) and “C” (COM Port). An optional 2-pin trigger can be installed to start a countdown timer. A zinc anode is also attached to each end cap.

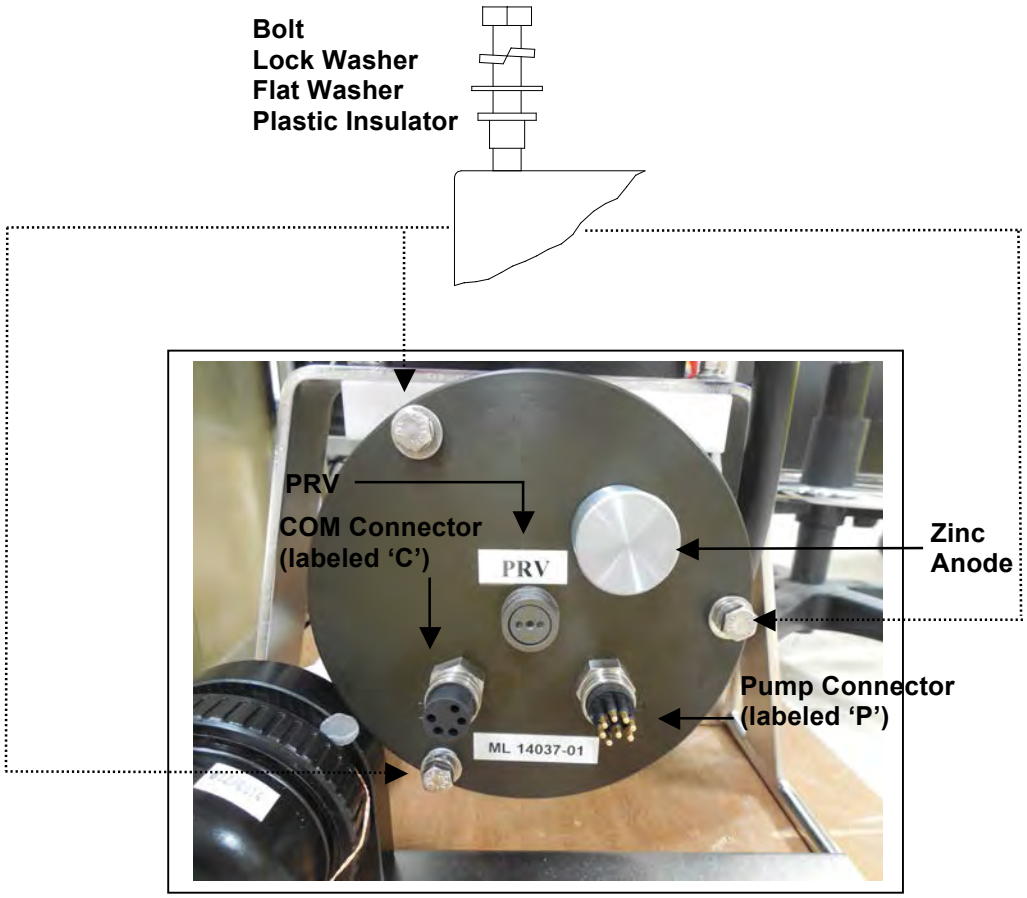

Figure 4-6: Controller Housing End Cap Bulkhead Connectors

End Cap Bolts, Plastic Inserts and Screw Holes

Three bolt/washer assemblies secure the controller housing end cap. A white plastic insert fits into the screw hole, with a flat washer, spring (lock) washer, and the bolt. Hardware is stainless steel type 316 (do not replace with any other type of material).

Do not over-tighten the end cap bolts. A 7/16” nut driver is included in the toolkit.

Pressure Relief Valve

Attention and care should be taken in maintaining, operating, and opening the pressure housing. As of Summer 2015, McLane includes pressure relief valves (PRV) on all new controller housings.

Though unlikely, an unsafe internal controller housing pressure is possible, resulting from the chemical reaction between alkaline electrolyte and anodized aluminum due to battery failure with or without the intrusion of seawater. There can be enough pressure to cause the endcap bolts to fail, especially when one or more are loosened or removed.

As with all pressure housings, special care should be taken with O-rings and associated surfaces. O-rings and surfaces should be cleaned with isopropyl alcohol. O-rings should be lubricated with provided Parker O-Lube and replaced when necessary. Spare O-rings are included in the toolkit, and more can be purchased from McLane.

The sections that follow provide procedures for opening the controller housing with the PRV installed and for detecting and relieving pressure build-up in the controller housing without the PRV installed.

Observe safety precautions including removing personnel and objects from the path of the end-cap when performing either of these procedures.

Opening a Controller Housing Equipped with the PRV

Controller housings manufactured after Summer 2015 include a Pressure Relief valve. This valve releases automatically at a pressure differential greater than 10psi. As an additional measure, the valve should be manually released prior to opening the controller housing by following the steps below.

1. Locate the threaded PRV release tool included in the toolkit.
2. Thread the PRV release tool into the center hole of the Pressure Relief valve.
3. Slowly pull the valve out to equalize pressure.

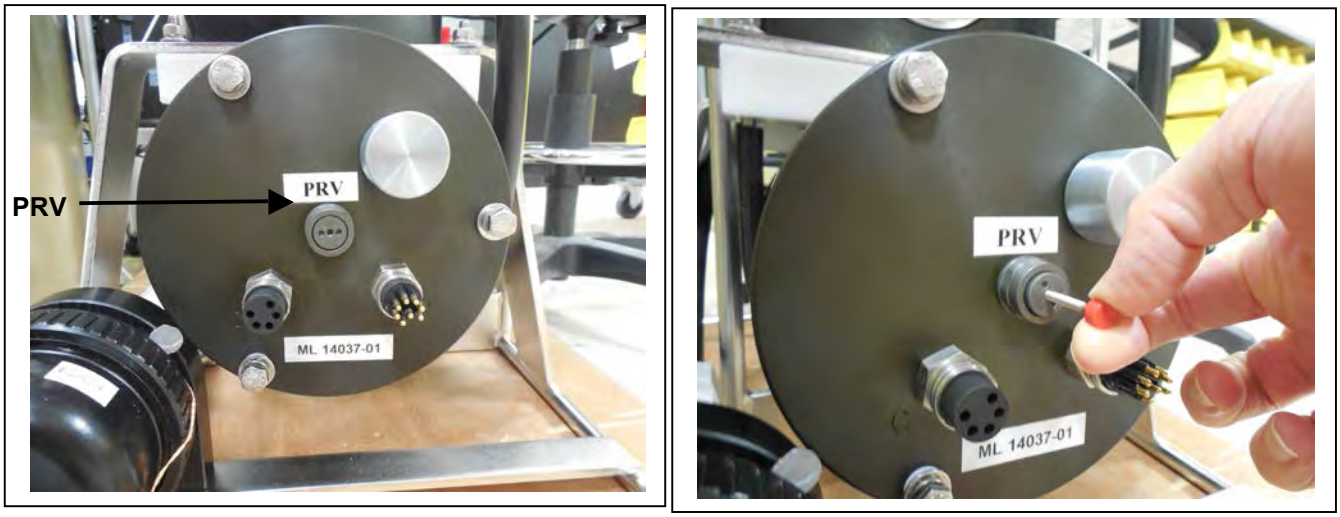

Figure 4-7: Controller End Cap, with PRV

Opening a Controller Housing not Equipped with the PRV

The procedure that follows should be used when opening a controller housing that does not have a PRV installed. Steps to detect and release a pressure build up are also provided.

1. Loosen all end cap bolts slightly. Do not completely remove the bolts.

Do not remove any individual bolts until pressure has equalized.

2. Observe whether the end cap moves once the bolts are loosened. Movement could indicate a pressure build-up inside the controller housing.
3. If a pressure build-up is suspected, loosen a bulkhead connector only one turn (do not remove the bulkhead connector) to allow the pressure to equalize.

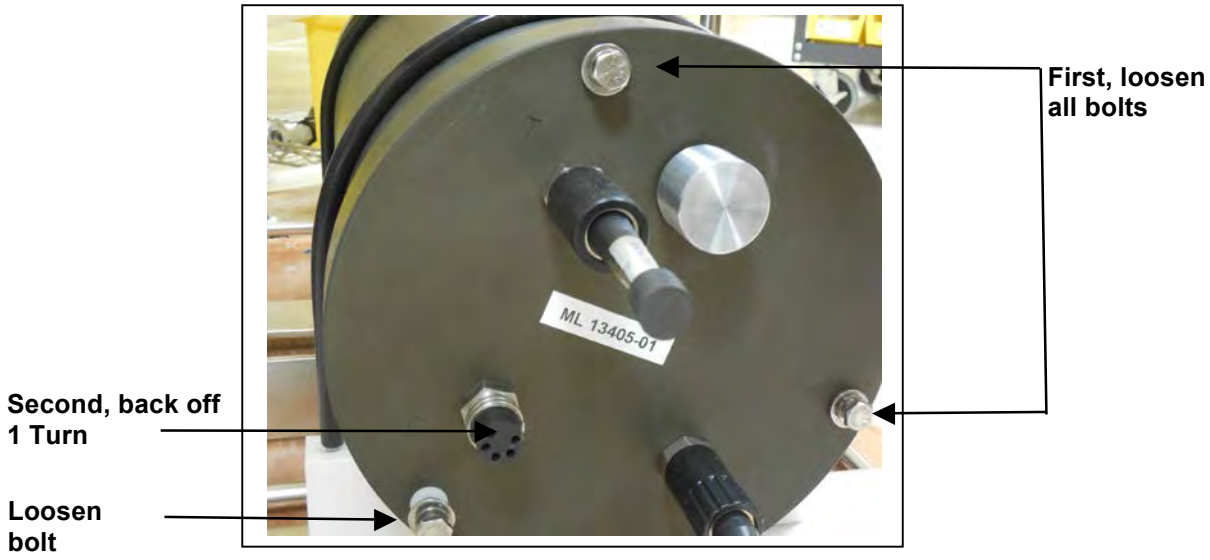

Figure 4-8: Controller End Cap, No PRV

4. Let the controller sit undisturbed to allow pressure to equalize before attempting to further loosen the end-cap bolts.

McLane offers a Pressure Relief valve upgrade retrofit for all controller housings (includes installation, not including shipping and insurance costs). The end-cap and anodizing must be in suitable condition for PRV retrofits.

Contact mclane@mclanelabs.com for more information about the retrofit.

Pump Assembly

The pump assembly (located downstream from the filter holder to prevent sample contamination) includes the 3-phase brushless DC motor and the pump head. The pump motor pressure housing is a titanium pressure housing. The pump motor is magnetically coupled to the pump head. The pump head is a dual piston, rotary design that provides accurate, even flow throughout its range. Different positive displacement pump heads can be used with the WTS-LV.

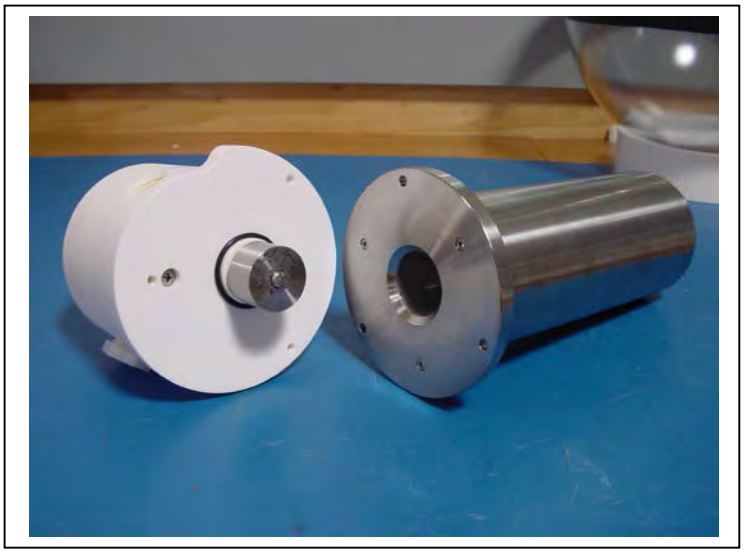

Figure 4-9: WTS-LV Pump Assembly

Properly sizing the pump head for the filter type is critical for accurate pump volume calculations. See Appendix E "Pump Head Sizing" in this User Manual for more information and contact McLane with any questions.

Depending on pump size, water is drawn through the filter holder at a flow rate between 1 and 30 liters per minute. Pump heads are made from Hydex® engineering plastic with Tectron® rotors and a ferralium shaft. A 3-phase circuit on the electronics stack uses feedback from Hall effect sensors within the motor to control pump speed. The flow rate is calculated from the motor RPM and a model of pump and motor characteristics.

Filter Holders

The standard WTS-LV 142mm filter holder is machined from black acetal stock, with large horizontal intake openings at the top for a low resistance path to the filter.

- Water flow moves through the horizontal intakes and then down through a titanium honeycomb baffle that straightens the flow and suppresses turbulence.
- The water then passes through a 316SS wire pre-filter support.
- The filter holder evenly distributes the sample flow over the entire filter surface. The filter is placed on a support frit approximately 5mm below the base of the baffle.
- Filtered water passes through the frit, down a short length of tubing, and through the pump to the exhaust port.

Filter Holder Cross-Section

The schematic below illustrates a cross section of the standard 142 mm filter holder.

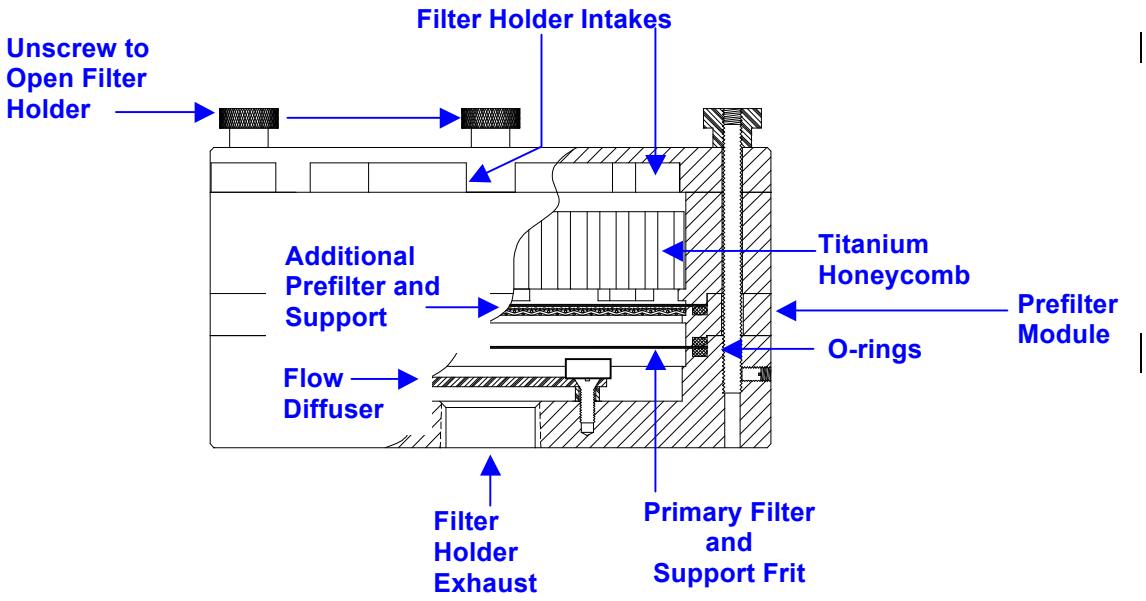

Figure 4-10: 142mm Standard Filter Holder Schematic

Additional filter holder options are described in Appendix D, "Optional Filter Holders" in this User Manual.

Flow Meter

A calibrated mechanical flow meter measures the WTS-LV pump exhaust for volume pumped. The cumulative meter reading cannot be reset. Flow meter calibration is in liters. To compare to the data recorded by the firmware, record the flow meter reading before deploying the WTS-LV and once again after recovery.

Figure 4-11: Flow Meter

Serial Number

The WTS-LV serial number is printed on a silver label and attached to the controller housing.

Figure 4-12: WTS-LV Serial Number Label

Notes

Chapter 5
Electronics Description

The WTS-LV controller electronics is a four board stack mounted on the chassis plate between the controller housing end cap and the battery holder. Each board is described below.

Board	Use
Persistor CF2 Microcontroller Board	Low power system controller and data logging.
Persistor CF2 Interface Board	Controls the signals from the Microcontroller to the AUX and Three Phase Board.
AUX Only	Powers communications.
Three Phase Board	Controls pump speed and operation.

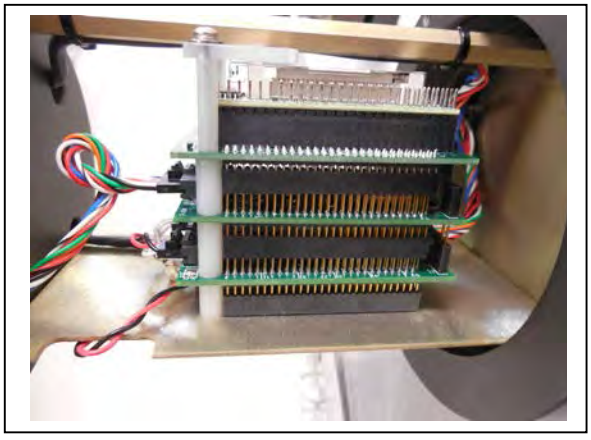

Figure 5-1: CF2 Four Board Stack

Figure 5-2: Microcontroller & Interface Board

Figure 5-3: Three Phase Board

Figure 5-4: AUX Only Board

Take standard electrostatic discharge (ESD) precautions when handling the electronics.

Battery Connection

Connecting and disconnecting the main battery is the only way to power the WTS-LV on and off. The firmware starts automatically when the main battery is connected. Two "AAA" cell backup batteries sustain non volatile controller memory in the event of a main battery failure.

- The Standard and Bore Hole WTS-LV models' main battery is a drop-in holder with 24 "D" cell batteries (10,000 mAh capacity).
- The Upright and Dual Filter WTS-LV models' main battery is a high capacity battery pack (30,000 mAh capacity).

Appendix C "WTS-LV Models" in this User Manual has more information about the 30,000 mAh A72-1000 battery pack.

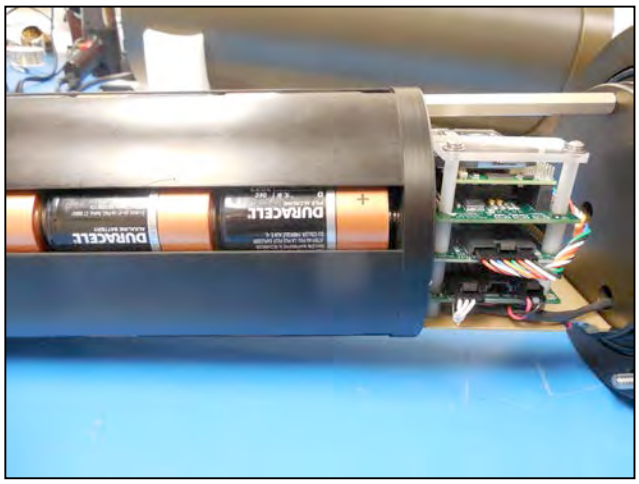

Figure 5-5: Main Battery - Standard WTS-LV

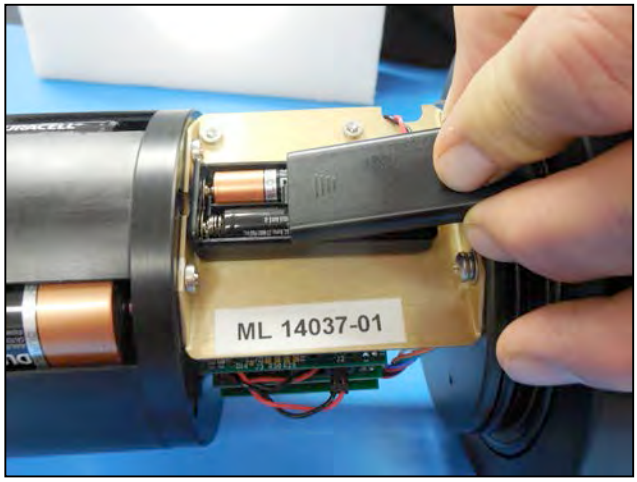

Figure 5-6: Backup Batteries

The backup batteries are required to deploy the sampler. However, these batteries will not power on the sampler.

Trigger Option

A trigger start option is included on the WTS-LV Upright and WTS-LV Dual Filter models. The trigger is available as an option on the Standard and Bore Hole WTS-LV models. The trigger allows the user to time synchronize and simultaneously deploy multiple WTS-LV samplers. During the deployment, the trigger delay count-down begins when the trigger is activated (the trigger plug is disconnected and reconnected). The wiring diagram for the trigger is included in Figure 5-6 for reference.

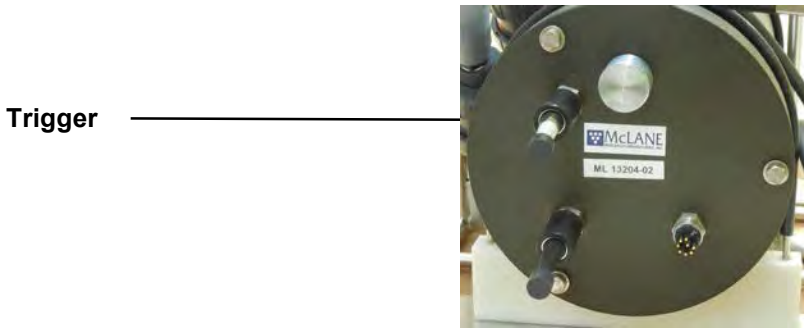

Figure 5-6: Trigger Plug

Trigger Option Wiring Diagram

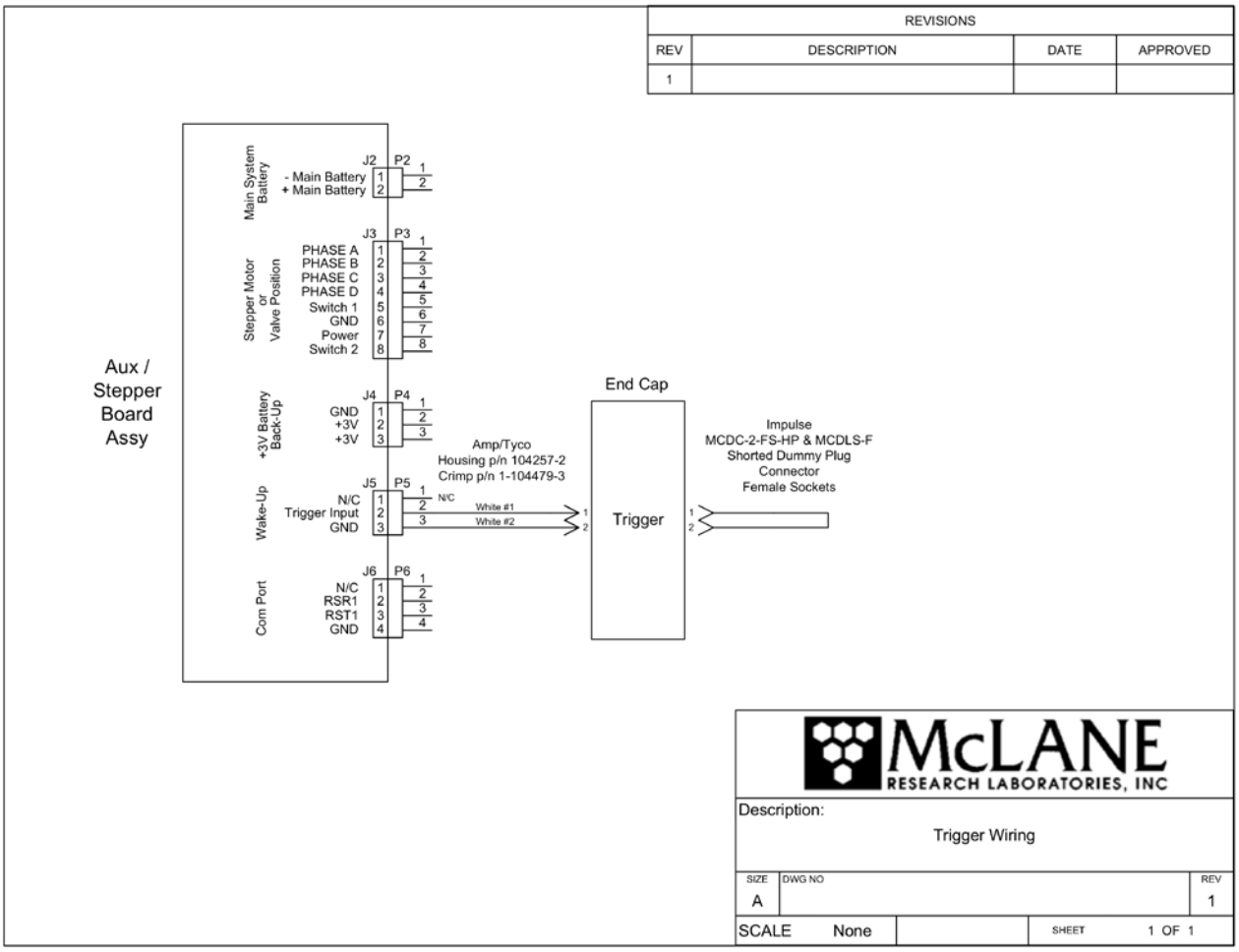

Figure 5-7: WTS-LV Trigger Wiring

Chapter 6
Operations

WTS-LV operations include pre-deployment processes such as installing the filter and pre-filter, assembling the filter holder and priming the pump. Values for pumping or moving the valve are also included in this chapter to help plan the battery life for a one-year deployment.

Priming removes any air pockets trapped in the tubing by flooding the tubing between the pump and filter holder with water. Priming steps vary according to WTS-LV model and filter holders. The sections that follow explain the recommended processes for priming the standard filter holder and the vertical intake filter holder.

Priming is a wet process. Ensure the electronics housing is sealed to keep the electronics dry.

Section 6.1
Priming with the Standard Filter Holder

For demonstration purposes, the photos in this section show the standard filter holder uninstalled from the frame. However, for priming, the filter holder should remain installed on the frame with the tubing between the filter holder and the pump connected as shown in Figure 6.1-1.

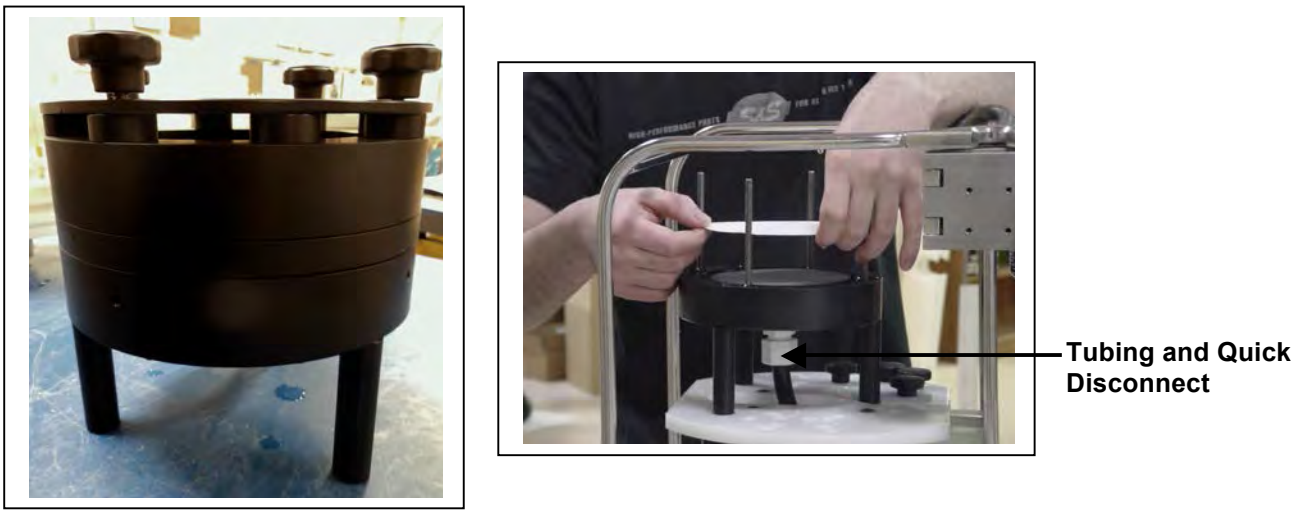

Figure 6.1-1: Standard Filter Holder

To install filters and prime with the standard filter holder, complete the following steps:

1. Leaving the filter holder on the frame, unscrew the four knurled nuts at the top of the filter assembly. Remove the filter holder top and any pre-filter plates.
2. Fill the 500mL squirt bottle included with the tool kit, with neutral water and flood the filter holder bottom plate. As the space below the frit is filled, water will puddle on the porous surface.

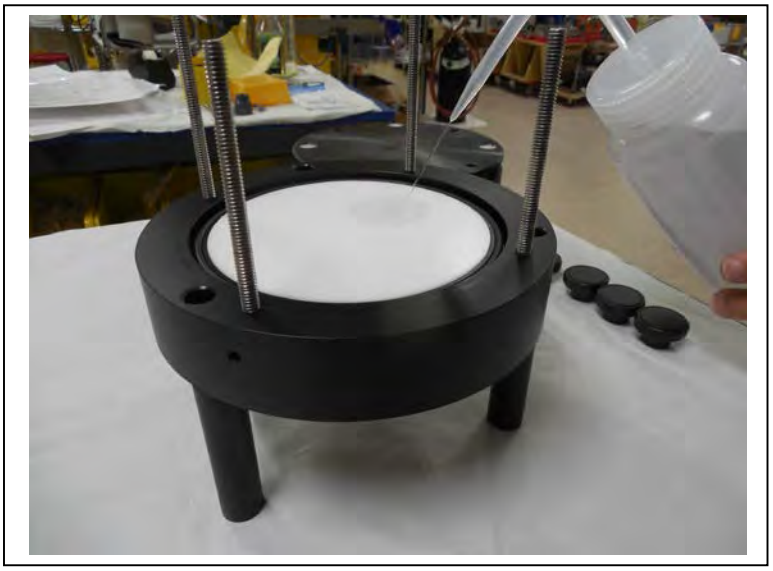

Figure 6.1-2: Wetting the Bottom Filter Holder Plate

3. Place a 142mm filter (customer supplied) onto the filter holder bottom plate.

Figure 6.1-3: Placing the Filter on the Bottom Filter Holder Plate

4. Confirm that the filter is flat and centered on the filter holder plate by gently moving the filter and pressing down lightly to displace trapped air.

5. Allow water to saturate the membrane from below and then flood the top of the filter with more water from the squirt bottle.

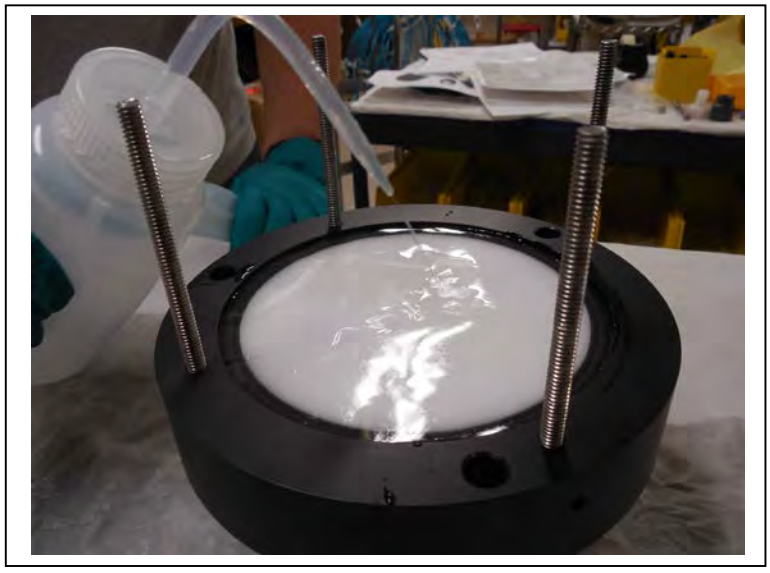

Figure 6.1-4: Soaking the Installed Filter

6. Install the pre-filter plate. Ensure that both the upper and lower o-rings are seated correctly.

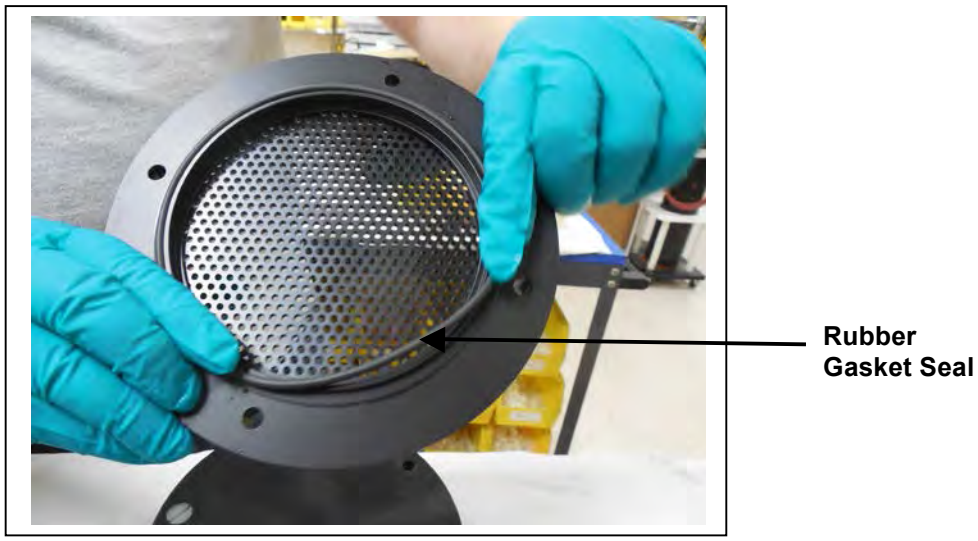

Figure 6.1-5: Seating the Pre-Filter Plate Rubber Gasket

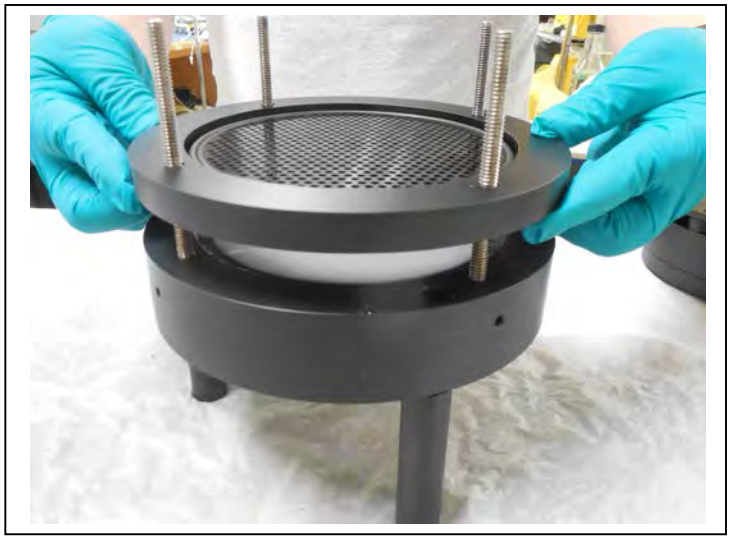

Figure 6.1-6: Placing the Pre-Filter Plate on the Filter Holder

7. Fill the pre-filter plate with neutral water until a pool forms on the plate surface.

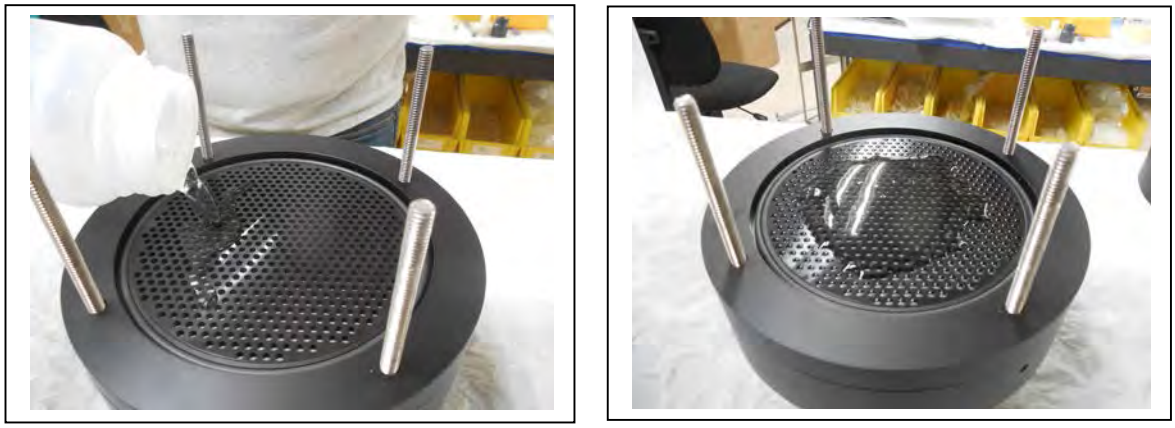

Figure 6.1-7: Fill the Pre-Filter Plate until Water Pools

8. Install a 142mm mesh pre-filter (customer supplied) and flood the top of the pre-filter with water.

9. Place the top section on the filter assembly.

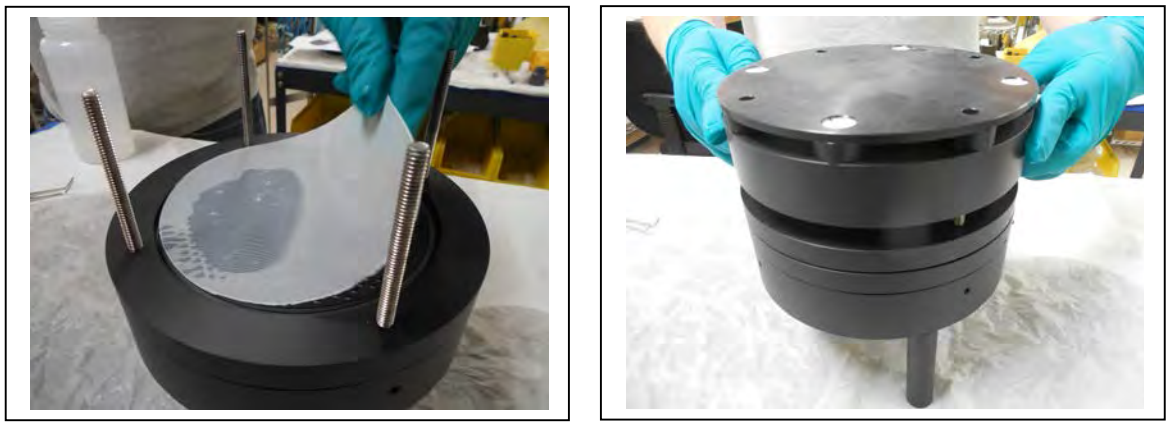

Figure 6.1-8: Install Filter and Top Section

10. Install and tighten the four knurled nuts.
11. Fill top of the filter assembly with neutral water prior to deployment.

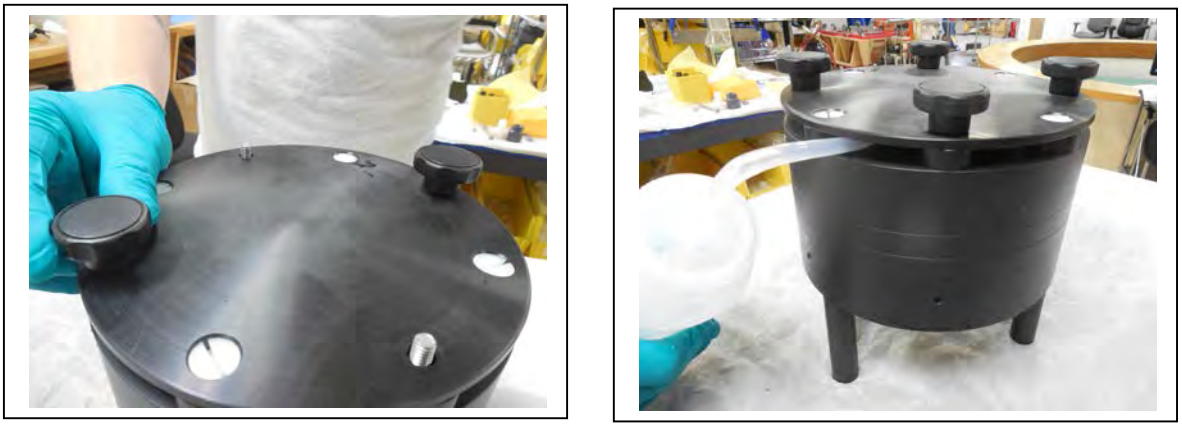

Figure 6.1-9: Tighten Nuts and Fill Assembly with Neutral Water

Correct Filter Plate Assembly

A correctly secured filter holder assembly will not have gaps between the plates. Use the knurled nuts to tighten the plates until they are closed without gaps.

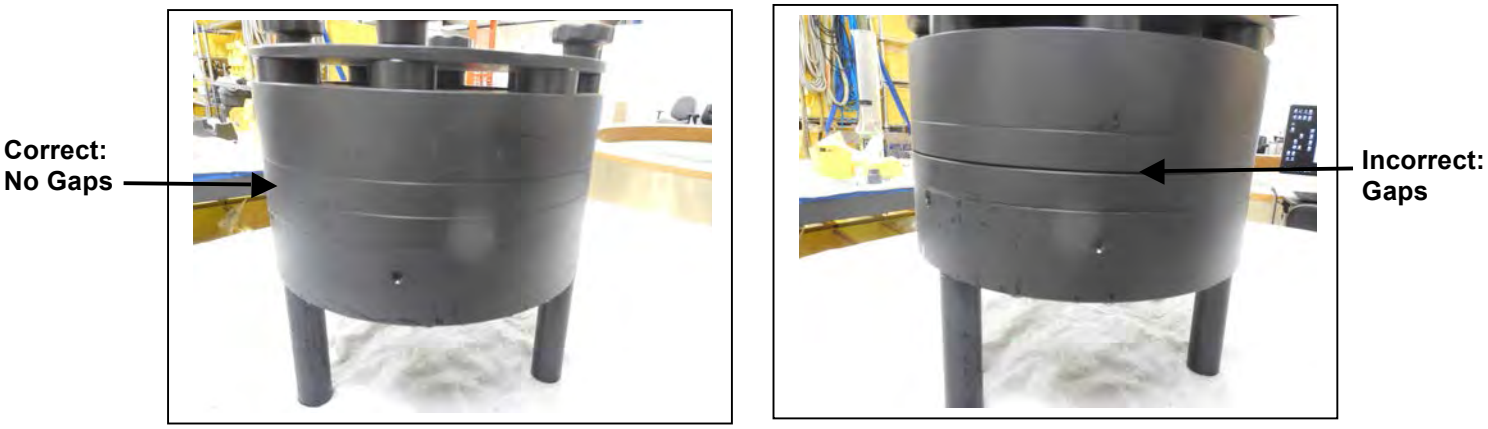

Figure 6.1-10: Correctly Closed Filter Holder *Figure 6.1-11: Incorrectly Closed Filter Holder*

Figures 6.1-10 and 6.1-11 show examples of the 3-tier filter holder. The correct assembly for the standard filter holder has one less filter holder section.

Section 6.2
Priming with Vertical Intake Filter Holder

For demonstration purposes, the photos in this section show the vertical intake filter holder uninstalled from the frame. However, for priming, the filter holder should remain installed on the frame, with the tubing between the filter holder and the pump connected as shown in Figure 6.2-1.

Figure 6.2-1: Vertical Intake Filter Holder

To install filters and prime with the vertical intake filter holder, complete the following steps:

1. Leaving the filter holder on the frame, unscrew the six wing nuts located at the top of the filter assembly. Remove the filter holder top and any pre-filter plates.

2. Fill the 500mL squirt bottle included with the tool kit with neutral water. Flood the filter holder bottom plate. Water will eventually pool on the porous surface when the space below the frit has filled completely.

Figure 6.2-2: Flood the Filter Holder Bottom Plate

3. Place a 142mm filter (customer supplied) onto the filter holder bottom plate.

4. Confirm that the filter is flat and centered on the filter holder plate by gently moving the filter and pressing down lightly to remove trapped air.

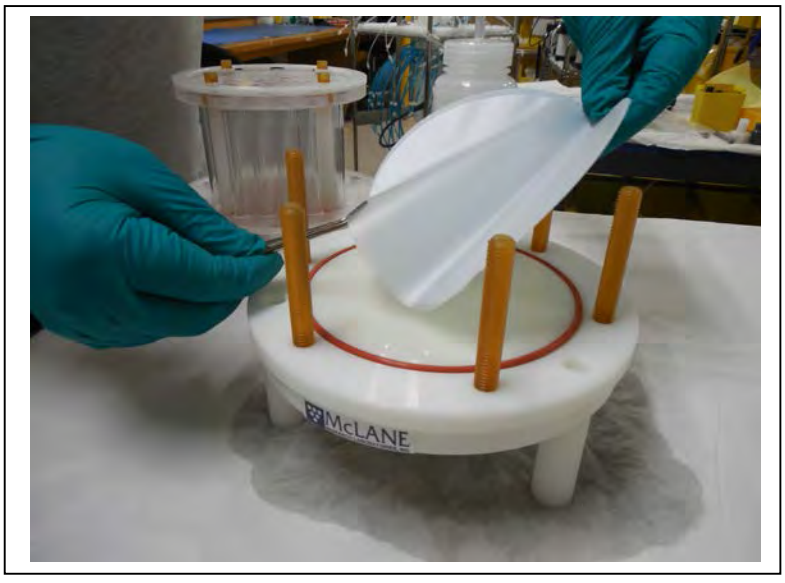

Figure 6.2-3: Placing the Filter onto the Filter Holder Plate

5. Allow water to saturate the membrane from below and then flood top of the filter with water.

6. Install the pre-filter plate. Ensure that the o-ring seal is seated in the groove.

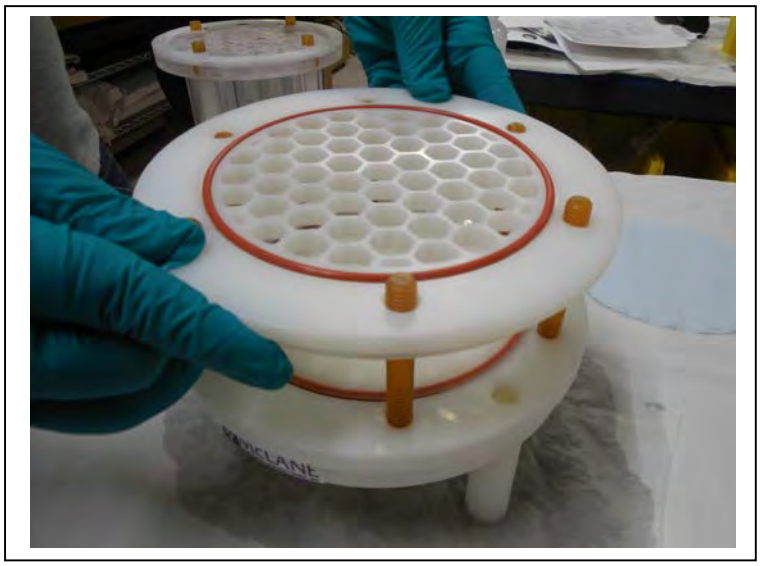

Figure 6.2-4: Installing the Pre-Filter Plate

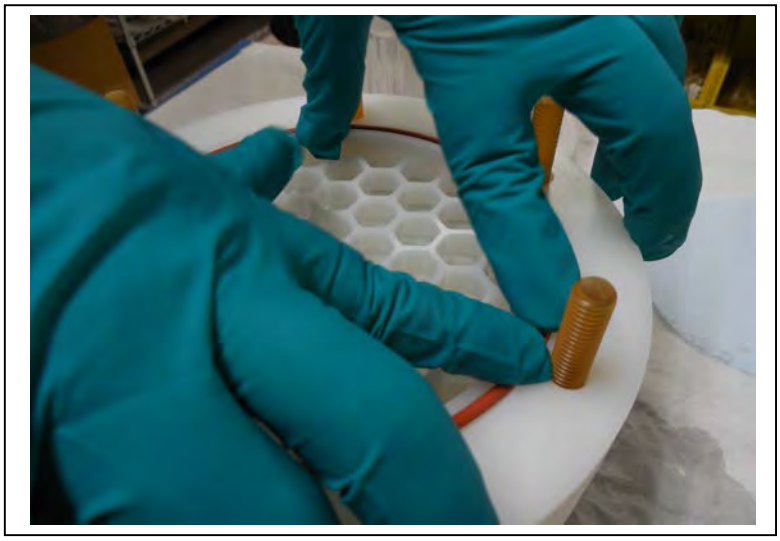

Figure 6.2-5: Secure Seal in Plate Groove

7. Install a 142mm mesh pre-filter and flood the top of the pre-filter with water. If the pre-filter is made from coarse material, it may also be necessary to install the optional gasket seal on the pre filter plate (Figure 6.2-7).

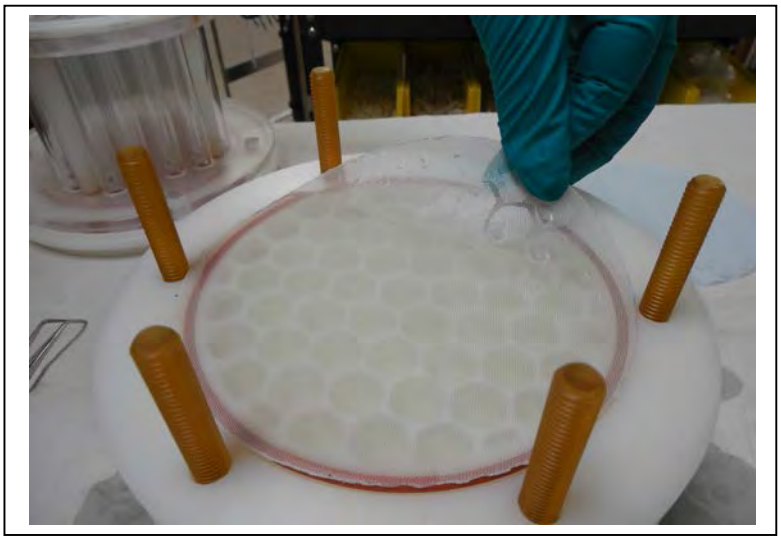

Figure 6.2-6: Installing the Pre Filter

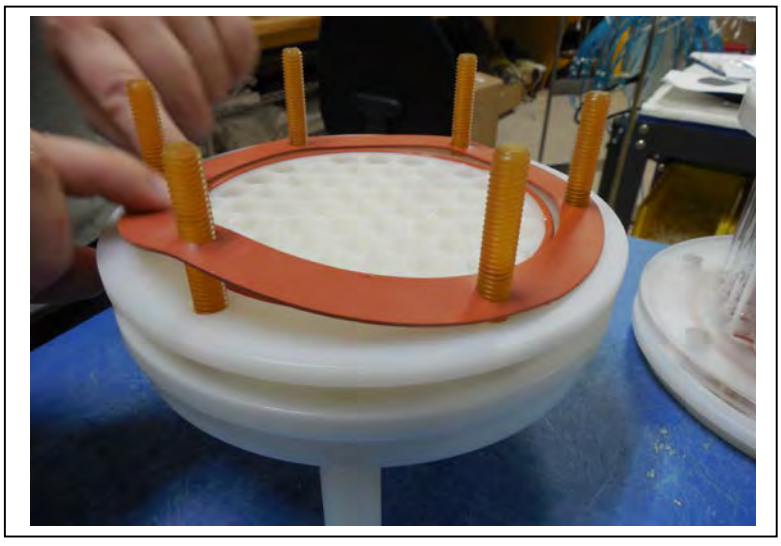

Figure 6.2-7: Installing the Optional Gasket to Seal the Pre Filter

8. Place the top section on the filter holder and evenly tighten the six wing nuts.

9. Fill the top of the filter holder with neutral water prior to deployment.

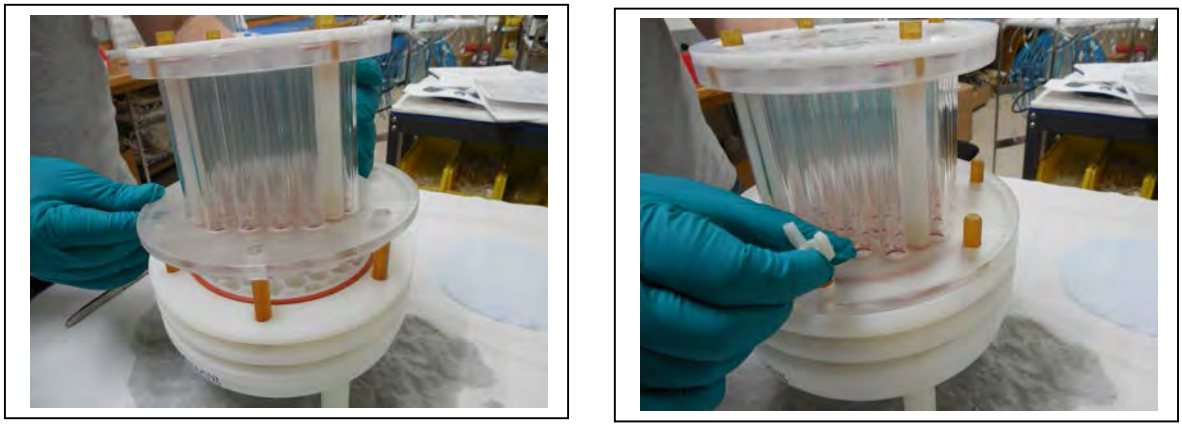

Figure 6.2-8: Install Filter Top and Tighten Wing Nuts

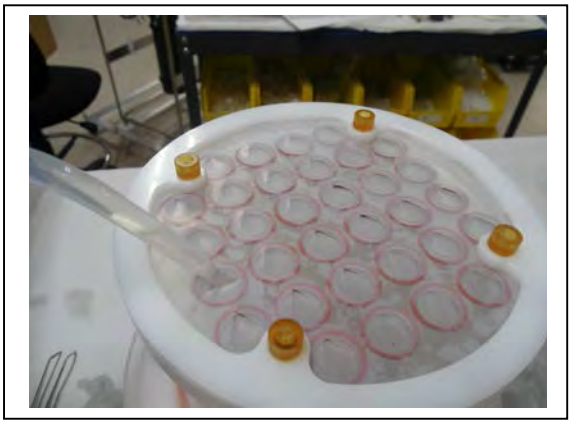

Figure 6.2-9: Fill the Filter Holder Assembly with Neutral Water

Correct Filter Plate Assembly

A correctly installed filter holder assembly will not have gaps between the plates. Use the wing nuts to tighten the plates until they are closed without gaps.

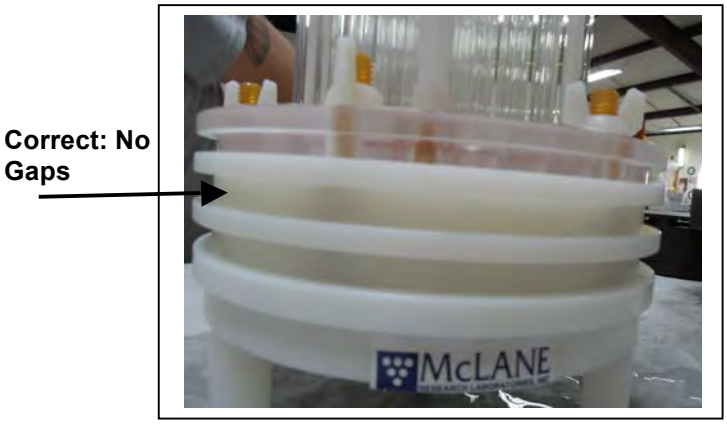

Figure 6.2-10: Correctly Closed Filter Holder

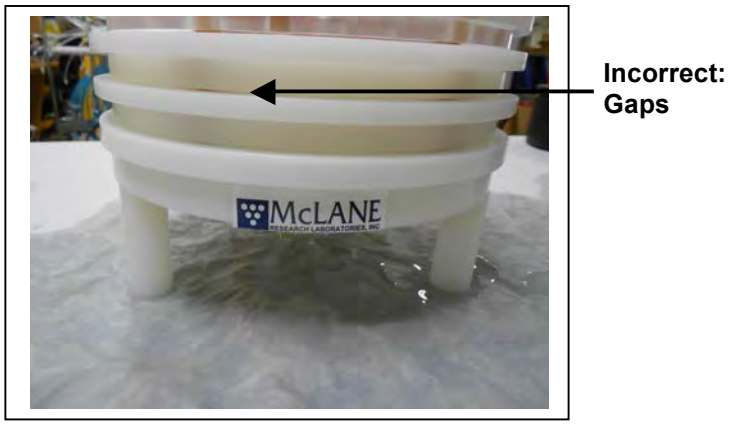

Figure 6.2-11: Incorrectly Closed Filter Holder

Section 6.3
Instrument Current Consumption

Battery life for a planned Standard WTS-LV deployment can be estimated using the instrument current consumption values provided here. These values apply to the CF2 microcontroller. An 8L/min pump operated at 7L/min is used for the example. The 24 alkaline "D" cells in the drop-in battery holder deliver approximately 10,000 mAh. In addition to pumping time, many other deployment conditions can affect the battery duration. Use this example for estimation only.

- Pre-deployment battery estimate assumes initial setup steps and does not include bench testing or running diagnostics.
- Pumping assumes unrestricted flow.

Pre-deployment	
Controller (1 hour)	1 h x 15 mA = 15 mAh
Pumping (0.2 hour)	0.2 x 750mA = 150 mAh
	Subtotal = 165 mAh
Deployment	
Controller (6 hours)	6 h x 15 mA = 90 mAh
Pumping (6 hours)	6 h x 750 mA = 4500 mAh
	Subtotal = 4590 mAh
Recovery	
Controller (1 hour)	1 h x 15 mA = 15 mAh
	Subtotal = 15 mAh
Total Current Consumption	**Total = 4,758 mAh**

This example shows that the total energy consumed is 4,758 mAh, which will not exceed the 10,000 mAh battery life.

The WTS-LV Upright and Dual Filter models' A72-1000 battery has a 30,000 mAh capacity. Use 30,000 mAh as the capacity rather than 10,000 mAh when estimating battery endurance for these WTS-LV models.

Notes

Chapter 7
Deployment and Recovery

Attaching to a Mooring

The WTS-LV can be deployed on different mooring types. As part of the mooring attachment, the WTS-LV has two clamps that attach to the wire. Two different insert sizes are included with a new WTS-LV. See Chapter 4, "Mechanical Description" in this User Manual for information about clamp insert sizes. Once sampling is complete, the recovery process includes removing the filter and offloading deployment data.

Deployment Preparation

After the filters are installed, deploying the WTS-LV requires the following (in order):

- Connect the battery and close the end cap (see chapter 4 and 5 for details about the end cap and battery installation).
- Connect the COM cable and confirm firmware deployment settings (see chapter 3 for details about programming the deployment).
- Disconnect the COM cable and attach the dummy plug.
- Attach the WTS-LV clamps to the wire.
- Deploy the WTS-LV.

Attaching the WTS-LV Clamps to the Wire

As shown below, the WTS-LV has two cable clamps that are designed for fast and easy attachment to and from oceanographic wires. The bottom clamp attaches to the wire first (supporting the full system weight) and the top clamp (which is permanently attached to the frame) is secured second.

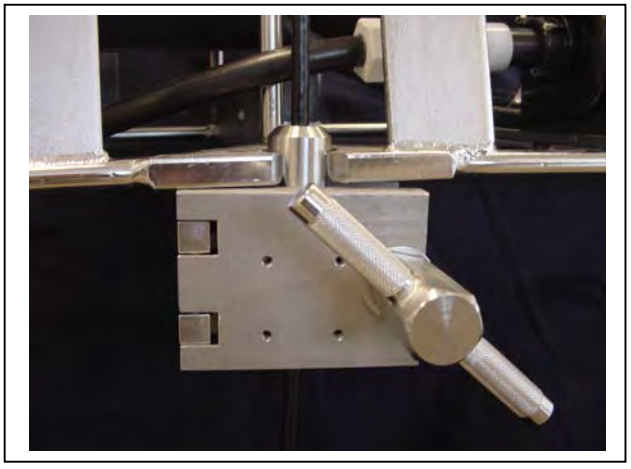

Figure 7-1: Bottom Clamp

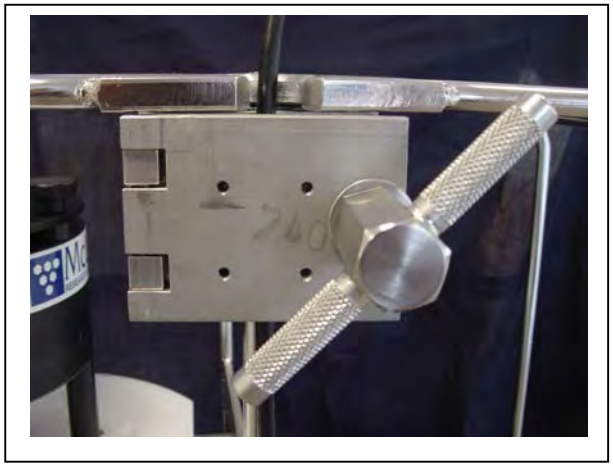

Figure 7-2: Top Clamp

Attach the WTS-LV to the wire by completing the following steps:

1. Secure the pin clamp around the wire and tighten the T-nut until the clamp is fastened (the pin should face pointing up, see Figure 7-1).
2. Slide the WTS-LV frame down onto the pin clamp placing the hole at the bottom of the frame onto the pin clamp.
3. Secure the top clamp to the wire confirming that the wire is taught between the top and bottom clamps (see Figure 7-2).
4. Confirm that both clamps are well tightened (a shackle can be placed around the deployment cable and connected to the WTS-LV with a short cable bridle as a safety wire).
5. Deploy the WTS-LV.

To ensure that the exhaust lines are completely wet, allow the instrument to flood near the surface for a few minutes before deploying to the target depth.

Recovery Procedure

Post-recovery steps include the following:

- Offload the deployment data.
- Remove the filter.

Removing the Standard Filter

To remove the standard WTS-LV filter, complete the following steps:

1. Power on the computer, plug the COM cable into the computer serial port, and then connect the COM cable to the controller housing.
2. Select <3> ‘Run Pump’ from the WTS-LV Main menu.
3. Select <1> ‘Run pump: forward’ from the Manual Operation menu.
4. To remove standing water from the filter holder run the pump at the minimum flow rate for 3-5 seconds and press [CTRL]-[C] to stop pumping when the standing water is gone.

5. Disconnect the tubing from the filter holder and unscrew the three large black screws under the filter holder plate.
6. Move the entire filter holder to a protected location.
7. Unscrew the four knurled nuts and remove the filter holder top.
8. Remove the 142 mm filter and store/secure as necessary for analysis.
9. Replace the top section of the filter holder and secure it with the knurled nuts.
10. Place the filter holder back onto its plate and install the three large black screws.
11. Reconnect the tubing to the filter holder.
12. If the WTS-LV is not being immediately redeployed, perform any necessary maintenance as described in this User Manual in Chapter 8, "Maintenance and Storage".

Offloading Data

Once the steps are completed to recover the WTS-LV, and the filter is removed, data can be offloaded. This section contains instructions for running the data offload. The deployment data will display on screen and a log file can be created for use in analysis.

After running the Offload Data option, confirm that the data is successfully offloaded by checking the capture files before disconnecting the battery (data is erased when the battery is disconnected).

Before offloading data, see post-deployment steps in Chapter 6 "Operations". To use the Offload Data option, complete the following steps:

1. Start Motocross on the host computer (see Chapter 2 in this User Manual for Terminal emulation details).
2. Within Motocross, specify a "Capture file" for the offloaded data.
3. If necessary, turn the capture On.
4. Connect the COM cable to the computer and then connect the COM cable to the WTS-LV.

The computer should be on and Motocross running before connecting to the WTS-LV electronics.

5. From the Offload/Display Data File menu select .
6. From the Offload/Display Data File menu, select <1> Display ALL data. The screen shown next displays.

```
_____________________________________________________________________
Configuration: LV-04M_TR                CF2 V2_07 of Jan 15 2015
                 ___________________________________
                     Offload/Display Data File
                 ___________________________________
                     Tue Mar 17 10:51:41 2015

       <1> Display ALL data
       <2> Display event summary data
       <3> Display pump data
       <4> EEPROM data backup cache

       <M> Main Menu

         Selection  [˘] ? 1
```

Figure 7-3: Offload/Display Data File Menu

The screens that follow show Option <1> 'Display All Data'.

7. Press any key to offload the data and display to the screen (the data is saved to the Capture filename specified in Step 2). An example data offload file is shown next.

```
HEADER


______

Bench Test, 3-17-2015
s/n 13344-01
FJH

Sample volume:           160 liters
Initial flow rate:      4000 ml/min
Minimum flow rate:      1000 ml/min
Time limit:              161 minutes
Pump data period:          1 minutes
Trigger delay:      00:05:00  [HH:MM:SS]

DEPLOYMENT DATA
_______________

Event start:  03/17/15 09:55:26   35.5 Vb   25 ∞C
 159.99 L delivered in 3354 seconds : Volume reached

Event end:    03/17/15 10:51:20   32.8 Vb   26 ∞C
Normal shutdown.

PUMPING DATA
____________

Sample interval = 1 [minutes]

   [L/min]    [liters]   [Vbat]
      3.99        2.77    33.3
      3.99        5.63    33.2
      4.01        8.50    33.1
      3.99       11.37    32.9
      3.99       14.23    32.9
      3.99       17.10    32.8
      3.99       19.96    32.7
      4.01       22.83    32.6
. . .  <-- Display shortened to save space
      3.99      148.87    31.4
      3.99      151.74    31.4
      3.99      154.60    31.4
      3.99      157.47    31.3

Lowest battery voltage measured while under load: 31.3
```

Figure 7-4: Offload/Display Data File Menu Example

8. After the data is offloaded, stop the Motocross file capture.

The Offload option can be repeated if necessary (the data file remains in memory until a new deployment schedule is created or the batteries are disconnected)..

9. From the Main menu, select <4>, Sleep, to put the system into Suspend mode.
10. Disconnect the COM cable from the WTS-controller and reinstall the dummy plug.

Chapter 8
Maintenance and Storage

Several maintenance procedures before and after each deployment provide smooth operation and long instrument life for the WTS-LV. Rinsing the entire instrument assembly with clean fresh water after every deployment is critical to prevent corrosion. Before and after each deployment, inspect the system for any worn or damaged components. Check the condition of the o-rings, cables, connectors, tubing and fasteners.

Cleaning and Inspecting the Controller Housing

Before every deployment, inspect, and if necessary, replace the zinc anodes attached to the controller housing end caps. When installing new zinc anodes, use 316 stainless steel hardware and include the o-ring.

Keep hard objects such as tools or shackles away from the anodized controller housing. Scratches from these objects will localize galvanic action and can cause deep crevices or pitting.

O-Ring Maintenance

Both ends of the WTS-LV controller housing have a set of o-rings in the end cap. Each set includes three o-rings. O-rings must be installed properly and kept in place at all times:

- Face O-ring (2-244 70 durometer, BUNA-N)
- Radial O-ring (2-240, 70 durometer, BUNA-N)
- Backup ring: (8-240, 90 durometer, BUNA-N)

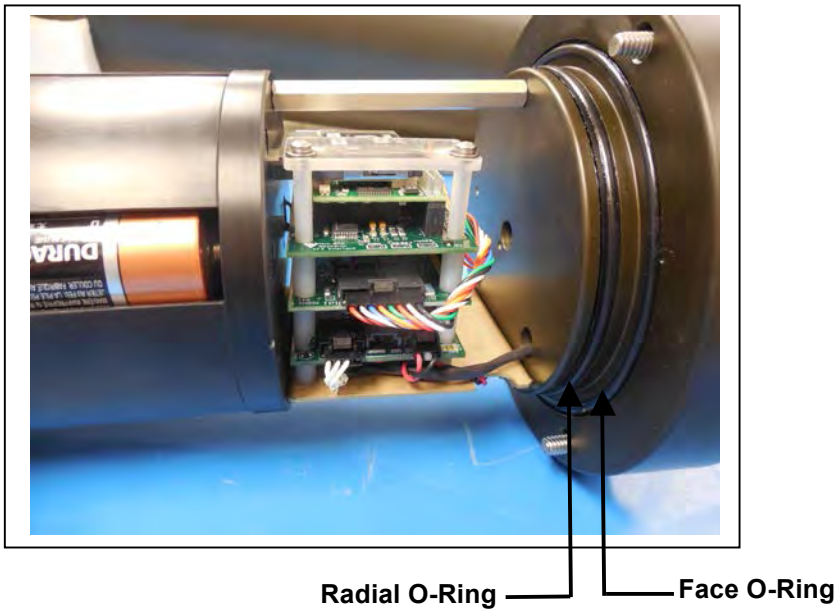

Figure 8-1: Controller Housing Top End Cap with O-Ring Seals

Positioning the larger o-ring (2-244) in the axial groove provides a seal against the face end of the pressure housing. Fit the smaller o-ring (2-240) and the backup ring (8-240) in the radial groove. Position the backup ring on the low pressure side of the radial groove (toward the interior of the controller housing). The backup ring concave side faces toward the round o-ring. The accompanying o-ring is seated on the concave side (high pressure side) of the backup ring.

Inspect o-rings for signs of wear and the presence of any foreign material (which can cause leaks). Look for small cracks and feel for grit, sand, or hair. O-rings should be cleaned with alcohol and lubricated with a thin coating of o-ring grease as necessary.

When inserting the end cap into the controller housing, ensure that the face o-ring remains seated in its groove and that the radial o-rings enter the housing uniformly without pinching.

Cleaning the Filter Holder

Before and after deployment, thoroughly clean the filter holder with a non-abrasive cleaner. For cleaning, the filter holder must be removed from the frame and disassembled.

Do not grease the filter holder o-rings or the sample could be contaminatated. The filter holder uses Viton Fluorpolymer o-rings which do not require lubrication.

Flushing the Pump Head

Option <2> from the Manual Operations menu provides a way to flush the pump head interior with fresh water. Flushing the pump head after every deployment can prevent salt crystal formation. To flush the pump head, complete the following steps:

1. Connect the plastic tubing (provided in the toolkit) to the pump exhaust port.
2. Place the free end of the tubing in a reservoir of fresh, clean water. Optionally, a mild detergent solution can be used for a first flush followed by a clean water flush.
3. Remove the filter holder.
4. Select <2> Run pump: reverse from the Manual Operation menu.
5. Reverse pump five liters of fresh water to clear the pump head of salt water.

Battery Maintenance

The WTS-LV includes a main battery and backup battery. The main and backup batteries are required to deploy the WTS-LV. An instructional video showing battery replacement is located on the WTS-LV product video page at www.mclanelabs.com. Before replacing the batteries, offload all data. Disconnecting the main and backup batteries erases all deployment data stored in memory.

Figure 8-2: Battery Orientation in Holder

Battery Replacement

Selecting <2> 'Diagnostics' from the Main Menu displays the no-load battery voltage, and a warning message if the battery is below 28 volts. Replace a battery below 28 volts before a deployment.

Be sure to install the main and backup batteries with the correct orientation in the holder terminals. See the WTS-LV product page at www.mclanelabs.com for a video that demonstrates battery replacement.

Storage

The shipping crate is a reusable international freight container that is ISPM-15 compliant for international transport.

To prevent instument damage during transport or storage, avoid excessive vibration and extreme temperatures for prolonged periods of time.

There are several procedures to complete before packing the WTS-LV in the crate for storage longer than one month:

- Offload all data from memory.
- Rinse all instrument components with fresh water.
- Disassemble and rinse the filter holder.
- Remove the main and backup batteries.
- Clean and grease controller end cap o-rings.
- Reassemble the main battery holder and insert the electronics package back into the controller housing.

Notes

Appendix A
Quick Reference to Sampling Parameters

WTS-LV Sampling Parameters - Quick Reference

Header: Three lines of text (up to 65 characters per line) can be entered as a file header and offloaded with the data. The header could be project name, deployment location or instrument number.

Sample Volume: The amount of water to be filtered before the pump stops.

Initial Flow Rate: The target flow rate. The pump will attempt to achieve this flow rate.

Minimum Flow Rate: If the flow rate drops below this value, the pump stops.

Time Limit: The maximum time limit before pumping stops. The minimum and maximum allowed values depend on the selected sample volume and the maximum and minimum flow rates. Time limit defaults to its maximum value. Smaller value can be set to establish time rather than volume control.

Pump Data Period: The sampling period of pump flow rates and volumes stored during each event. These samples are logged in the system data file.

Trigger Delay: If the trigger option is installed, this is the time delay for the trigger to start. This option allows for time synchronizing multiple instruments.

Count-down Timer: The delay from the time the operator commits to the deployment until the pumping starts. If a scheduled start has been chosen, the scheduled start date and time would be displayed and would be available to change.

Notes

Appendix B
Training Videos

There is a priming and pre-deployment training video available for the RAS. This video is included on the media that ships with a new sampler and can also be downloaded from the McLane website at:

http://www.mclanelabs.com/product-type/samplers/wts-lv-video

A description of each video and content is provided below for reference.

Video	Content
WTS-LV Battery Video	Replacing the Standard WTS-LV battery holder.
WTS-LV (Large Volume Pump) Battery Unit Change	Changing the battery unit on a Standard WTS-LV.
WTS-LV (Large Volume Pump) Deployment Preparation	Replacing the battery on the Standard WTS-LV, changing a filter, removing the filter holder unit, connecting to a computer.

Notes

Appendix C
WTS-LV Models

This Appendix explains the non-standard WTS-LV sampler models.

Contents	
Section	**Sensor**
C.1	Dual Filter Model
C.2	Upright Model
C.3	Bore Hole Model

Notes

Section C.1
WTS-LV Dual Filter Model

The dual filter WTS-LV model (WTS-LVDF) features two vertical intake 142 mm filter holders that allow for simultaneous, independent sampling within the same water mass. The LVDF model is designed for applications that require sampling of very large water volumes in order to capture sufficient amounts of trace elements, suspended metals or other particulate matter. The vertical intake filter holder follows a modular design and functions as an optional replacement for the standard radial intake filter holder in traditional WTS-LV and Upright LV systems.

The vertical intake filter holder incorporates increased internal baffling in order to mitigate losses of large particles during handling and recovery of the instrument. The ability to utilize two different filter porosities during a single deployment allows for greater sampling flexibility and may increase overall volume capacity when compared to single filter designs. Other features include:

- A72-1000 battery pack (30,000 mAh), which provides three times the battery capacity of the standard WTS-LV.
- Trigger start to time synchronize and simultaneously deploy multiple instruments.
- Independently metered flow circuits plus metered "total output" at exhaust.

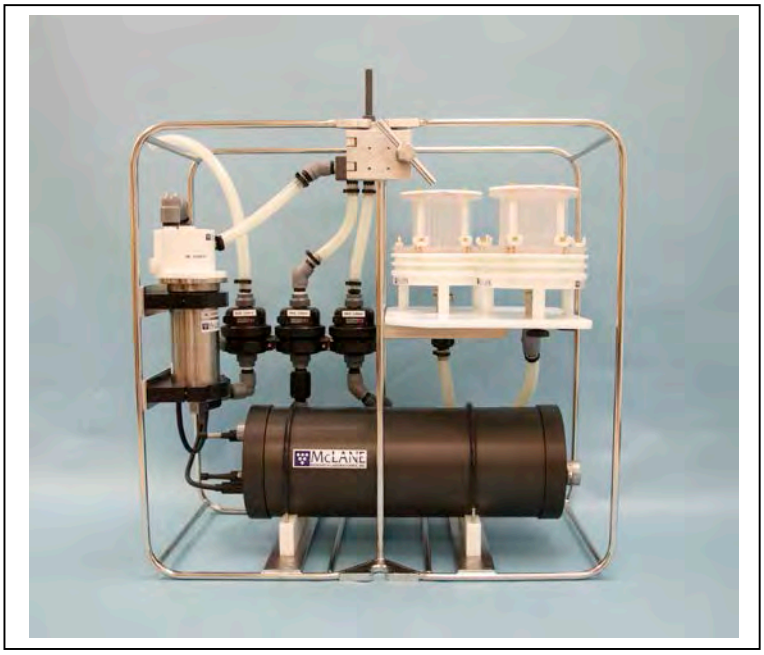

Figure C.1-1: WTS-LV Dual Filter Model

Section C.1.1
Specifications

WTS-LV Dual Filter Model Dimensions

The WTS-LV Dual Filter instrument dimensions are as follows:

Length (body)	79 cm (31.25 in)
Width	38 cm (15 in)
Height	74.9 cm (29.5 in)

Filter Porosity

The WTS-LVDF is calibrated to perform optionally with membrane filters ranging from 0.22 μM to 3.00 μM or greater porosity. A cross section of the filter holder is shown next.

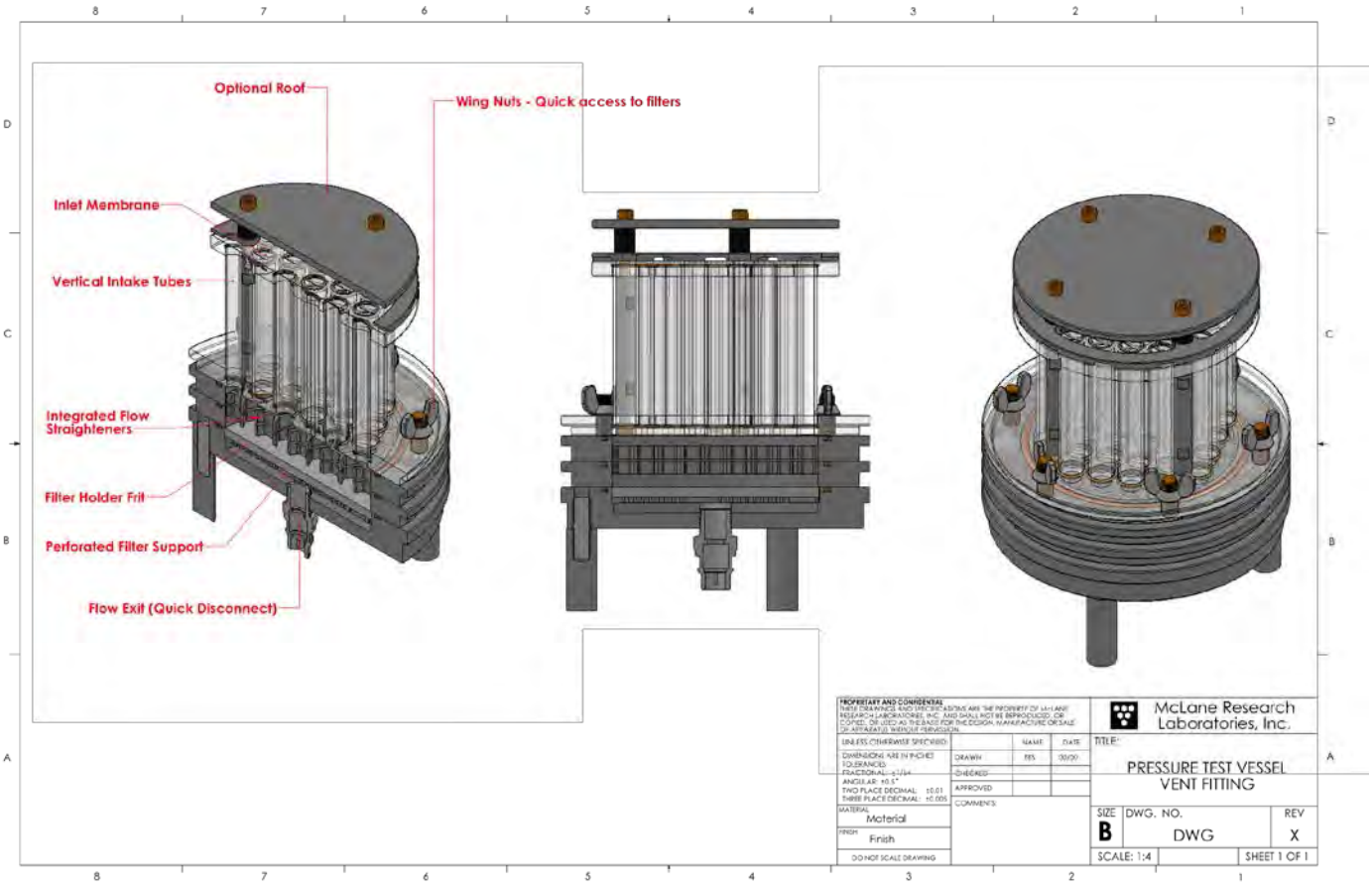

Figure C.1.1-1: WTSLV-DF Filter Holder Cross Section

The diagram shown next illustrates the intake flow path.

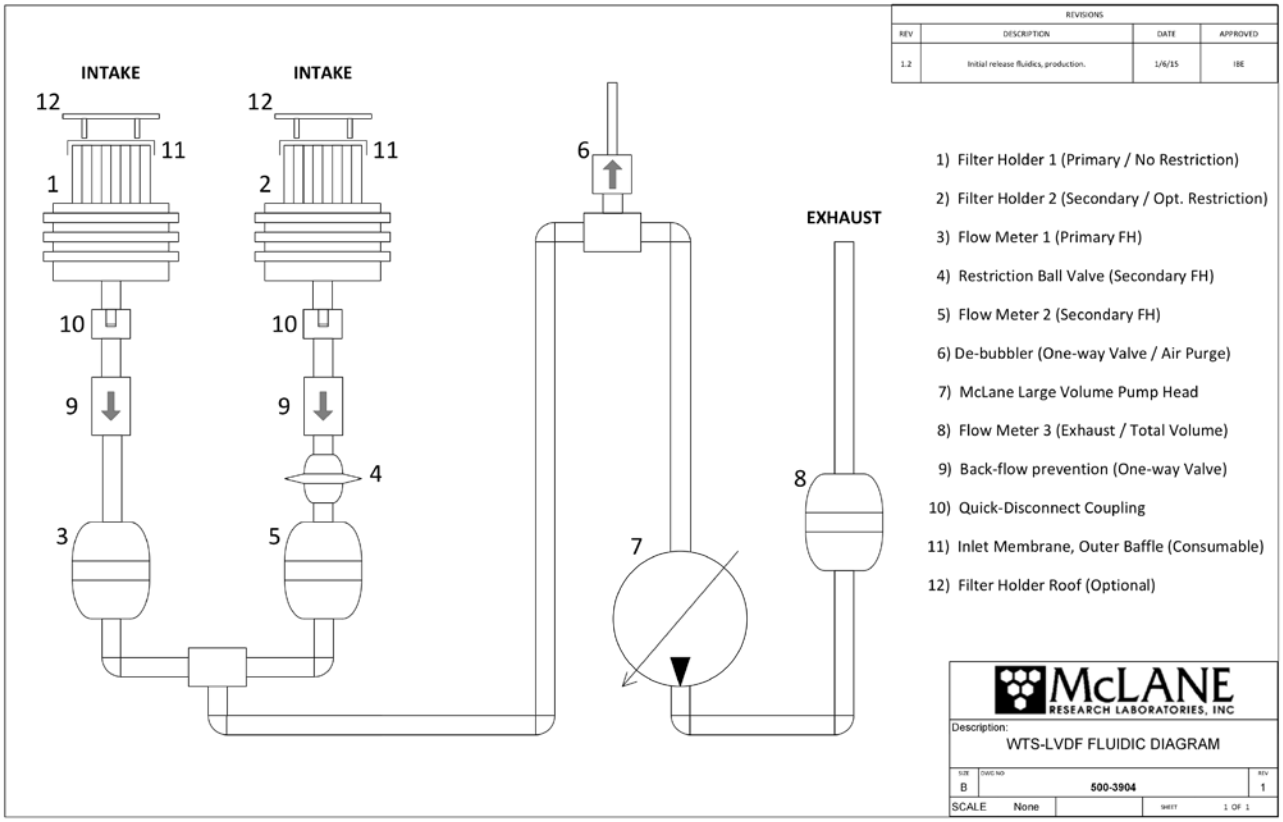

Figure C.1.1-2: WTSLV-DF Fluidic Diagram

Section C.1.2
WTS-LVDF Operations

The WTS-LVDF vertical intake filter holder is interchangeable with the traditional radial intake on standard WTS-LV systems. To operate the WTS-LVDF as a single filter sampler, turn the red flow valve counterclockwise. Figures C.2-1 and C.2-2 show the flow valve positions for single and dual filter sampling.

Figure C.1.2-1: Valve Closed

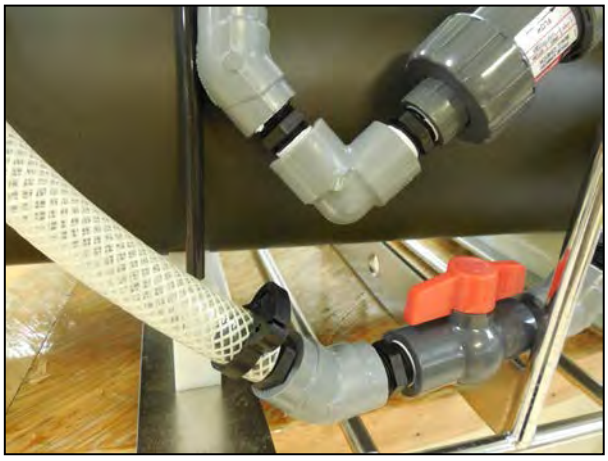

Figure C.1.2-2: Valve Open

The WTS-LVDF includes a Trigger Start option. For details see Chapter 5 "Electronics Description" and Chapter 6 " Operations", in this User Manual.

Removing Filter Holders

The WTS-LVDF ships with filter holders installed. To remove either filter holder, complete the following steps:

1. Remove each of the three thumb screws at the bottom of the filter holder plate.
2. Press to release the quick disconnect fitting from below the filter holder.

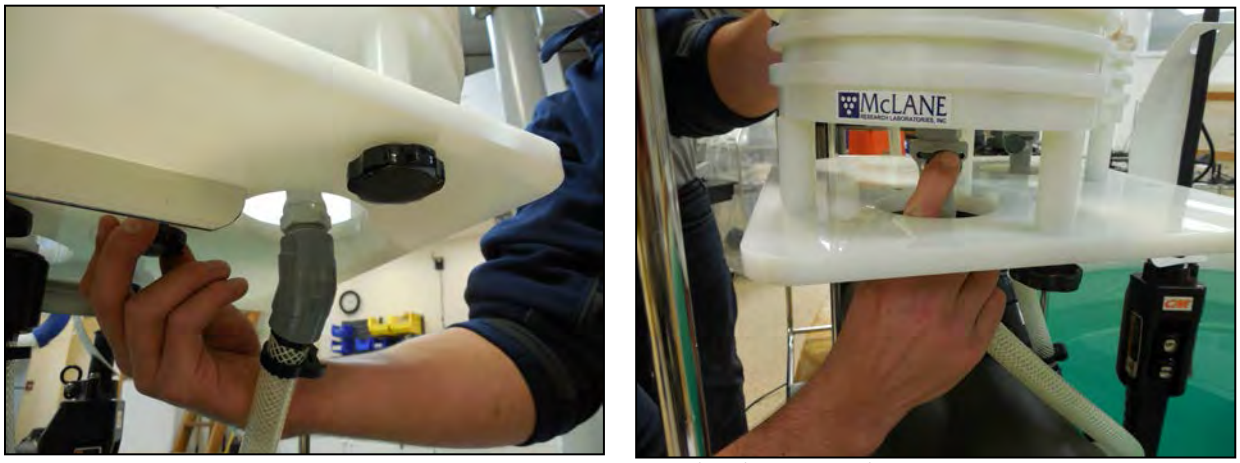

Figure C.1.2-3: Remove Nuts and Release Quick Disconnect

3. Gently lift the filter holder from the filter holder plate and remove filter holder unit from connector.

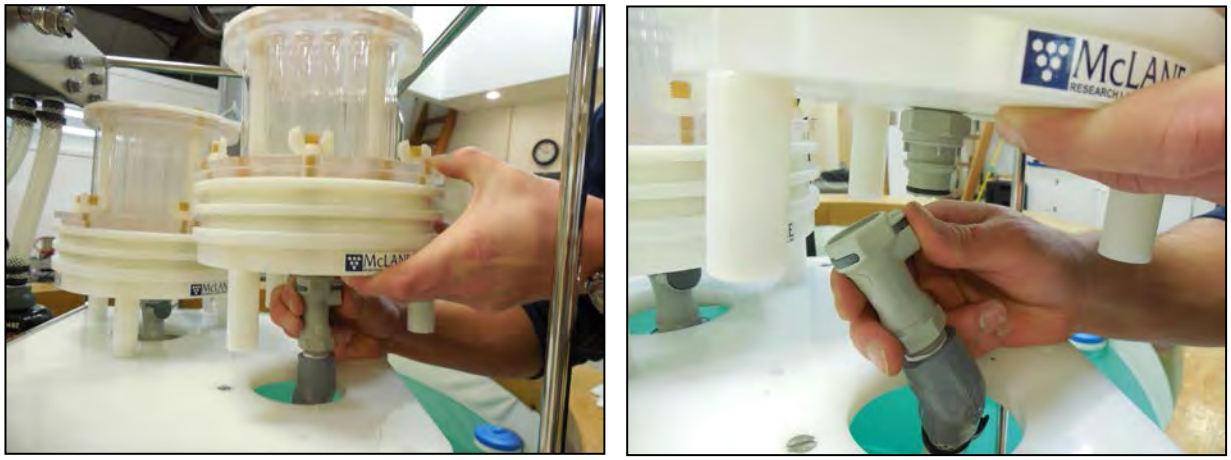

Figure C.1.2-4: Lifting Filter Holder off of Plate

Installing Filter Holders

To install either filter holder, complete the following steps:

1. Place the filter holder over the filter holder plate and push the connecter onto the quick disconnect.

Figure C.1.2-5: Securing Filter Holder to Quick Disconnect

2. Secure the three thumb screws through the filter holder plate up into the filter holder legs.
3. Confirm that the red flow valve is correctly set for either single or dual filtering.

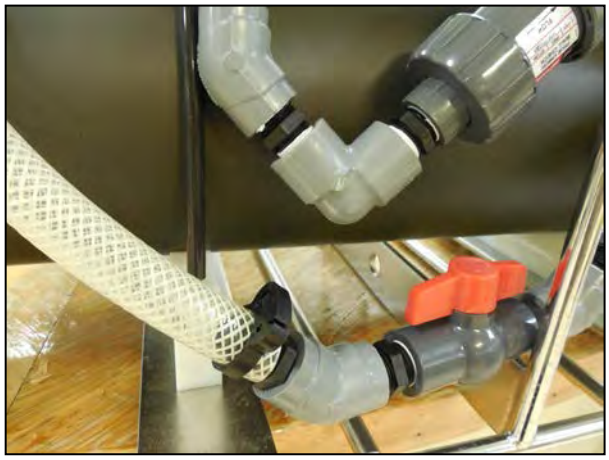

Figure C.1.2-6: Flow Valve Positioned for Dual Filtering

Section C.1.3
WTS-LVDF Deployment Preparation

Installing the Optional Debubbler

The WTS-LVDF ships with an optional debubbler. The debubbler must be installed prior to use.

IMPORTANT
The WTS-LVDF must be deployed with plug at the top of the manifold in place if the debubber is not installed. Spare plugs are included in the toolkit.

Figure C.1.3-1: Debubbler Plug

Remove the plug from the top of the manifold. Screw the threaded end of the debubbler into the manifold until tight.

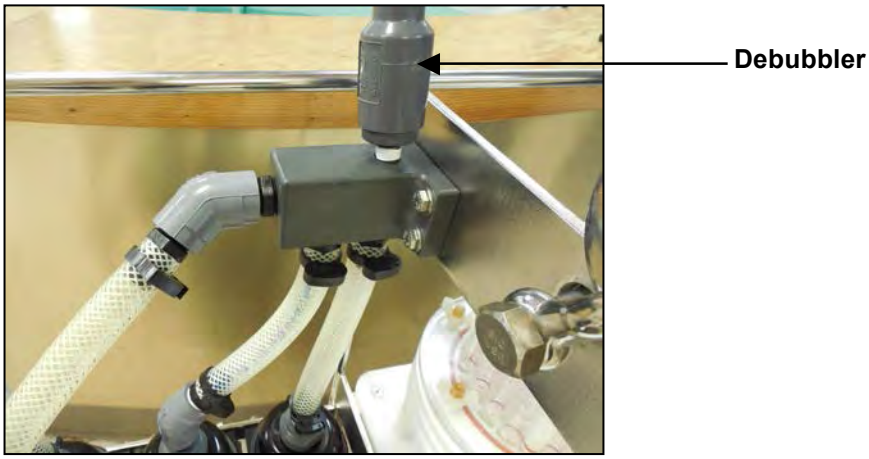

Figure C.1.3-2: Screw Debubbler into Manifold

Connecting the Battery

Connecting and disconnecting the battery to the electronics powers the WTS-LVDF on and off. The firmware starts automatically when either the main or backup batteries are connected.

Figure C.1.3-3: WTS-LVDF Controller with A72-1000 Battery Pack

To power on the WTS-LVDF and connect to a PC, complete the following steps:

1. Place the WTS-LVDF in a dry area.
2. Boot the operator PC and start the communications software.
3. Open the WTS-LVDF controller housing.

Follow standard electrostatic discharge (ESD) precautions when handling the electronics and place the WTS-LVDF in a dry area.

4. Using a screwdriver, loosen the screws and remove the bottom plate.

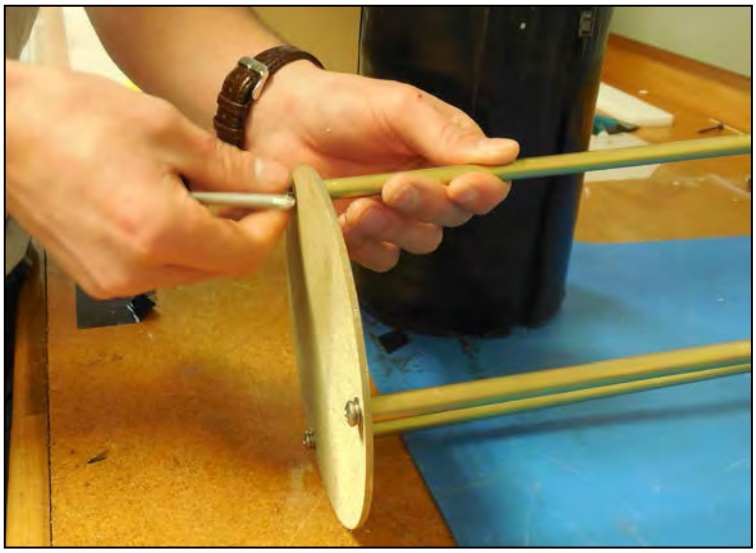

Figure C.1.3-4: Removing Battery Housing End Plate

5. Align the battery to insert the connector through the hole in the Top Plate.

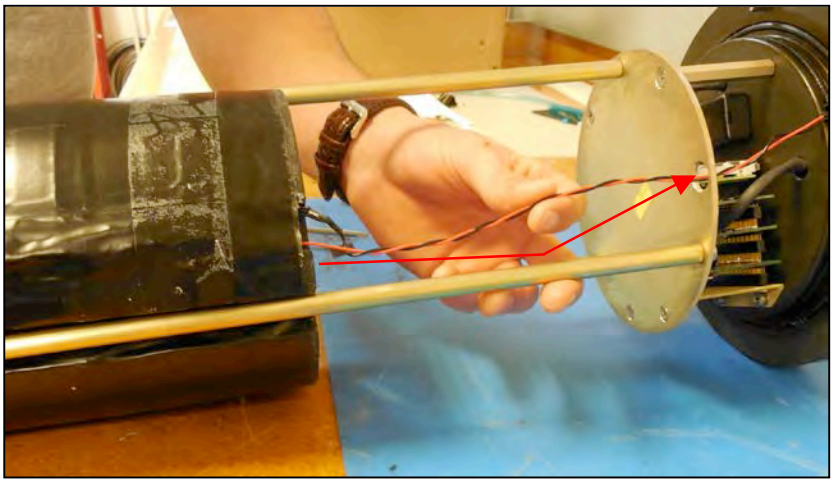

Figure C.1.3-5: Align Battery to Fit Connecter Through Hole in Top Plate

6. When installing the A72-1000 battery pack, align the hole in the battery frame with the wires at the top of the battery. Feed the connector wires through the battery feed through hole in the battery holder frame. (Figure C.1.3-6).

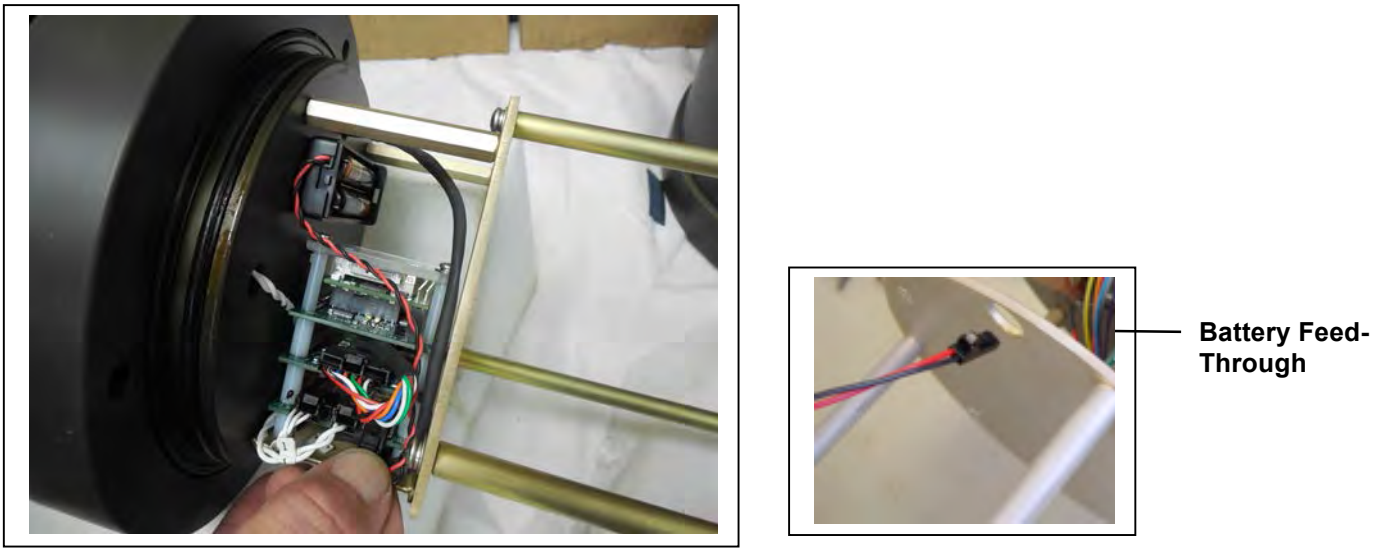

Figure C.1.3-6: Correctly Feeding Battery Connection Wires and Connecting Battery

7. Connect the main battery to the connector on the electronics stack.

8. Install the AAA batteries into the holder. These batteries are shipped with the toolkit. The backup batteries are required to deploy the sampler but will not power the instrument.

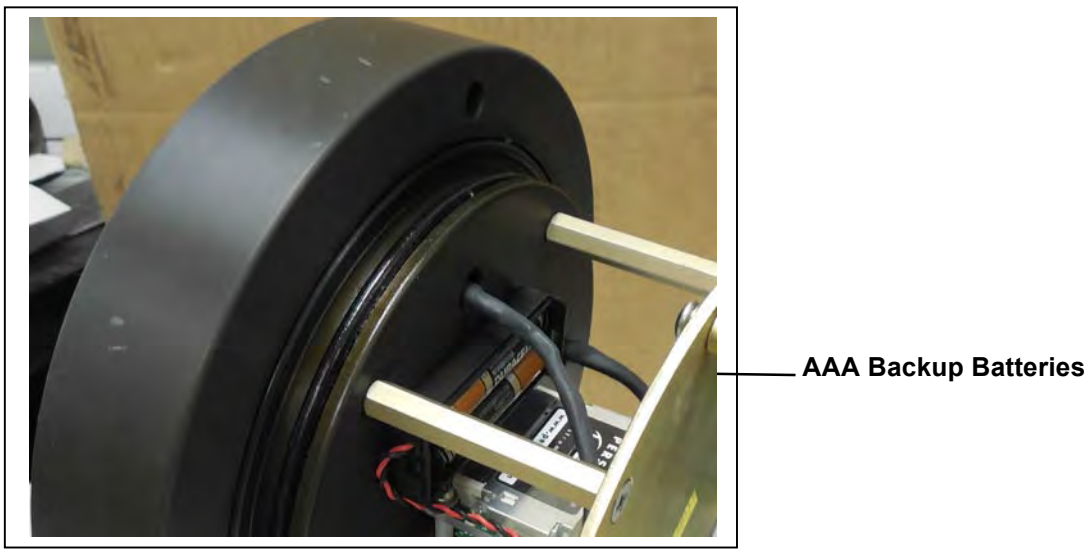

Figure C.1.3-7: Backup Batteries

9. Close the controller housing.

10. Remove the dummy plug from the communications connector.

11. Attach the communication cable assembly (supplied in the Toolkit) first to the PC serial port and then to the main battery bulkhead connector on the controller housing.
12. Before disconnecting power, press [CTRL]-[C] to return to the Main Menu and select Sleep
13. Continue with deployment steps as explained in the 'User Interface' chapter of this User Manual.

Priming the WTSLV-DF

Priming the WTSLV-DF is a best practices procedure recommended by McLane. To prime the sampler, complete the following steps

1. Locate the priming fixture from the toolkit. Connect the fixture to Inlet 2.
2. Connect the sampler to a computer and run the Pump Forward firmware option to fill lines with water.

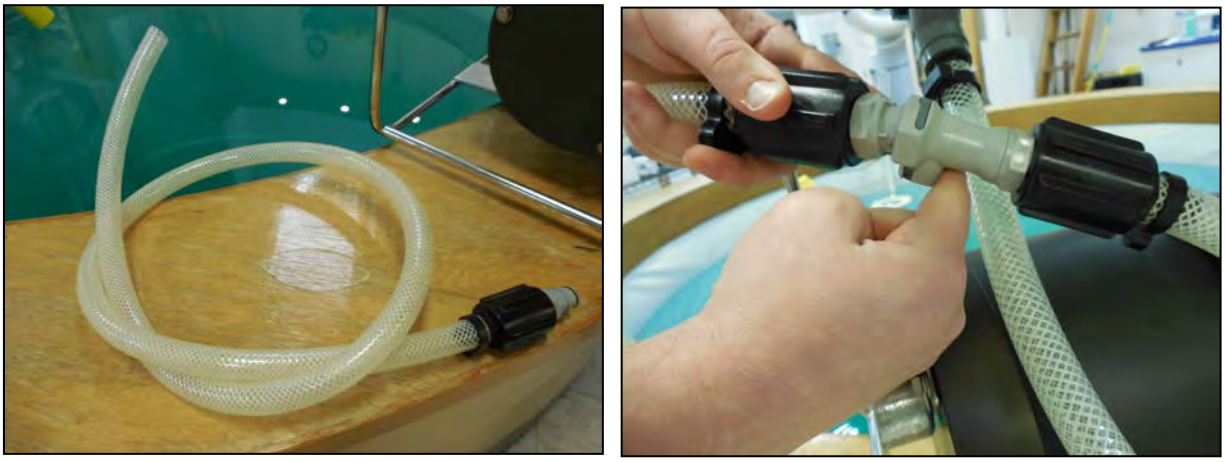

Figure C.1.3-8: Priming Tubing and Quick Disconnect

```
Configuration: LV-08M_TR                CF2 V2_06 of Mar 10 2014

                    Manual Operation

                  Fri Apr 18 14:11:54 2014

          <1> Run pump forward (10 liters @ 7 L/min)
          <2> Run pump reverse (10 liters @ 7 L/min)
          <3> Run pump programmable

          <M> Main Menu
          Selection [M] ? 1

  2399 h  209 I_Hz   52 A_Hz    0.1 L   9.2 L/min     1 secs
  2303 h  207 I_Hz  104 A_Hz    0.3 L   9.1 L/min     2 secs
  2224 h  198 I_Hz  153 A_Hz    0.4 L   8.7 L/min     3 secs
. . .
  2012 h  159 I_Hz  158 A_Hz    9.7 L   7.0 L/min    98 secs
  2013 h  158 I_Hz  158 A_Hz    9.8 L   7.0 L/min    99 secs
  2012 h  159 I_Hz  158 A_Hz    9.9 L   7.0 L/min   100 secs

Volume reached

 Total volume pumped     = 9993 ml
 Elapsed time of event   = 101 sec
 Lowest battery detected = 36.0 V
 Press any key to return to pump menu.
```

Figure C.1.3-9: Run Pump Forward

3. Turn the red flow valve for the side being primed to the 'off' position, then attach priming tube to Inlet 1.

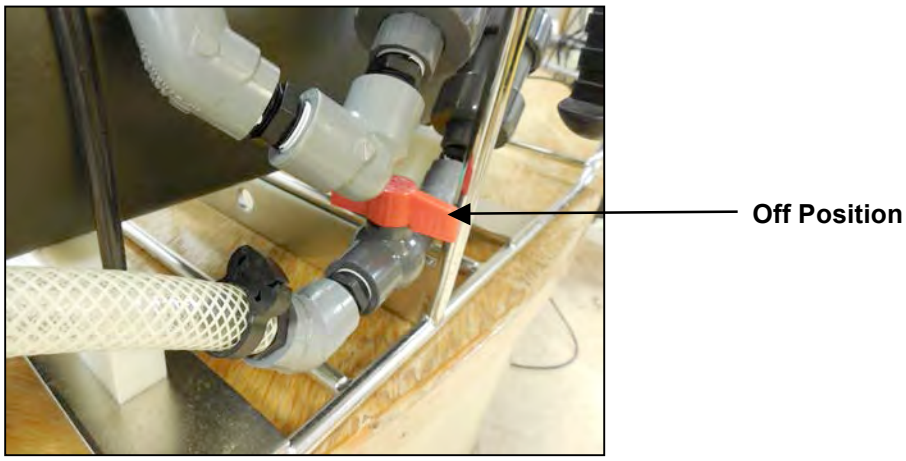

Figure C.1.3-10:Setting the Flow Valve

4. Run the Pump Forward firmware option.

5. Attach filter holders. Using a squirt bottle, fill the top of the filter holder with clean deionized water.

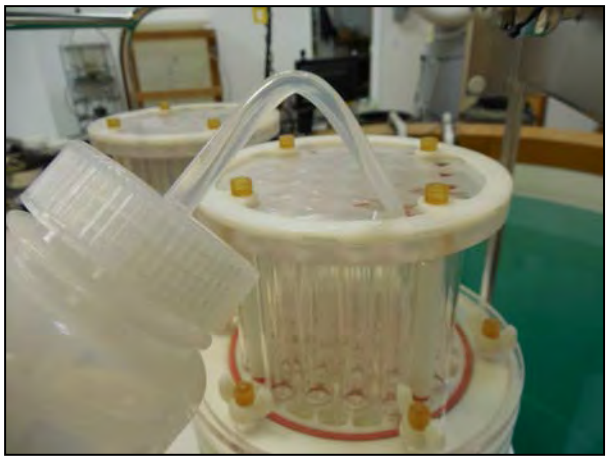

Figure C.1.3-11: Filling Filter Holder Top with Water

Reading and Recording Flow Meters

The WTS-LVDF has three flow meters. Each filter holder has a flow meter and the third flow meter is for the exhaust. Recording the mechanical flow meters before and after deployment is a recommended best practice that provides an accurate reading of volume pumped. This reading is a true measurement compared to the firmware pumped volume reading, which can vary greatly based on deployment conditions and filter types.

Figure C.1.3-12:Mechanical Flow Meters

Trigger Start

A trigger start is included with the Dual Filter WTS-LV. This trigger provides a way to time synchronize multiple instruments. See Chapter 5 “Electronics Description” and Chapter 6 “Operations” for details about the Trigger option.

Notes

Section C.1
WTS-LV Dual Filter Model

The dual filter WTS-LV model (WTS-LVDF) features two vertical intake 142 mm filter holders that allow for simultaneous, independent sampling within the same water mass. The LVDF model is designed for applications that require sampling of very large water volumes in order to capture sufficient amounts of trace elements, suspended metals or other particulate matter. The vertical intake filter holder follows a modular design and functions as an optional replacement for the standard radial intake filter holder in traditional WTS-LV and Upright LV systems.

The vertical intake filter holder incorporates increased internal baffling in order to mitigate losses of large particles during handling and recovery of the instrument. The ability to utilize two different filter porosities during a single deployment allows for greater sampling flexibility and may increase overall volume capacity when compared to single filter designs. Other features include:

- A72-1000 battery pack (30,000 mAh), which provides three times the battery capacity of the standard WTS-LV.
- Trigger start to time synchronize and simultaneously deploy multiple instruments.
- Independently metered flow circuits plus metered "total output" at exhaust.

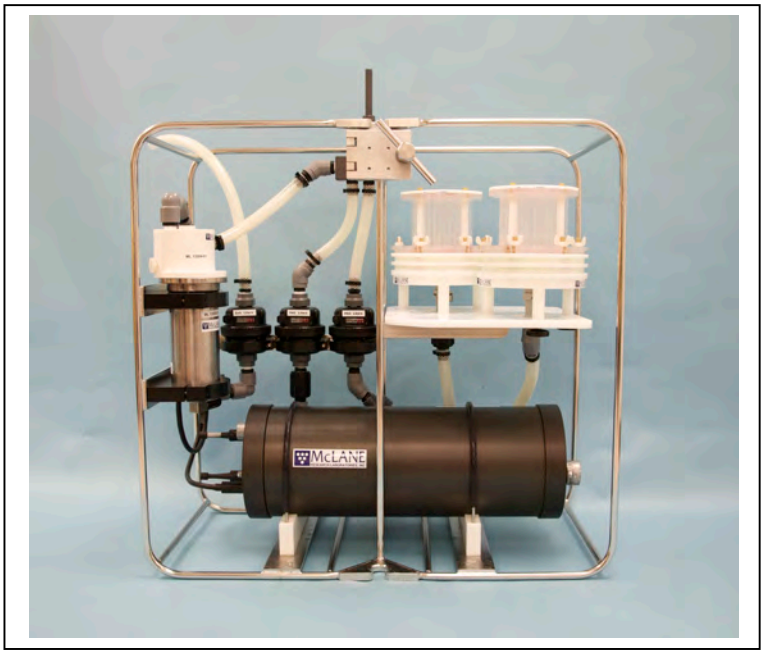

Figure C.1-1: WTS-LV Dual Filter Model

Section C.1.1
Specifications

WTS-LV Dual Filter Model Dimensions

The WTS-LV Dual Filter instrument dimensions are as follows:

Length (body)	79 cm (31.25 in)
Width	38 cm (15 in)
Height	74.9 cm (29.5 in)

Filter Porosity

The WTS-LVDF is calibrated to perform optionally with membrane filters ranging from 0.22 μM to 3.00 μM or greater porosity. A cross section of the filter holder is shown next.

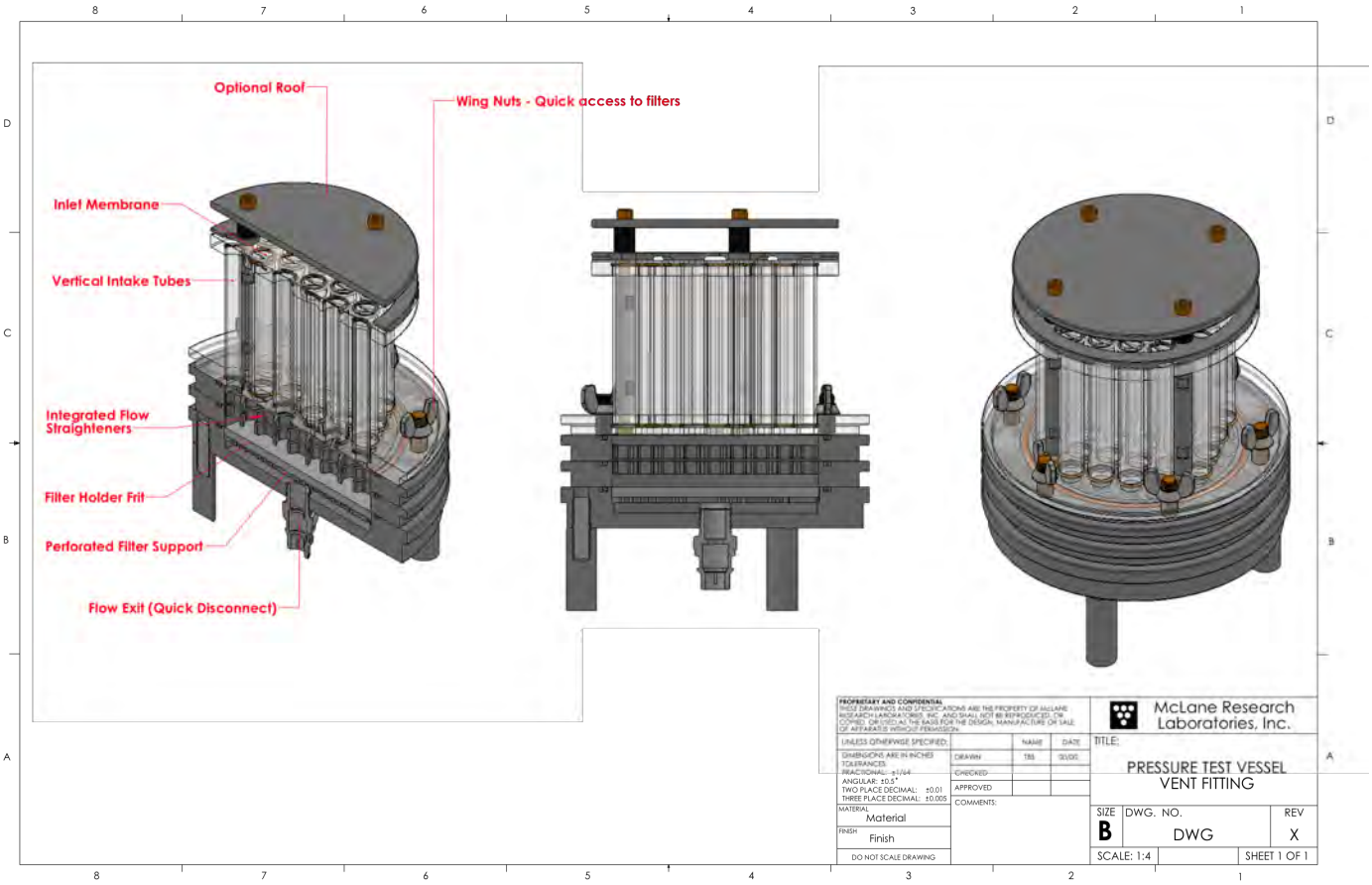

Figure C.1.1-1: WTSLV-DF Filter Holder Cross Section

The diagram shown next illustrates the intake flow path.

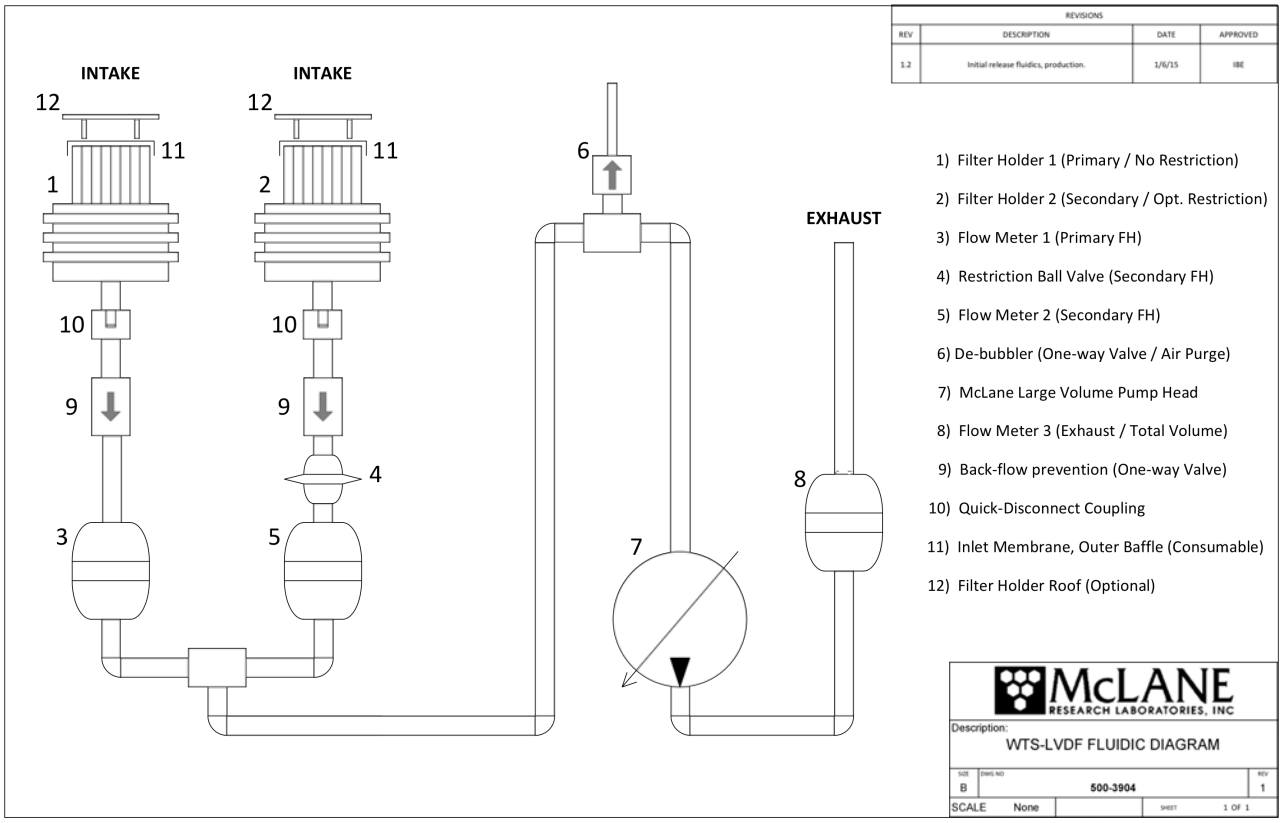

Figure C.1.1-2: WTSLV-DF Fluidic Diagram

Section C.1.2
WTS-LVDF Operations

The WTS-LVDF vertical intake filter holder is interchangeable with the traditional radial intake on standard WTS-LV systems. To operate the WTS-LVDF as a single filter sampler, turn the red flow valve counterclockwise. Figures C.2-1 and C.2-2 show the flow valve positions for single and dual filter sampling.

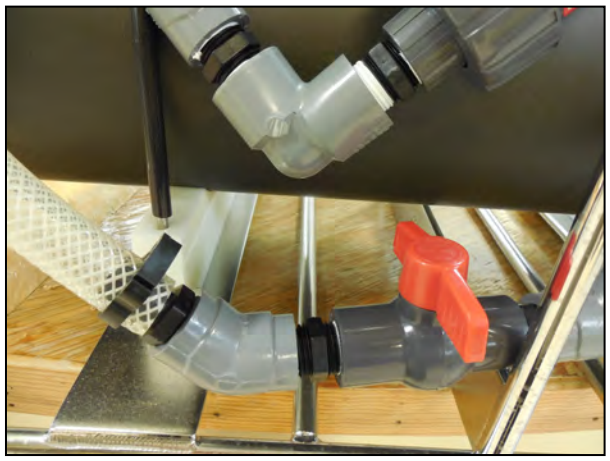

Figure C.1.2-1: Valve Closed

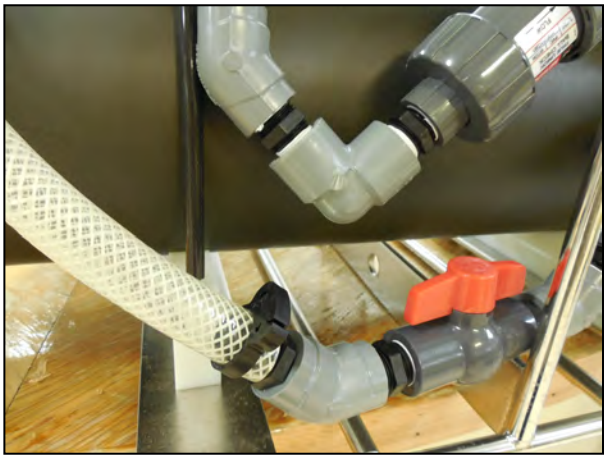

Figure C.1.2-2: Valve Open

The WTS-LVDF includes a Trigger Start option. For details see Chapter 5 "Electronics Description" and Chapter 6 " Operations", in this User Manual.

Removing Filter Holders

The WTS-LVDF ships with filter holders installed. To remove either filter holder, complete the following steps:

1. Remove each of the three thumb screws at the bottom of the filter holder plate.
2. Press to release the quick disconnect fitting from below the filter holder.

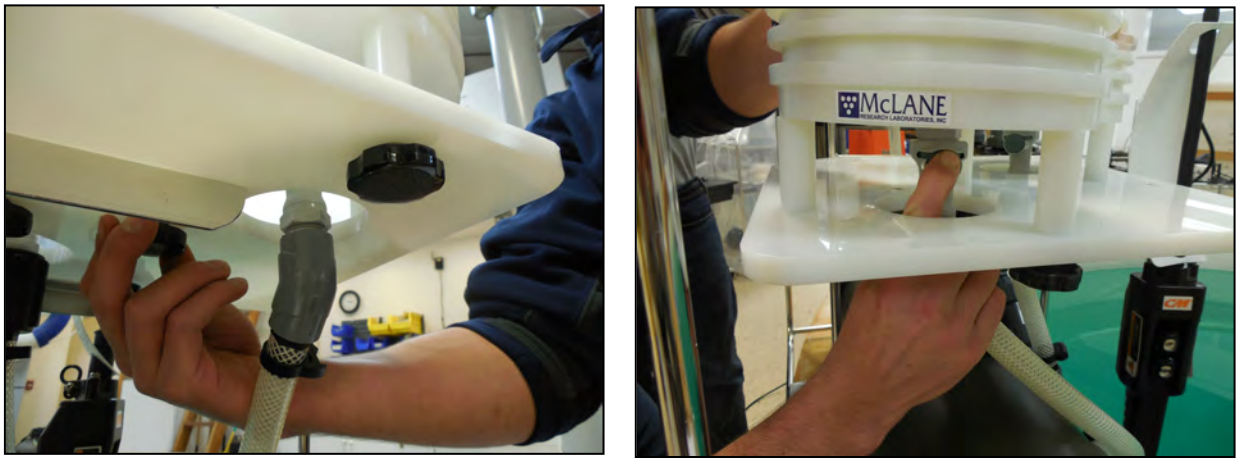

Figure C.1.2-3: Remove Nuts and Release Quick Disconnect

3. Gently lift the filter holder from the filter holder plate and remove filter holder unit from connector.

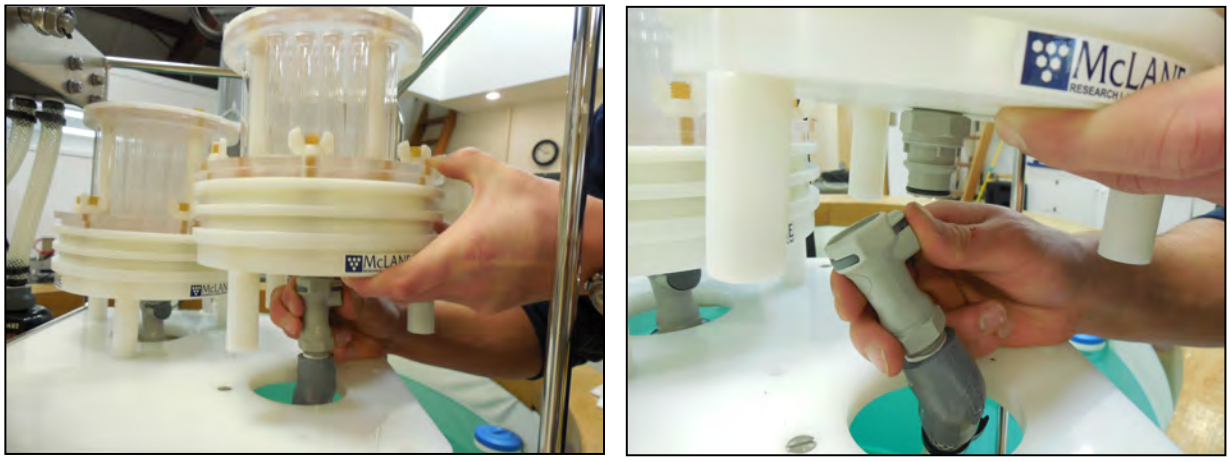

Figure C.1.2-4: Lifting Filter Holder off of Plate

Installing Filter Holders

To install either filter holder, complete the following steps:

1. Place the filter holder over the filter holder plate and push the connecter onto the quick disconnect.

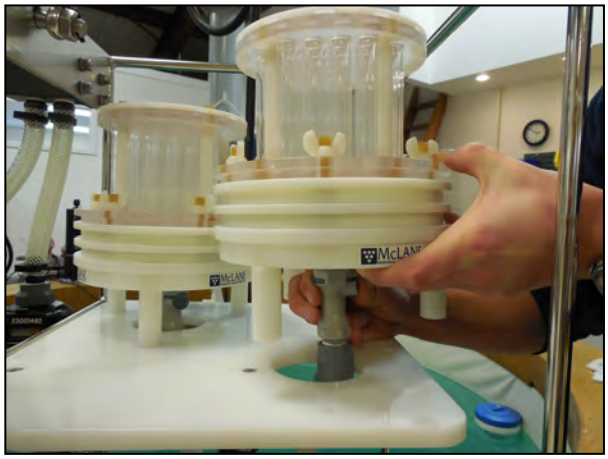

Figure C.1.2-5: Securing Filter Holder to Quick Disconnect

2. Secure the three thumb screws through the filter holder plate up into the filter holder legs.
3. Confirm that the red flow valve is correctly set for either single or dual filtering.

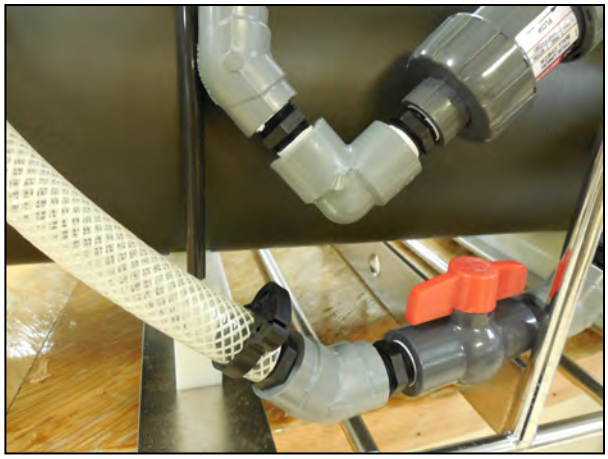

Figure C.1.2-6: Flow Valve Positioned for Dual Filtering

Section C.1.3
WTS-LVDF Deployment Preparation

Installing the Optional Debubbler

The WTS-LVDF ships with an optional debubbler. The debubbler must be installed prior to use.

IMPORTANT
The WTS-LVDF must be deployed with plug at the top of the manifold in place if the debubber is not installed. Spare plugs are included in the toolkit.

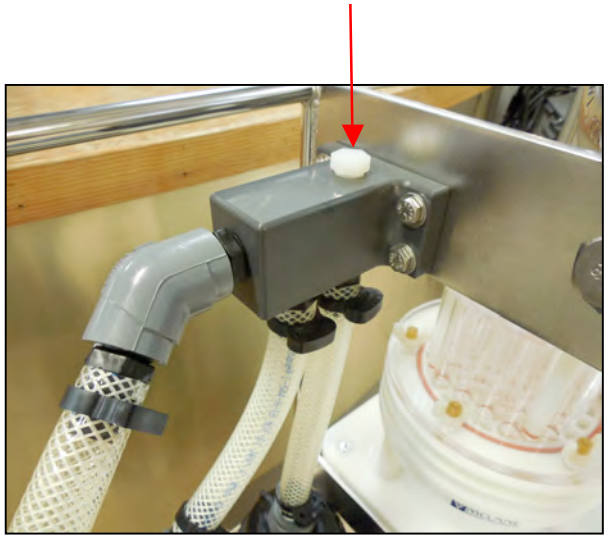

Figure C.1.3-1: Debubbler Plug

Remove the plug from the top of the manifold. Screw the threaded end of the debubbler into the manifold until tight.

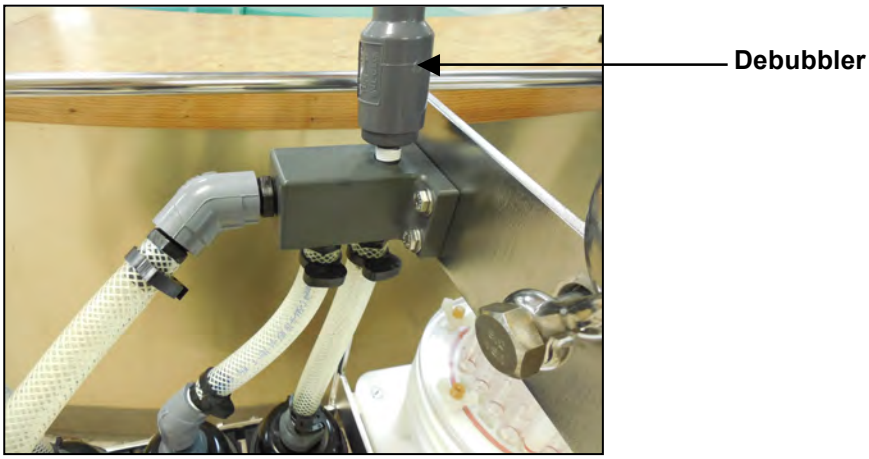

Figure C.1.3-2: Screw Debubbler into Manifold

Connecting the Battery

Connecting and disconnecting the battery to the electronics powers the WTS-LVDF on and off. The firmware starts automatically when either the main or backup batteries are connected.

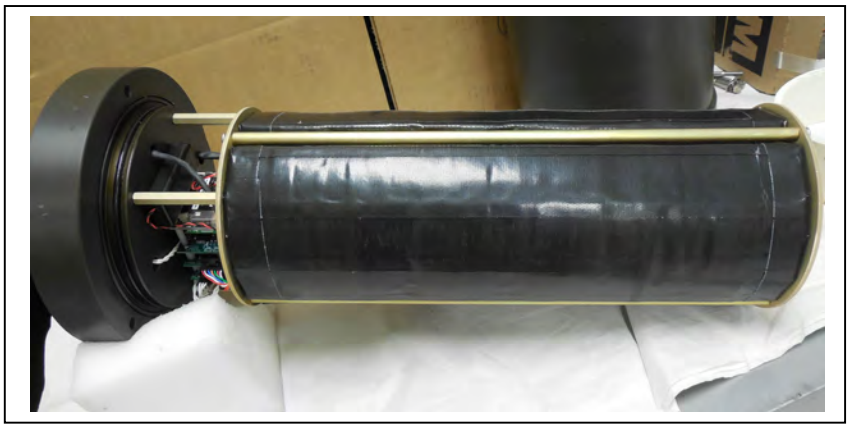

Figure C.1.3-3: WTS-LVDF Controller with A72-1000 Battery Pack

To power on the WTS-LVDF and connect to a PC, complete the following steps:

1. Place the WTS-LVDF in a dry area.
2. Boot the operator PC and start the communications software.
3. Open the WTS-LVDF controller housing.

Follow standard electrostatic discharge (ESD) precautions when handling the electronics and place the WTS-LVDF in a dry area.

4. Using a screwdriver, loosen the screws and remove the bottom plate.

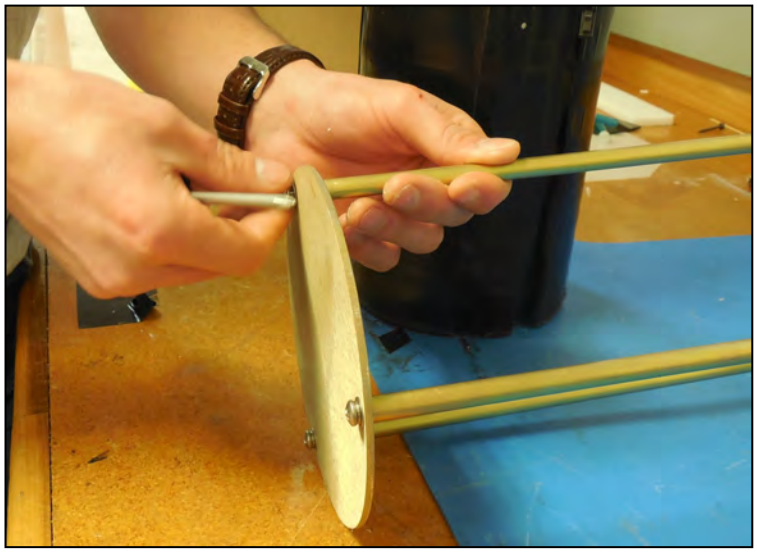

Figure C.1.3-4: Removing Battery Housing End Plate

5. Align the battery to insert the connector through the hole in the Top Plate.

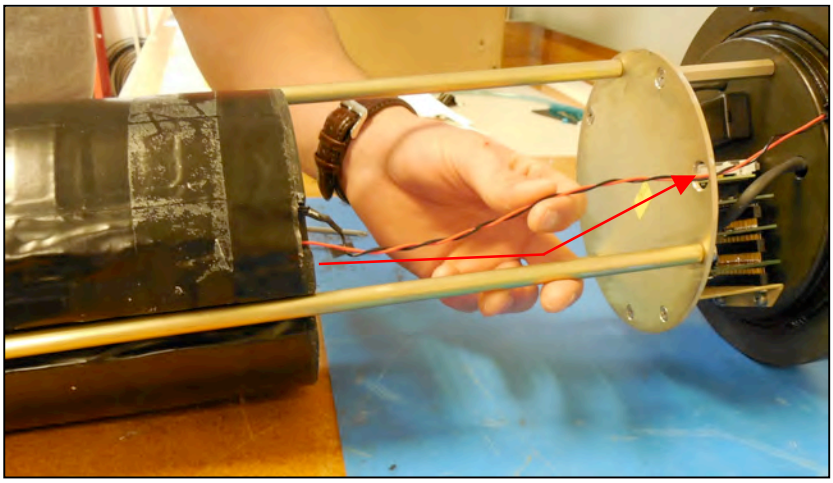

Figure C.1.3-5: Align Battery to Fit Connecter Through Hole in Top Plate

6. When installing the A72-1000 battery pack, align the hole in the battery frame with the wires at the top of the battery. Feed the connector wires through the battery feed through hole in the battery holder frame. (Figure C.1.3-6).

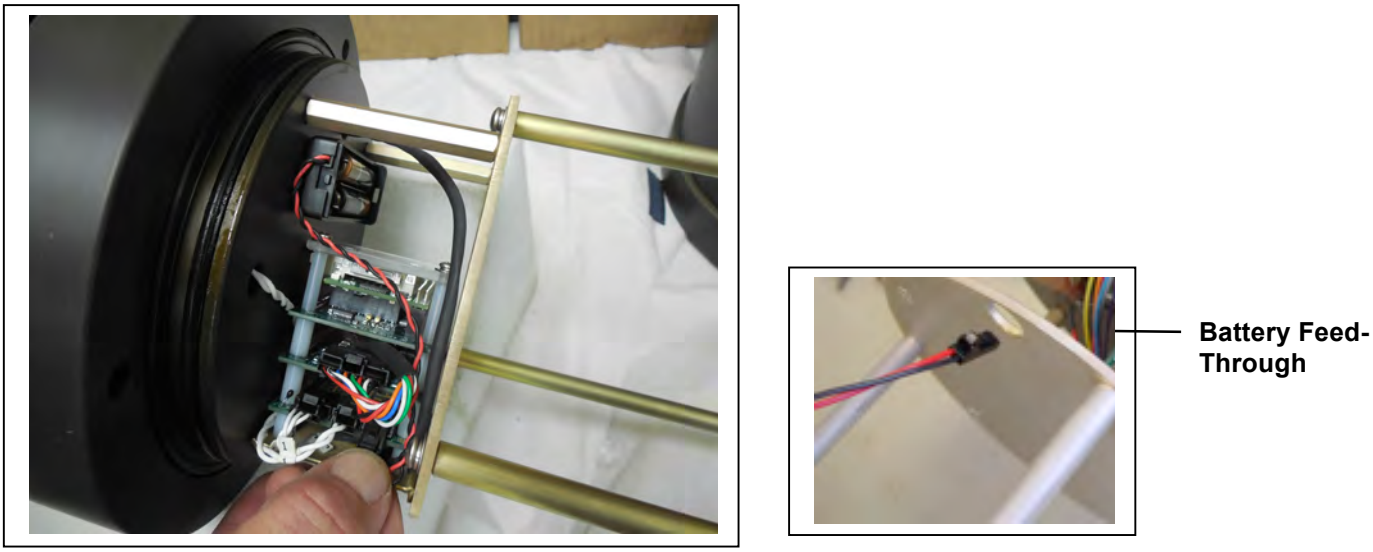

Figure C.1.3-6: Correctly Feeding Battery Connection Wires and Connecting Battery

7. Connect the main battery to the connector on the electronics stack.

8. Install the AAA batteries into the holder. These batteries are shipped with the toolkit. The backup batteries are required to deploy the sampler but will not power the instrument.

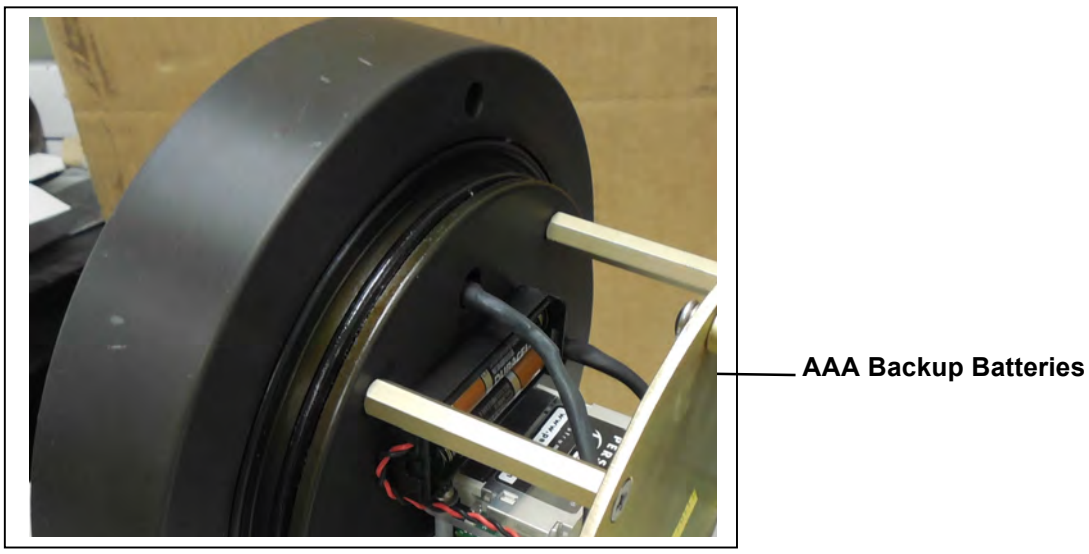

Figure C.1.3-7: Backup Batteries

9. Close the controller housing.

10. Remove the dummy plug from the communications connector.

11. Attach the communication cable assembly (supplied in the Toolkit) first to the PC serial port and then to the main battery bulkhead connector on the controller housing.
12. Before disconnecting power, press [CTRL]-[C] to return to the Main Menu and select Sleep
13. Continue with deployment steps as explained in the 'User Interface' chapter of this User Manual.

Priming the WTSLV-DF

Priming the WTSLV-DF is a best practices procedure recommended by McLane. To prime the sampler, complete the following steps

1. Locate the priming fixture from the toolkit. Connect the fixture to Inlet 2.
2. Connect the sampler to a computer and run the Pump Forward firmware option to fill lines with water.

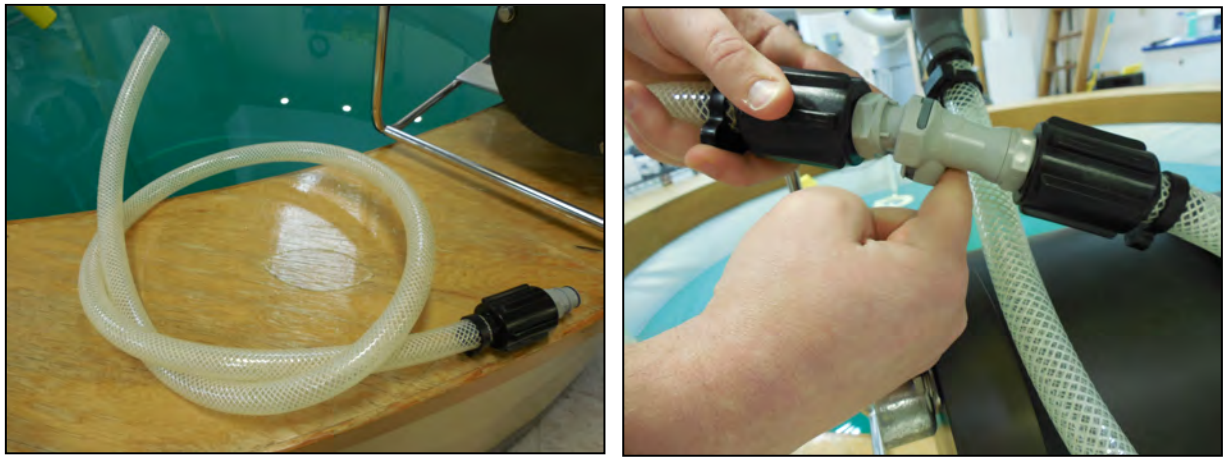

Figure C.1.3-8: Priming Tubing and Quick Disconnect

```
Configuration: LV-08M_TR                CF2 V2_06 of Mar 10 2014

                    Manual Operation

                  Fri Apr 18 14:11:54 2014

          <1> Run pump forward (10 liters @ 7 L/min)
          <2> Run pump reverse (10 liters @ 7 L/min)
          <3> Run pump programmable

          <M> Main Menu
          Selection [M] ? 1

  2399 h  209 I_Hz   52 A_Hz    0.1 L   9.2 L/min     1 secs
  2303 h  207 I_Hz  104 A_Hz    0.3 L   9.1 L/min     2 secs
  2224 h  198 I_Hz  153 A_Hz    0.4 L   8.7 L/min     3 secs
. . .
  2012 h  159 I_Hz  158 A_Hz    9.7 L   7.0 L/min    98 secs
  2013 h  158 I_Hz  158 A_Hz    9.8 L   7.0 L/min    99 secs
  2012 h  159 I_Hz  158 A_Hz    9.9 L   7.0 L/min   100 secs

Volume reached

 Total volume pumped     = 9993 ml
 Elapsed time of event   = 101 sec
 Lowest battery detected = 36.0 V
 Press any key to return to pump menu.
```

Figure C.1.3-9: Run Pump Forward

3. Turn the red flow valve for the side being primed to the 'off' position, then attach priming tube to Inlet 1.

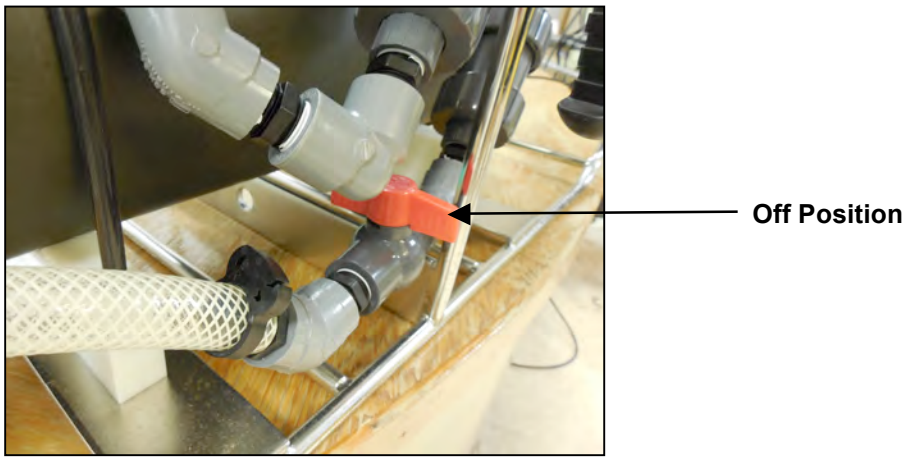

Figure C.1.3-10:Setting the Flow Valve

4. Run the Pump Forward firmware option.

5. Attach filter holders. Using a squirt bottle, fill the top of the filter holder with clean deionized water.

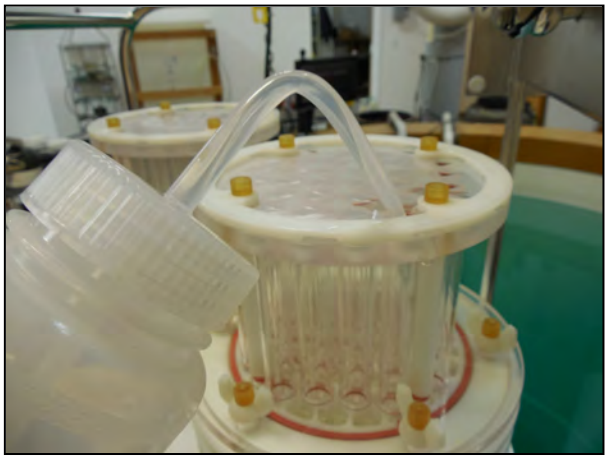

Figure C.1.3-11: Filling Filter Holder Top with Water

Reading and Recording Flow Meters

The WTS-LVDF has three flow meters. Each filter holder has a flow meter and the third flow meter is for the exhaust. Recording the mechanical flow meters before and after deployment is a recommended best practice that provides an accurate reading of volume pumped. This reading is a true measurement compared to the firmware pumped volume reading, which can vary greatly based on deployment conditions and filter types.

Figure C.1.3-12:Mechanical Flow Meters

Trigger Start

A trigger start is included with the Dual Filter WTS-LV. This trigger provides a way to time synchronize multiple instruments. See Chapter 5 “Electronics Description” and Chapter 6 “Operations” for details about the Trigger option.

Notes

Section C.2
WTS-LV Upright Model

The WTS-LV upright model includes the same features and user interface as the standard WTS-LV. This Appendix explains the following options on the upright model that differ from the standard WTS-LV:

- Larger controller housing to accommodate the A72-1000 battery pack (30,000 mAh), which provides three times the battery capacity of the standard WTS-LV.
- Trigger start to time synchronize and simultaneously deploy multiple instruments.

Figure C.2-1: WTS-LV Upright Model

WTS-LV Upright Model Dimensions

The WTS-LV upright model instrument dimensions are as follows:

Length (body)	91 cm (36 in)
Width	61 cm (24 in)
Height	33 cm (13 in)

Connecting the Battery

Connecting and disconnecting the battery to the electronics powers the WTS-LVUP on and off. The firmware starts automatically when either the main or backup batteries are connected.

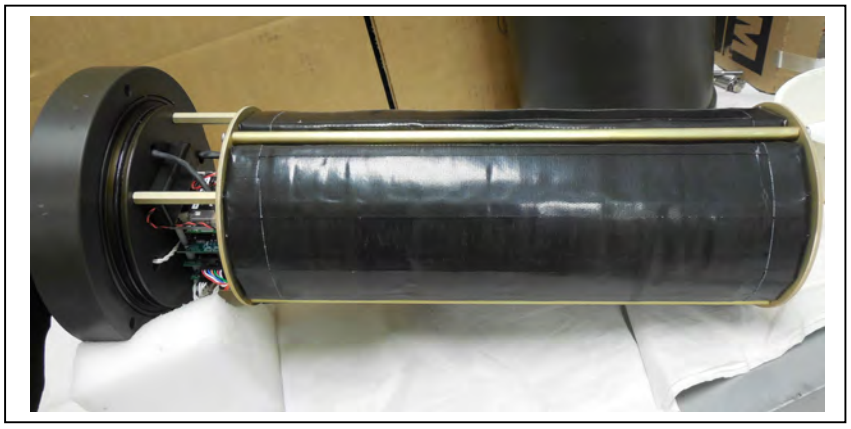

Figure C.2-2: WTS-LVUP Controller with A72-1000 Battery Pack

To power on the WTS-LVUP and connect to a PC, complete the following steps:

1. Place the WTS-LVUP in a dry area.
2. Boot the operator PC and start the communications software.
3. Open the WTS-LVUP controller housing.

Follow standard electrostatic discharge (ESD) precautions when handling the electronics and place the WTS-LVUP in a dry area.

4. Using a screwdriver, loosen the screws and remove the bottom plate.

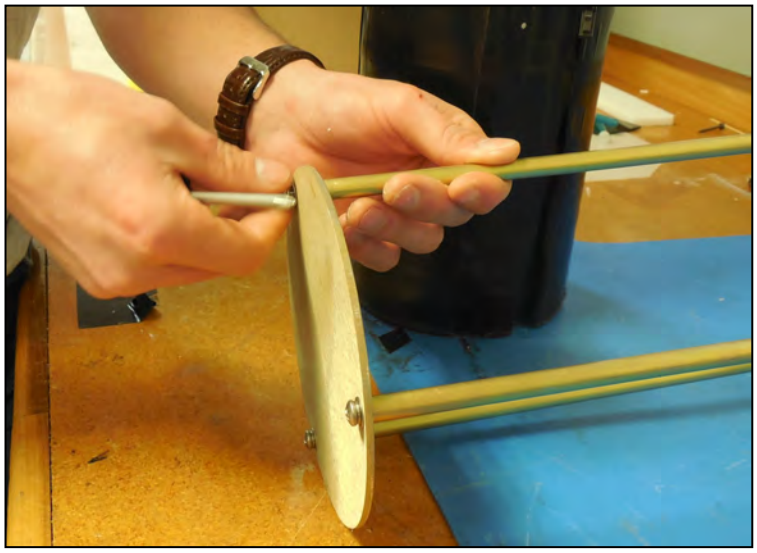

Figure C.2-3: Removing Battery Housing End Plate

5. Align the battery to insert the connector through the hole in the Top Plate.

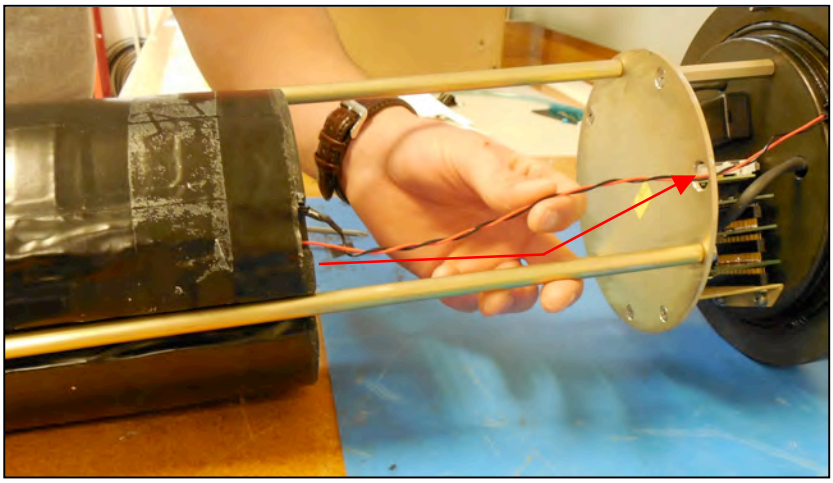

Figure C.2-4: Align Battery to Fit Connecter Through Hole in Top Plate

6. When installing the A72-1000 battery pack, align the hole in the battery frame with the wires at the top of the battery. Feed the connector wires through the battery feed through hole in the battery holder frame. (Figure C.2-5).

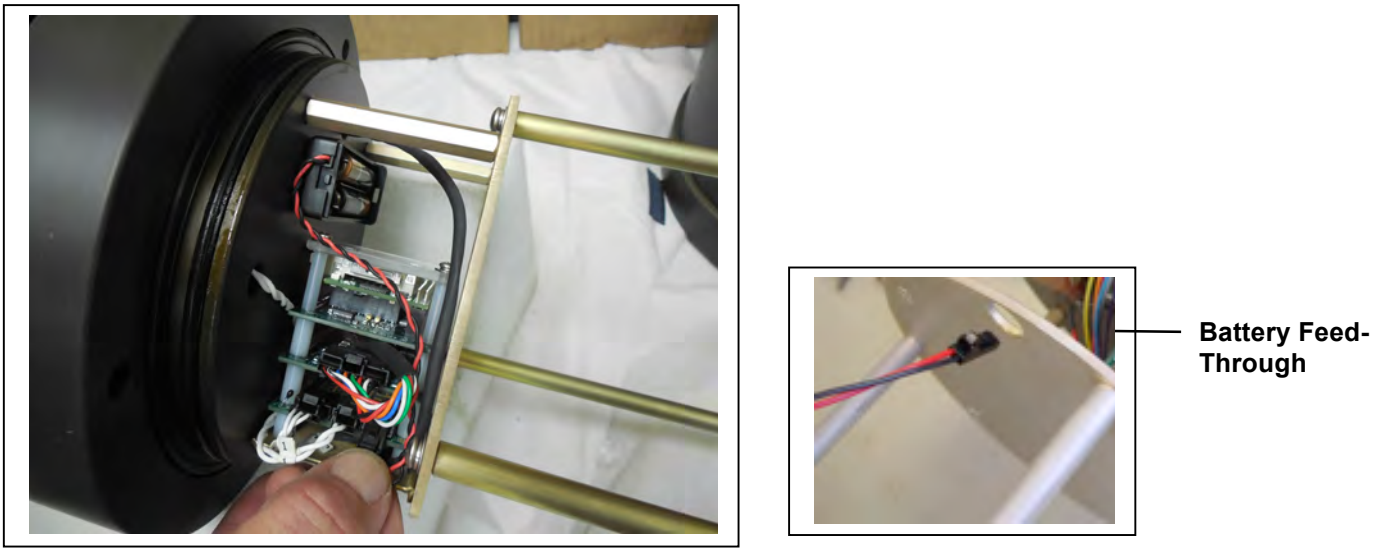

Figure C.2-5: Correctly Feeding Battery Connection Wires and Connecting Battery

7. Connect the main battery to the connector on the electronics stack.

8. Install the AAA batteries into the holder. These batteries are shipped with the toolkit. The backup batteries are required to deploy the sampler but will not power the instrument.

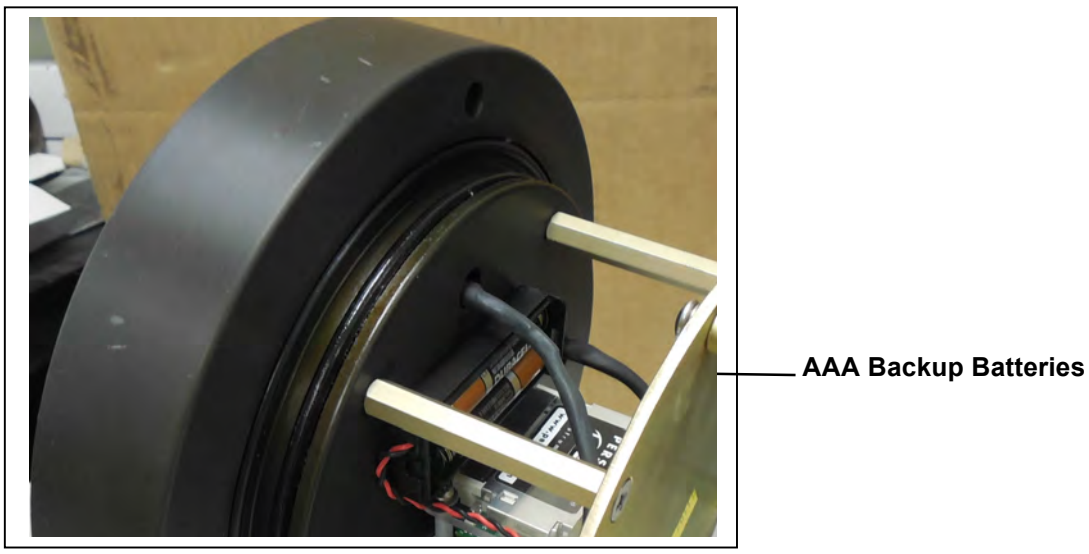

Figure C.2-6: Backup Batteries

9. Close the controller housing.

10. Remove the dummy plug from the communications connector.

11. Attach the communication cable assembly (supplied in the toolkit) first to the PC serial port and then to the main battery bulkhead connector on the controller housing.
12. Before disconnecting power, press [CTRL]-[C] to return to the Main Menu and select Sleep
13. Continue with deployment steps as explained in the 'User Interface' chapter of this User Manual.

Trigger Start

The trigger start is included on the WTS-LV Upright and WTS-LV Dual Filter models.

For details on the Trigger Start see Chapter 5 "Electronics Description" and Chapter 6 " Operations", in this User Manual.

Deploy

```
Selection [] ? D

System status:

   Date     Time    Battery    Temp Port
 03/17/15 13:18:27  30.8 Vb  18.0∞C 00 (home)

Caution: Deployment will overwrite the EEPROM data backup cache.

Performing 6 second Backup Battery test...

!!! CANNOT CONTINUE - CHECK BACKUP BATTERY !!!
```

Figure C.2-7: System Status

The steps that follow explain how to complete the deployment.

1. Select *D* to proceed with the deployment when the sample parameters are complete.
2. One line of system status information displays followed by a message reminder to offload data written to the EEPROM backup during a previous deployment. Disregard the message if the data has already been recovered.

In firmware v2.08 and above, the pre-deployment process checks to confirm that backup batteries are correctly installed. If backup batteries are not detected, the firmware will not accept the 'Y' entry to start the deployment.

3. The data offload reminder and battery check will be followed by and a prompt to proceed with or terminate the deployment (a final chance to check the settings prior to deployment).

4. The firmware performs a consistency check. If the main battery voltage is too low to support the deployment, warnings will display (see Chapter 3 for battery voltage warnings).

5. Once the system is ready to deploy, remove the communications cable, replace the dummy connector, and connect to the wire. The system will remain in the Suspend mode until the scheduled time of the pumping event. At that time the system will automatically wake up and begin sampling.

```
CAUTION: Deployment will ERASE all EEPROM data backup entries.

 Proceed with the deployment [N] ? y

 Trigger delay: 00:30:00  [HH:MM:SS]

 Disconnect and reconnect trigger plug, or press ^C to abort...
Trigger received.
Waiting for scheduled event @ 04/06/15 12:29:08
Remove communication cable and attach dummy plug.
System is ready to deploy...
04/06/15 11:59:08 Suspended until 04/06/15 12:29:08 ...
```

Figure C.2-8: Deploy System – Trigger Installed

Pumping begins whether or not the WTS-LV is on station. Reconnecting the COM cable and typing [CTRL]-[C] will terminate the deployment.

Notes

Section C.3
WTS-LV Bore Hole Model

The Bore-Hole WTS-LV (Figure C.3-1) is designed to fit through a narrow opening such as a 30cm bore-hole and collect a single suspended particulate sample *in situ* onto a 142mm membrane filter.

Figure C.3-1: Bore-Hole WTS-LV

The Bore-Hole WTS-LV is identical to the standard WTS-LV, with a re-arrangement of the components. The physical dimensions and component arrangement are illustrated in Figure C.3-2:

Height: 160cm (63in)
Diameter: 26cm (10.36in)

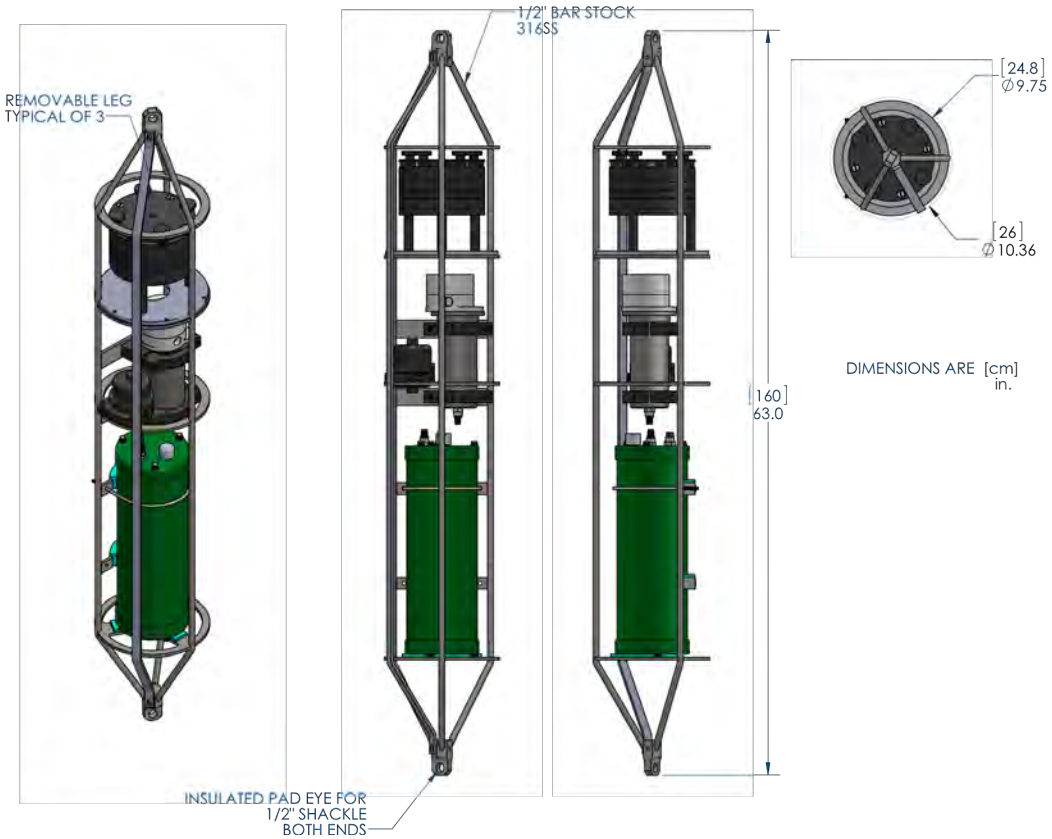

Figure C.3-2: Bore-Hole WTS-LV Schematic

Installing the Batteries

The Bore-Hole WTS-LV uses the drop-in battery pack (same as the standard WTS-LV), which contains 24 “D” cell batteries and has 10,000 mAh of battery capacity. To install the batteries, one of the three frame guards that protect the controller housing and the two u-bolts that further secure the controller housing must be removed and the controller housing lifted out of the frame.

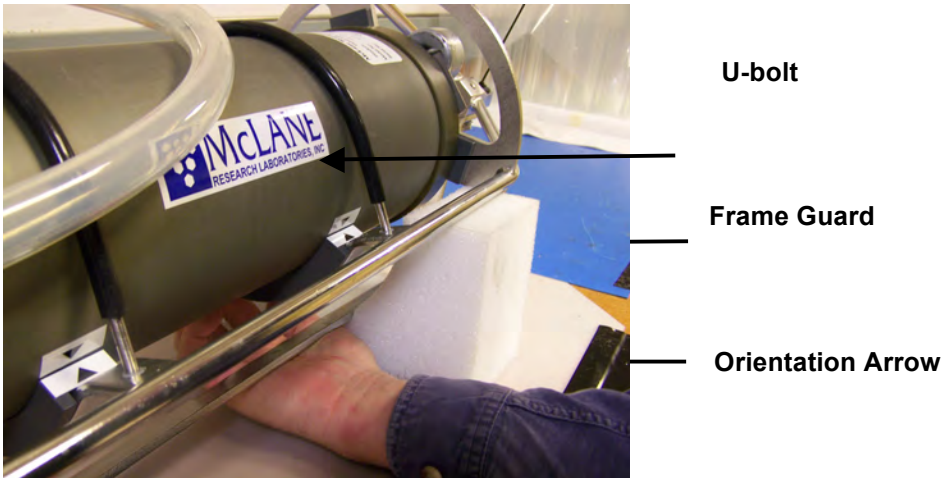

Figure C.3-3: WTS-LV Frame Guards, U-Bolts and Orientation Arrows

A 7/16” Box Wrench and an Adjustable Wrench are included in the toolkit as shown in Figure C-3.4 to remove and reinstall the frame guard and u-bolts.

When removing the controller housing, the white exhaust tubing can be moved out of the way or disconnected at the inlet to the flow meter as shown in Figure C.3-5. To install batteries in the controller housing, complete the following steps:

Figure C.3-4: 7/16" Box Wrench, Adjustable Wrench

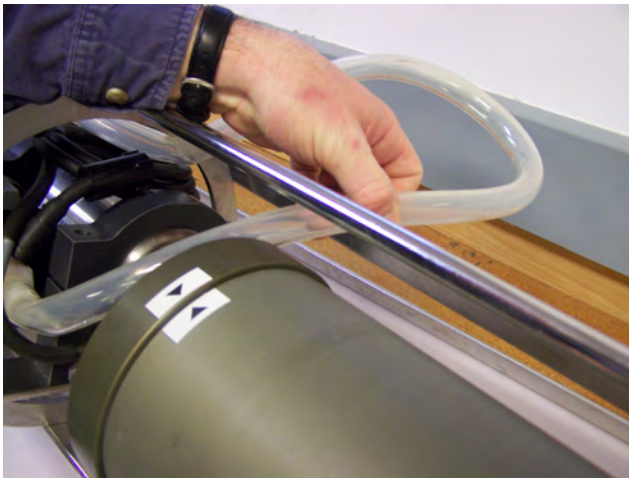

Figure C.3-5: Moving Exhaust Tubing

1. Position the WTS-LV on a flat surface and stable support so that it does not roll (Figure C.3-6). Foam cradles from the shipping crate work well for this purpose.

Figure C.3-6: Place on a Stable Surface

2. Remove the connector from the controller housing (Figure C.3-7).
3. Using the adjustable wrench, loosen the connecting bolt on one of the frame guards (Figure C.3-8)

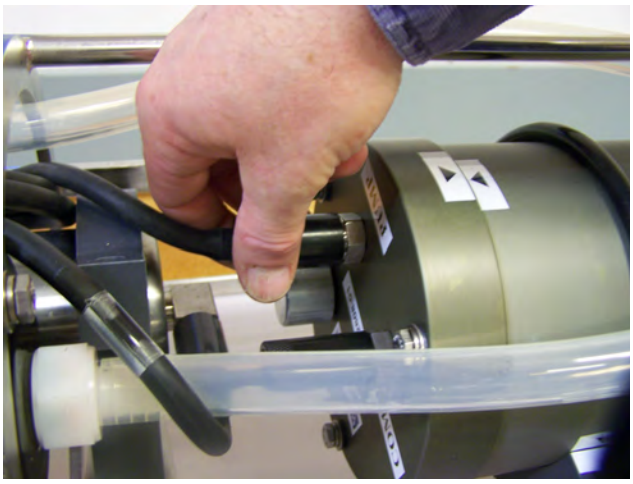

Figure C.3-7: Removing Connector

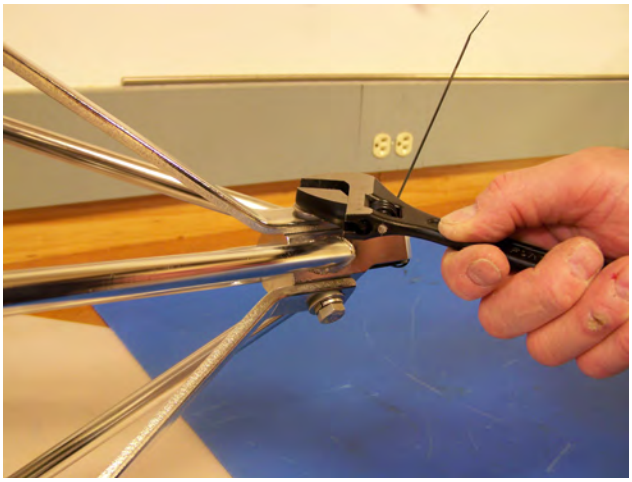

Figure C.3-8: Loosening Frame Guard

4. Slide the frame guard away from the controller housing (Figure C.3-9).
5. Using the box wrench, loosen the bolts at the bottom of the u-bolts (Figure C.3-10).

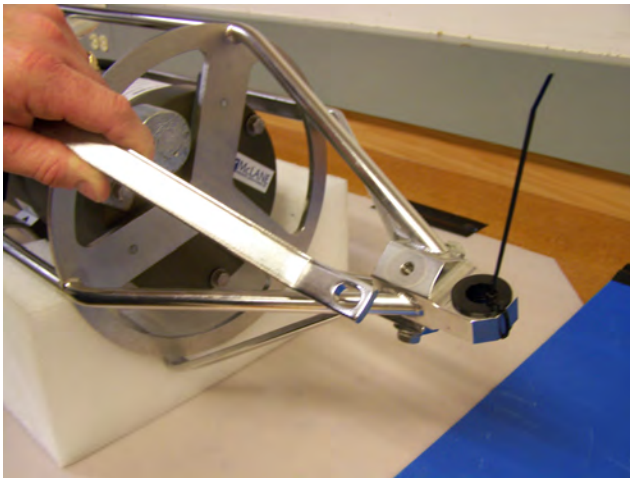

Figure C.3-9: Removing Leg Bolt

Figure C.3-10: Loosening U-Bolt Clamp

6. Using the box wrench, loosen the bolts at the bottom of the u-bolts and remove the u-bolts (Figure C.3-11).
7. Gently lift the controller housing away from the frame (Figure C.3-12).

Figure C.3-11: Removing U-Bolt

Figure C.3-12: Removing Controller Housing

8. See Chapter 5 “Electronics Description” in this User's Manual for the steps to install batteries.

9. Plug in the battery connector to power the electronics before closing the controller housing.

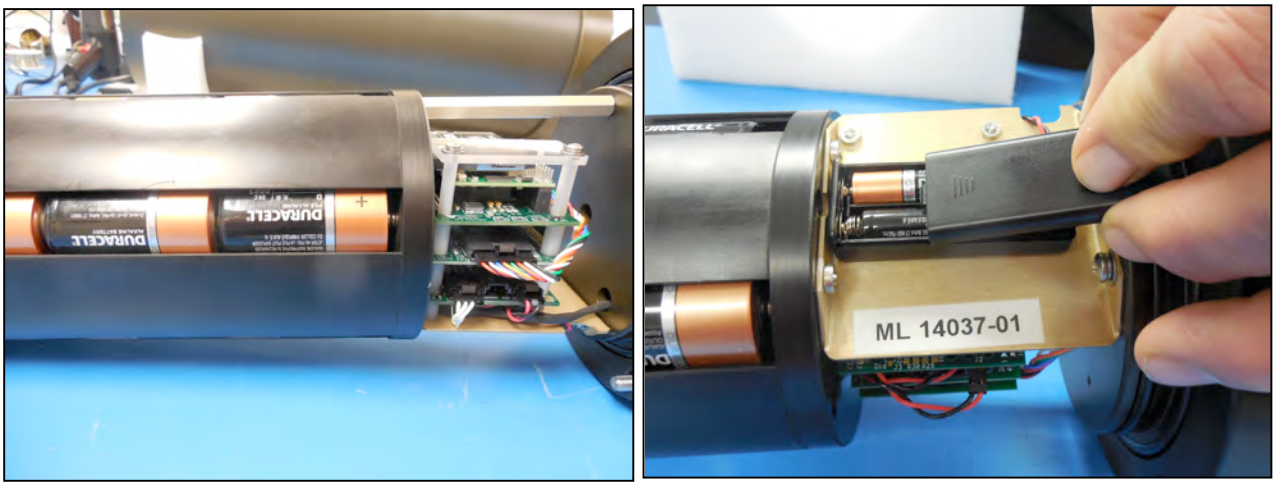

Figure C.3-13: Main and Backup Batteries

10. Connect the main battery to the 2-pin connector on the middle board of the electronics stack.

11. Install the ‘AAA’ backup batteries into the holder.

The backup batteries are required to deploy the sampler. However, these batteries will not power on the sampler.

12. Close the controller housing.

13. Return the controller housing to the frame and reattach the bulkhead connector.
14. Position the controller housing with the alignment arrows as shown in Figure C.3-15.

Correctly aligning the end cap with the orientation arrows is important to ensure proper alignment of the top end cap bulkhead connectors.

Figure C.3-14: Returning Controller to Frame

Figure C.3-15: Aligning Arrows, Reattaching Connector

Notes

Appendix D
Optional Filter Holders

Filters for the WTS-LV are supplied by the user. Available filter holder styles include the standard, vertical intake, 3-tier, cartridge, zooplankton and 293mm filters. The chart in Figure D-1 shows the filter holder options and compatibility with different WTS-LV models. This Appendix describes the 3-tier, and cartridge filter holders. Appendix 'WTS-LV Dual Filter Model' has information about the Vertical Intake filter holder option.

	Standard Radial	Vertical Intake	3-Tier	Cartridge	Zooplankton	293mm
						
Sampler Fit	WTS-LV, WTSLV-DF, WTS-LVUP	WTS-LV, WTSLV-DF, WTS-LV-UP	WTS-LV, WTSLV-DF, WTS-LVUP	WTS-LV	WTS-LV, WTS-LVUP	WTS-LV (special frame)
Description	Radial intake has large horizontal intake openings at the top to provide low resistance path to the filter	Vertical intake minimizes particle wash out	Large horizontal intake with additional pre-filter (mesh or glass)	Cartridge housing for standard 2.5 x 10 inch double open ended (DOE) cartridges	Valved intake	Same as standard radial filter holder with larger diameter for more filter surface area
Filter Size & Specs	142mm mesh, GFF or membrane	142mm mesh, GFF or membrane	142mm mesh, GFF or membrane	10in DOE Cartridge filter	203mm mesh 60μm or greater	293mm mesh or GFF
Flow Rates (Dependent on filter load and pore size)	2-8 liters/min (based on pump head size)	2-8 liters/min(based on pump head size)	2-8 liters/min(based on pump head size)	Variable with choice of cartridge	Up to 30 liters/min depends on mesh size	2-8 liters per minute
Material	Black Acetal	HDPE/Acrylic	Black Acetal	Styrene Acrylon-itrite (SAN) & Polypropylene CAP	HDPE	Black Acetal

WTS-LV and WTS-LV-BH powered by 24 drop-in "D" cell alkaline batteries (10,000 mAh). WTSLV-UP and WTSLV-DF powered by A72-1000 battery pack (30,000 mAh) (3x the battery capacity of the drop-in "D" batteries). Trigger is standard on WTS-LVUP and WTSLV-DF, optional on other WTS-LV models.

15.I.04

Figure D-1: Filter Holder Specifications Chart

WTS-LV with Optional 3-Tier Filter Holders

The WTS-LV modular filter design permits several filters to be stacked in series and used simultaneously. Each filter tier has a filter support frit and supports an independent filter with intermediate spacing for sample accumulation. Multiple filter layers can be used for size fractionation or other specialized programs where *in situ* sample separation is appropriate.

Chapter 6 of this User Manual contains steps for priming the standard WTS-LV filter holder. Follow this procedure for priming the 3-tier filter holder.

Figure D-2: *WTS-LV 3-Tier Filter Holder*

WTS-LV with Optional Cartridge Filter Holder

If optional cartridge filter holders are used, priming is completed using reverse pumping (priming is filling the tubing between the filter holder and the pump with water before installing the filter, to displace any air pockets).

If water can be pumped through the cartridge filters in reverse, install them before the priming process, otherwise install them after the priming is completed. When installing filters after priming, completely refill the cartridge holders before reinstalling on the system.

Figure D-3: WTS-LV with Cartridge Filter Holders

To prime the pump when the cartridge filter holder is in use, complete the following steps:

1. Without removing the filter holder from the frame, unscrew the four knurled nuts located on the top of the assembly and remove the filter holder top and any prefilters.
2. Attach the priming tubing with the quick disconnect (included in the toolkit) to the pump exhaust port located at the end of the flow meter (see Figure D-4).

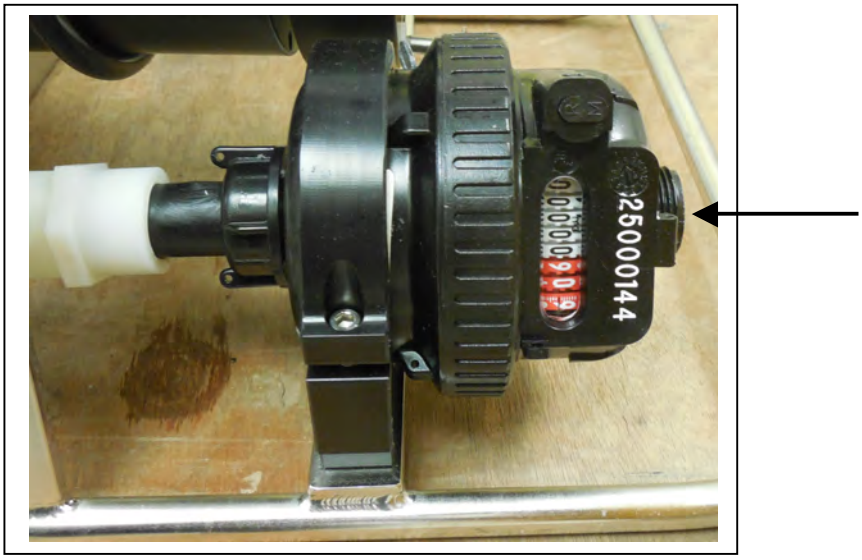

Figure D-4: *Exhaust Port*

3. Once the priming tubing is connected to the pump exhaust, boot the PC, plug the COM cable into the PC serial port and then connect the COM cable to the controller housing.
4. Connect the battery if necessary (if this is the first use of the WTS-LV, the battery will be inside the controller housing but not connected). Steps for connecting the battery are in chapter 3 of this User Manual.
5. Close and seal the controller housing.
6. Using a beaker, pour water into the open end of the priming tube until water drips from one of the Cartridge Holders.
7. Place the free end of the priming tubing into a (minimum) 5 gallon bucket or large reservoir containing several liters of distilled/neutral water. Keep the hose submerged during priming so that air bubbles are not introduced into the system.
8. To assist the water flow, set the reservoir with the intake tube at or above the level of the filter housings.
9. From the Main Menu of the WTS-LV firmware, select <3>, Run Pump.
10. Select <2> run pump: programmable.
11. When prompted, set the volume to several liters, the flow rate to 5000 (the minimum value), the minimum flow rate to 4000 (the minimum value), and the time limit to several minutes.
12. At the prompt, type ‘R’ Reverse pumping.

13. The pump will begin drawing water into the system from the bucket (each of the cartridge holders will fill up consecutively). Once the cartridge holders are all full, water will enter the filter holder below the lowest frit.

This process will occur in approximately 20 seconds or less so watch carefully.

14. Once the water penetrates the frit and begins filling the void above the frit, press [CTRL]-[C] to stop pumping.

Notes

Appendix E
Pump Head Sizing

Available WTS-LV Pump Heads

**** LVO8 is standard on the WTS-LV***

The tables shown next provide a list of available pump heads and recommendations based on compatible filter type and flow rate.

Pump Size	LV04	*LV08	LV30
Flow Rate Range (L/min)	1–4	5–8	15–30

Filter Types and Recommended Pump Heads

			Recommended Pump Heads		
Filter Type	**Pore Size (micron)**	**Max Flow Rate (L/min)**	**LV04**	**LV08**	**LV30**
Polycarbonate and Polyester Membrane (Nucleopore®, Millipore®)	0.2	3	●		
Polycarbonate and Polyester Membrane (Nucleopore®, Millipore®)	0.4	4	●		
Polycarbonate and Polyester Membrane (Nucleopore®, Millipore®)	0.8	8	●	●	
Polycarbonate and Polyester Membrane (Nucleopore®, Millipore®)	1.0	10	●	●	
Glass Fiber (GF/F®, QMA®)	0.8	8	●	●	
	1.7	10	●	●	
	5.0	20	●	●	●
Mesh (Nytex®)	60.0	50	●	●	●

Notes

Appendix F
Using the 30L/Min Pump

The 30L/min pump head is an optional feature of the Upright WTS-LV model (WTS-LVUP). The maximum flow rate of 30L/min can be reached with a 100 µm mesh filter, no frit, no cartridge housing and no flow meter installed. Installing a frit, cartridge housing and/or flow meter produces lower maximum flow rates.

As shown in Figure F-1, the WTS-LVUP with 30L/min pump is shipped with no flow meter installed (the flow meter is included in the crate). Installing the flow meter creates back pressure on the pump exhaust which slows the maximum flow rate. A 16L/min flow rate is the maximum that is reached with the flow meter installed. Pump testing results shown on the next page explain how maximum flow rate is affected by the flow meter, cartridge housing, and frits.

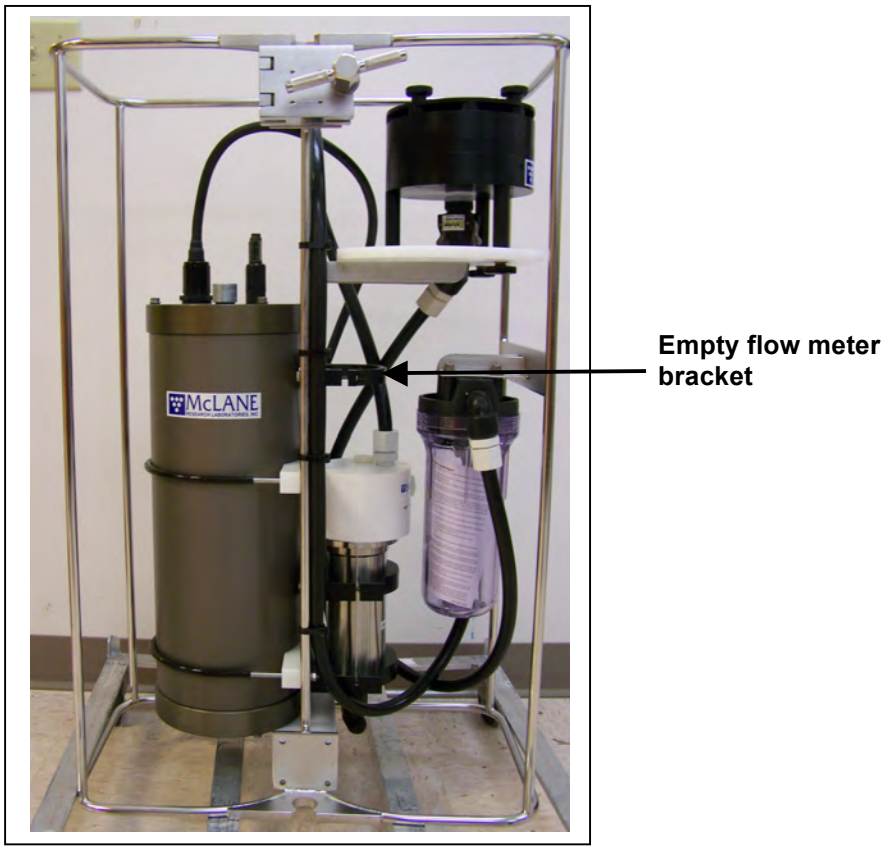

Figure F-1: WTS-LV Upright with 30L/min Pump Head

The table below shows flow rate results testing the 30L/min pump head with different options. A 2000 mA motor current was used for this testing. There was no filter in the cartridge housing to maximize the flow rate. As shown, adding a cartridge filter holder or flow meter further reduces the maximum flow rate.

Filter	Frit	Cartridge Housing	Flowmeter	Maximum Flow Rate (L/min)
100 µm Mesh	None	None	None	30
3 µm	Standard	None	None	25
3 µm	Standard	10" DOE (double open ended plumbing only - no filter installed)	None	23
3 µm	Standard	10" DOE (double open ended plumbing only - no filter installed)	V100	16

The WTS-LV requires a filter with a pore size of 3 µm or greater. Pumping through a 3 µm filter with the 30L/min pump head, no cartridge housing and no flow meter produces a maximum flow rate of 25L/min. When the 30L/min pump head is installed, the WTS-LVUP firmware initial pumping flow rate can be set from 15000 to 25000 ml/min (15L/ - 25L /min). Using the flow meter reduces the maximum flow rate to 16L/min.

Deployment Programming Settings

The screens that follow show deployment settings when the 30L/min pump is installed.

```
_____________________________________________________________
Configuration: LV-30G_TR               CF2 V2_07 of Jan 15 2015

               McLane Research Laboratories, Inc.
                      Large Volume Sampler
                           ML12345-02
               _____________________________________
                           Main Menu
               _____________________________________
                   Tue Jun 16 10:52:47 2015

          <1> Set Time          <5> Deploy System
          <2> Diagnostics       <6> Offload Data
          <3> Manual Operation  <7> Contacting McLane
          <4> Sleep             <C> Configure

          Selection [] ? c  Password: ***


_____________________________________________________________

Configuration: LV-30G_TR               CF2 V2_07 of Jan 15 2015
               _____________________________________
                        Configuration Menu
               _____________________________________
                   Tue Jun 16 10:52:53 2015

          <A> Pressure Sensor               [No]
          <B> Pump                          [Gearhead  30 L/Min.]
          <C> Rechargeable Battery          [No]
          <D> Trigger                       [Enabled]

          <X> Save & Exit          <^C> Cancel & Exit


          Selection [ ] ? x

          Configuration successfully stored
```

Figure F-2: WTS-LV Configuration Settings

The WTS-LV is expected to stop pumping on minimum flow rate due to accumulation of the sample on the filter. The sampler will also stop pumping if the sample volume or time limit is reached or the battery drops below 18 V.

```
_____________________________________________________________________

Configuration: LV-30G_TR               CF2 V2_07 of Jan 15 2015

               McLane Research Laboratories, Inc.
                      Large Volume Sampler
                           ML12345-02
               ____________________________________
                           Main Menu
               ____________________________________
                   Tue Jun 16 10:58:01 2015

          <1> Set Time          <5> Deploy System
          <2> Diagnostics       <6> Offload Data
          <3> Manual Operation  <7> Contacting McLane
          <4> Sleep             <C> Configure

          Selection [] ? 5

Clock reads 06/16/15 10:58:06.  Change [N] ? y

Format is mm/dd/[yyyy or yy] hh:mm:ss

Enter correct time [06/16/2015 10:58:09] ? 06/16/2015 10:58:15

Clock reads 06/16/15 10:58:15.  Change [N] ?

_____________________________________________________________________

 Header 1|
        2|
        3|

 Sample 4| Sample volume     =      100  [liters]
        5| Initial flow rate =    20000  [ml/min]
        6| Minimum flow rate =    10000  [ml/min]
        7| Time limit        =        9  [minutes]

 Data   8| Pump data period  =        1  [minutes]

 Start  9| Countdown timer:    01:00:00  [HH:MM:SS]

        D| Done.  Continue pre-deployment set-up.

        Selection [] ? 1

> Test, 6-16-2015
```

Initial Flow Rate 15000 – 25000 mL/min

Figure F-2: WTS-LV Deployment Settings

Battery Endurance Example Calculation

Battery life for a planned WTS-LV upright sampler deployment can be estimated using the instrument current consumption values provided here. These values apply to the CF2 microcontroller. A 30L/min pump operated at 25L/min is used for the example. In addition to pumping time, many other deployment conditions can affect the battery duration. Use this example for estimation only.

- The pre-deployment pumping time assumes initial setup steps and does not include bench testing or running diagnostics.
- Pumping assumes an unrestricted flow.

Battery Estimate – A72-1000 Battery

The WTS-LV Upright model uses an A72-1000 battery with a 30,000 mAh capacity.

Pre-deployment	
Controller (1 hour)	1 h x 15 mA = 15 mAh
Pumping (0.2 hour)	0.2 x 2000 mA = 400 mAh
	Subtotal = 415 mAh
Deployment	
Controller (6 hours)	6 h x 15 mA = 90 mAh
Pumping (6 hours)	6 h x 2000 mA = 12,000mAh
	Subtotal = 12,090 mAh
Recovery	
Controller (1 hour)	1 h x 15 mA = 15 mAh
	Subtotal = 15 mAh
Total Power Consumption	**Total = 12,520 mAh**

In this example deployment, the estimated battery drain totals 12,520 mAh. This is less than the 30,000 mAh capacity of the A72-1000 battery.

Notes

4. Using a screwdriver, loosen the screws and remove the bottom plate.

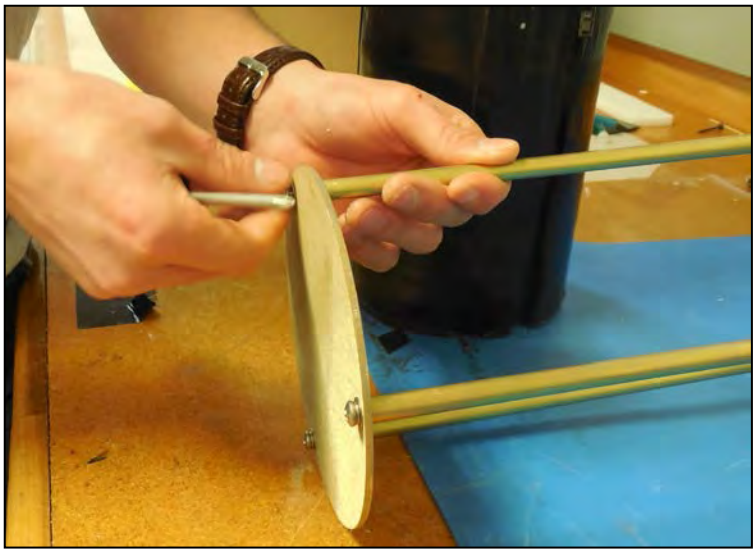

Figure C.2-3: Removing Battery Housing End Plate

5. Align the battery to insert the connector through the hole in the Top Plate.

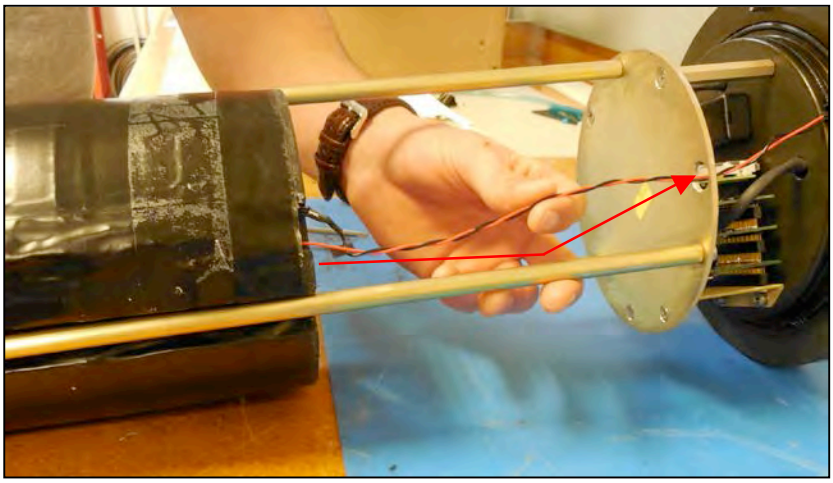

Figure C.2-4: Align Battery to Fit Connecter Through Hole in Top Plate

6. When installing the A72-1000 battery pack, align the hole in the battery frame with the wires at the top of the battery. Feed the connector wires through the battery feed through hole in the battery holder frame. (Figure C.2-5).

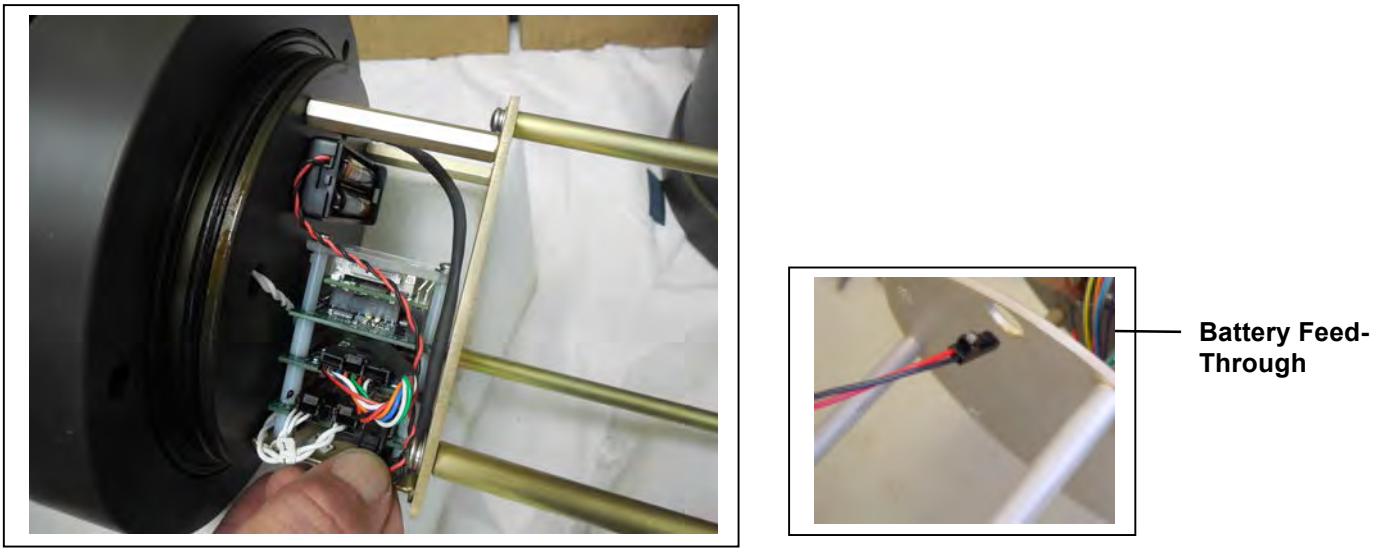

Figure C.2-5: Correctly Feeding Battery Connection Wires and Connecting Battery

7. Connect the main battery to the connector on the electronics stack.

8. Install the AAA batteries into the holder. These batteries are shipped with the toolkit. The backup batteries are required to deploy the sampler but will not power the instrument.

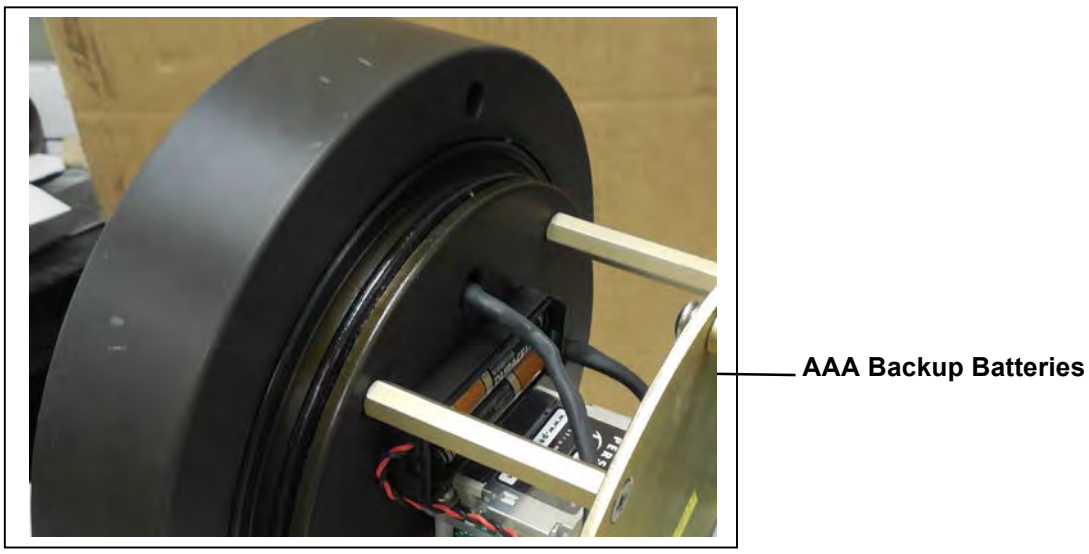

Figure C.2-6: Backup Batteries

9. Close the controller housing.

10. Remove the dummy plug from the communications connector.

11. Attach the communication cable assembly (supplied in the toolkit) first to the PC serial port and then to the main battery bulkhead connector on the controller housing.
12. Before disconnecting power, press [CTRL]-[C] to return to the Main Menu and select Sleep
13. Continue with deployment steps as explained in the 'User Interface' chapter of this User Manual.

Trigger Start

The trigger start is included on the WTS-LV Upright and WTS-LV Dual Filter models.

For details on the Trigger Start see Chapter 5 "Electronics Description" and Chapter 6 " Operations", in this User Manual.

Deploy

```
Selection [] ? D

System status:

   Date     Time     Battery    Temp Port
 03/17/15 13:18:27  30.8 Vb  18.0∞C 00 (home)

Caution: Deployment will overwrite the EEPROM data backup cache.

Performing 6 second Backup Battery test...

!!! CANNOT CONTINUE - CHECK BACKUP BATTERY !!!
```

Figure C.2-7: System Status

The steps that follow explain how to complete the deployment.

1. Select *D* to proceed with the deployment when the sample parameters are complete.
2. One line of system status information displays followed by a message reminder to offload data written to the EEPROM backup during a previous deployment. Disregard the message if the data has already been recovered.

In firmware v2.08 and above, the pre-deployment process checks to confirm that backup batteries are correctly installed. If backup batteries are not detected, the firmware will not accept the 'Y' entry to start the deployment.

3. The data offload reminder and battery check will be followed by and a prompt to proceed with or terminate the deployment (a final chance to check the settings prior to deployment).

4. The firmware performs a consistency check. If the main battery voltage is too low to support the deployment, warnings will display (see Chapter 3 for battery voltage warnings).

5. Once the system is ready to deploy, remove the communications cable, replace the dummy connector, and connect to the wire. The system will remain in the Suspend mode until the scheduled time of the pumping event. At that time the system will automatically wake up and begin sampling.

```
CAUTION: Deployment will ERASE all EEPROM data backup entries.

 Proceed with the deployment [N] ? y

 Trigger delay: 00:30:00  [HH:MM:SS]

 Disconnect and reconnect trigger plug, or press ^C to abort...
Trigger received.
Waiting for scheduled event @ 04/06/15 12:29:08
Remove communication cable and attach dummy plug.
System is ready to deploy...
04/06/15 11:59:08 Suspended until 04/06/15 12:29:08 ...
```

Figure C.2-8: Deploy System – Trigger Installed

Pumping begins whether or not the WTS-LV is on station. Reconnecting the COM cable and typing [CTRL]-[C] will terminate the deployment.

Notes

Section C.3
WTS-LV Bore Hole Model

The Bore-Hole WTS-LV (Figure C.3-1) is designed to fit through a narrow opening such as a 30cm bore-hole and collect a single suspended particulate sample *in situ* onto a 142mm membrane filter.

Figure C.3-1: Bore-Hole WTS-LV

The Bore-Hole WTS-LV is identical to the standard WTS-LV, with a re-arrangement of the components. The physical dimensions and component arrangement are illustrated in Figure C.3-2:

Height: 160cm (63in)
Diameter: 26cm (10.36in)

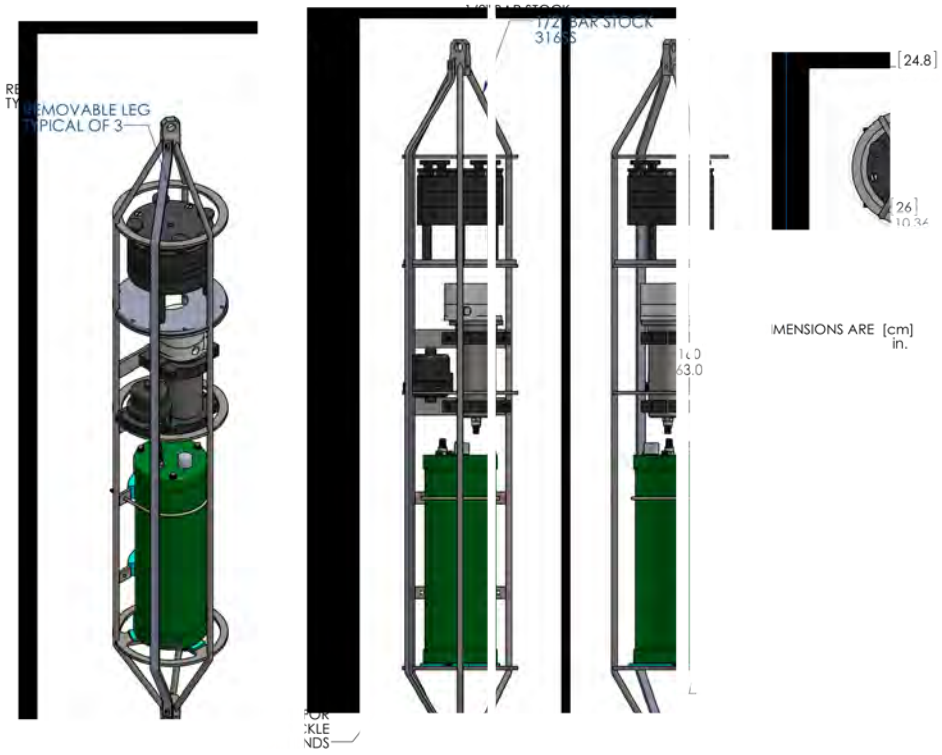

Figure C.3-2: Bore-Hole WTS-LV Schematic

Installing the Batteries

The Bore-Hole WTS-LV uses the drop-in battery pack (same as the standard WTS-LV), which contains 24 “D” cell batteries and has 10,000 mAh of battery capacity. To install the batteries, one of the three frame guards that protect the controller housing and the two u-bolts that further secure the controller housing must be removed and the controller housing lifted out of the frame.

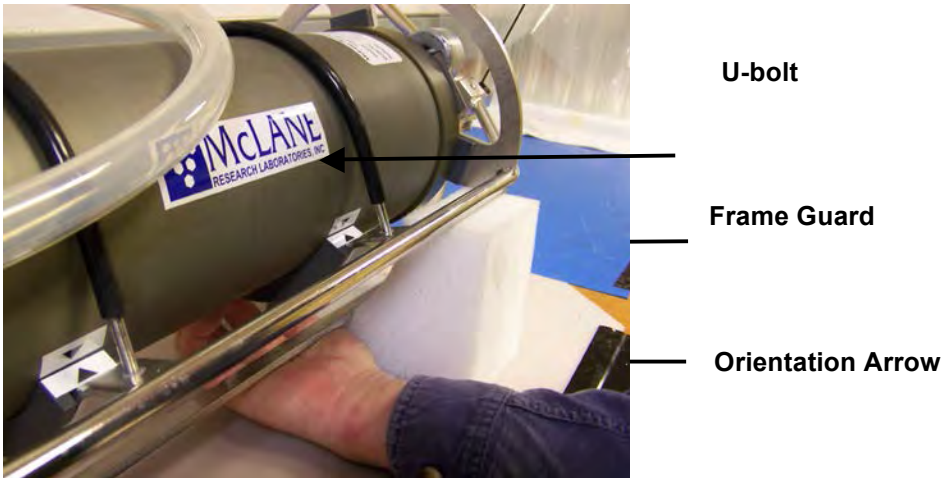

Figure C.3-3: WTS-LV Frame Guards, U-Bolts and Orientation Arrows

A 7/16” Box Wrench and an Adjustable Wrench are included in the toolkit as shown in Figure C-3.4 to remove and reinstall the frame guard and u-bolts.

When removing the controller housing, the white exhaust tubing can be moved out of the way or disconnected at the inlet to the flow meter as shown in Figure C.3-5. To install batteries in the controller housing, complete the following steps:

Figure C.3-4: 7/16" Box Wrench, Adjustable Wrench

Figure C.3-5: Moving Exhaust Tubing

1. Position the WTS-LV on a flat surface and stable support so that it does not roll (Figure C.3-6). Foam cradles from the shipping crate work well for this purpose.

Figure C.3-6: Place on a Stable Surface

2. Remove the connector from the controller housing (Figure C.3-7).
3. Using the adjustable wrench, loosen the connecting bolt on one of the frame guards (Figure C.3-8)

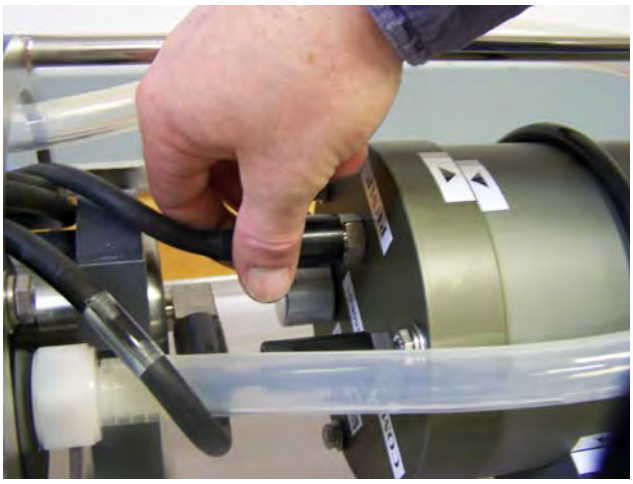

Figure C.3-7: Removing Connector

Figure C.3-8: Loosening Frame Guard

4. Slide the frame guard away from the controller housing (Figure C.3-9).
5. Using the box wrench, loosen the bolts at the bottom of the u-bolts (Figure C.3-10).

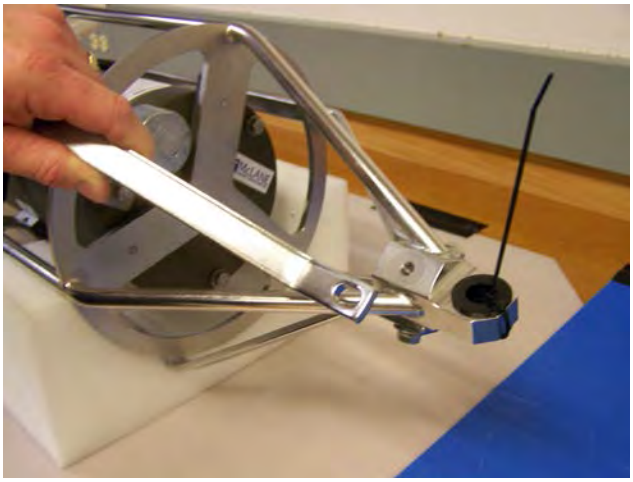

Figure C.3-9: Removing Leg Bolt

Figure C.3-10: Loosening U-Bolt Clamp

6. Using the box wrench, loosen the bolts at the bottom of the u-bolts and remove the u-bolts (Figure C.3-11).
7. Gently lift the controller housing away from the frame (Figure C.3-12).

Figure C.3-11: Removing U-Bolt

Figure C.3-12: Removing Controller Housing

8. See Chapter 5 “Electronics Description” in this User's Manual for the steps to install batteries.
9. Plug in the battery connector to power the electronics before closing the controller housing.

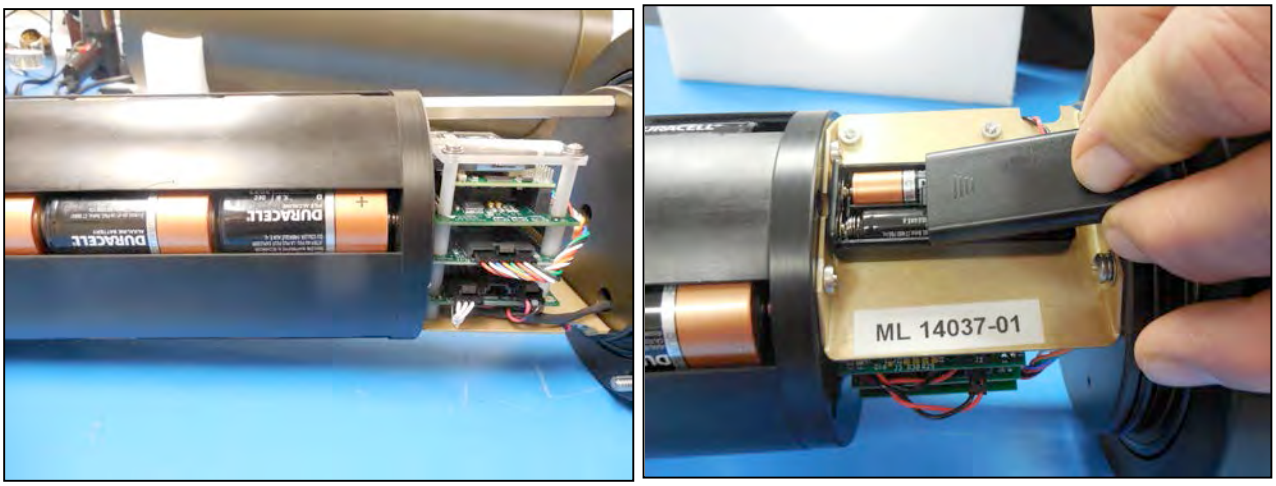

Figure C.3-13: Main and Backup Batteries

10. Connect the main battery to the 2-pin connector on the middle board of the electronics stack.
11. Install the ‘AAA’ backup batteries into the holder.

The backup batteries are required to deploy the sampler. However, these batteries will not power on the sampler.

12. Close the controller housing.

13. Return the controller housing to the frame and reattach the bulkhead connector.
14. Position the controller housing with the alignment arrows as shown in Figure C.3-15.

Correctly aligning the end cap with the orientation arrows is important to ensure proper alignment of the top end cap bulkhead connectors.

Figure C.3-14: Returning Controller to Frame

Figure C.3-15: Aligning Arrows, Reattaching Connector

Notes

Appendix D
Optional Filter Holders

Filters for the WTS-LV are supplied by the user. Available filter holder styles include the standard, vertical intake, 3-tier, cartridge, zooplankton and 293mm filters. The chart in Figure D-1 shows the filter holder options and compatibility with different WTS-LV models. This Appendix describes the 3-tier, and cartridge filter holders. Appendix 'WTS-LV Dual Filter Model' has information about the Vertical Intake filter holder option.

	Standard Radial	Vertical Intake	3-Tier	Cartridge	Zooplankton	293mm
						
Sampler Fit	WTS-LV, WTSLV-DF, WTS-LVUP	WTS-LV, WTSLV-DF, WTS-LV-UP	WTS-LV, WTSLV-DF, WTS-LVUP	WTS-LV	WTS-LV, WTS-LVUP	WTS-LV (special frame)
Description	Radial intake has large horizontal intake openings at the top to provide low resistance path to the filter	Vertical intake minimizes particle wash out	Large horizontal intake with additional pre-filter (mesh or glass)	Cartridge housing for standard 2.5 x 10 inch double open ended (DOE) cartridges	Valved intake	Same as standard radial filter holder with larger diameter for more filter surface area
Filter Size & Specs	142mm mesh, GFF or membrane	142mm mesh, GFF or membrane	142mm mesh, GFF or membrane	10in DOE Cartridge filter	203mm mesh 60μm or greater	293mm mesh or GFF
Flow Rates (Dependent on filter load and pore size)	2-8 liters/min (based on pump head size)	2-8 liters/min(based on pump head size)	2-8 liters/min(based on pump head size)	Variable with choice of cartridge	Up to 30 liters/min depends on mesh size	2-8 liters per minute
Material	Black Acetal	HDPE/Acrylic	Black Acetal	Styrene Acrylon-itrite (SAN) & Polypropylene CAP	HDPE	Black Acetal

WTS-LV and WTS-LV-BH powered by 24 drop-in "D" cell alkaline batteries (10,000 mAh). WTSLV-UP and WTSLV-DF powered by A72-1000 battery pack (30,000 mAh) (3x the battery capacity of the drop-in "D" batteries). Trigger is standard on WTS-LVUP and WTSLV-DF, optional on other WTS-LV models.

15.1.04

Figure D-1: Filter Holder Specifications Chart

WTS-LV with Optional 3-Tier Filter Holders

The WTS-LV modular filter design permits several filters to be stacked in series and used simultaneously. Each filter tier has a filter support frit and supports an independent filter with intermediate spacing for sample accumulation. Multiple filter layers can be used for size fractionation or other specialized programs where *in situ* sample separation is appropriate.

Chapter 6 of this User Manual contains steps for priming the standard WTS-LV filter holder. Follow this procedure for priming the 3-tier filter holder.

Figure D-2: *WTS-LV 3-Tier Filter Holder*

WTS-LV with Optional Cartridge Filter Holder

If optional cartridge filter holders are used, priming is completed using reverse pumping (priming is filling the tubing between the filter holder and the pump with water before installing the filter, to displace any air pockets).

If water can be pumped through the cartridge filters in reverse, install them before the priming process, otherwise install them after the priming is completed. When installing filters after priming, completely refill the cartridge holders before reinstalling on the system.

Figure D-3: WTS-LV with Cartridge Filter Holders

To prime the pump when the cartridge filter holder is in use, complete the following steps:

1. Without removing the filter holder from the frame, unscrew the four knurled nuts located on the top of the assembly and remove the filter holder top and any prefilters.
2. Attach the priming tubing with the quick disconnect (included in the toolkit) to the pump exhaust port located at the end of the flow meter (see Figure D-4).

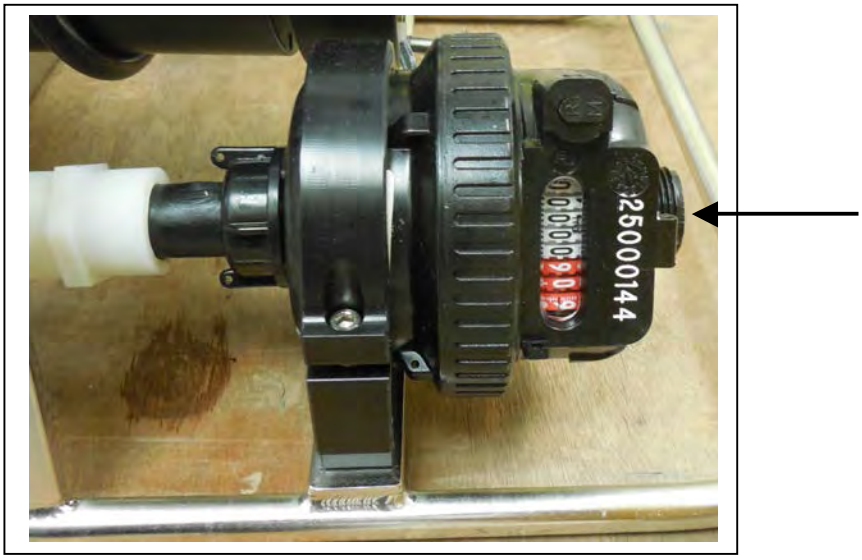

Figure D-4: *Exhaust Port*

3. Once the priming tubing is connected to the pump exhaust, boot the PC, plug the COM cable into the PC serial port and then connect the COM cable to the controller housing.
4. Connect the battery if necessary (if this is the first use of the WTS-LV, the battery will be inside the controller housing but not connected). Steps for connecting the battery are in chapter 3 of this User Manual.
5. Close and seal the controller housing.
6. Using a beaker, pour water into the open end of the priming tube until water drips from one of the Cartridge Holders.
7. Place the free end of the priming tubing into a (minimum) 5 gallon bucket or large reservoir containing several liters of distilled/neutral water. Keep the hose submerged during priming so that air bubbles are not introduced into the system.
8. To assist the water flow, set the reservoir with the intake tube at or above the level of the filter housings.
9. From the Main Menu of the WTS-LV firmware, select <3>, Run Pump.
10. Select <2> run pump: programmable.
11. When prompted, set the volume to several liters, the flow rate to 5000 (the minimum value), the minimum flow rate to 4000 (the minimum value), and the time limit to several minutes.
12. At the prompt, type ‘R’ Reverse pumping.

13. The pump will begin drawing water into the system from the bucket (each of the cartridge holders will fill up consecutively). Once the cartridge holders are all full, water will enter the filter holder below the lowest frit.

This process will occur in approximately 20 seconds or less so watch carefully.

14. Once the water penetrates the frit and begins filling the void above the frit, press [CTRL]-[C] to stop pumping.

Notes

Appendix E
Pump Head Sizing

Available WTS-LV Pump Heads

**** LVO8 is standard on the WTS-LV***

The tables shown next provide a list of available pump heads and recommendations based on compatible filter type and flow rate.

Pump Size	LV04	*LV08	LV30
Flow Rate Range (L/min)	1–4	5–8	15–30

Filter Types and Recommended Pump Heads

			Recommended Pump Heads		
Filter Type	**Pore Size (micron)**	**Max Flow Rate (L/min)**	**LV04**	**LV08**	**LV30**
Polycarbonate and Polyester Membrane (Nucleopore®, Millipore®)	0.2	3	●		
Polycarbonate and Polyester Membrane (Nucleopore®, Millipore®)	0.4	4	●		
Polycarbonate and Polyester Membrane (Nucleopore®, Millipore®)	0.8	8	●	●	
Polycarbonate and Polyester Membrane (Nucleopore®, Millipore®)	1.0	10	●	●	
Glass Fiber (GF/F®, QMA®)	0.8	8	●	●	
	1.7	10	●	●	
	5.0	20	●	●	●
Mesh (Nytex®)	60.0	50	●	●	●

Notes

Appendix F
Using the 30L/Min Pump

The 30L/min pump head is an optional feature of the Upright WTS-LV model (WTS-LVUP). The maximum flow rate of 30L/min can be reached with a 100 µm mesh filter, no frit, no cartridge housing and no flow meter installed. Installing a frit, cartridge housing and/or flow meter produces lower maximum flow rates.

As shown in Figure F-1, the WTS-LVUP with 30L/min pump is shipped with no flow meter installed (the flow meter is included in the crate). Installing the flow meter creates back pressure on the pump exhaust which slows the maximum flow rate. A 16L/min flow rate is the maximum that is reached with the flow meter installed. Pump testing results shown on the next page explain how maximum flow rate is affected by the flow meter, cartridge housing, and frits.

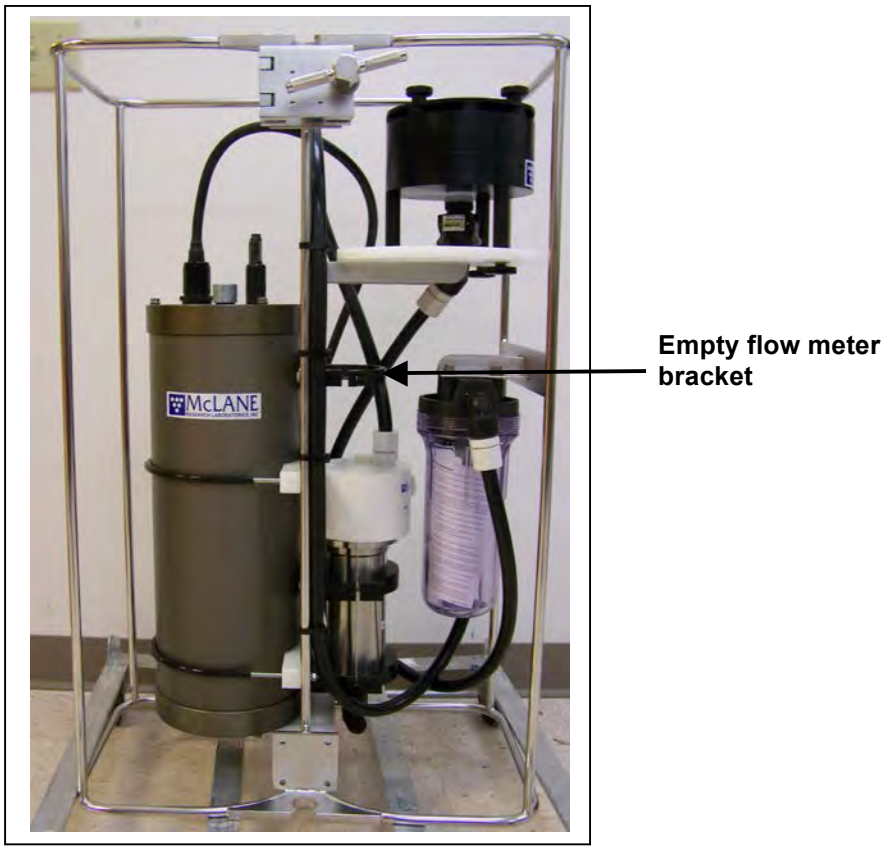

Figure F-1: WTS-LV Upright with 30L/min Pump Head

The table below shows flow rate results testing the 30L/min pump head with different options. A 2000 mA motor current was used for this testing. There was no filter in the cartridge housing to maximize the flow rate. As shown, adding a cartridge filter holder or flow meter further reduces the maximum flow rate.

Filter	Frit	Cartridge Housing	Flowmeter	Maximum Flow Rate (L/min)
100 µm Mesh	None	None	None	30
3 µm	Standard	None	None	25
3 µm	Standard	10" DOE (double open ended plumbing only - no filter installed)	None	23
3 µm	Standard	10" DOE (double open ended plumbing only - no filter installed)	V100	16

The WTS-LV requires a filter with a pore size of 3 µm or greater. Pumping through a 3 µm filter with the 30L/min pump head, no cartridge housing and no flow meter produces a maximum flow rate of 25L/min. When the 30L/min pump head is installed, the WTS-LVUP firmware initial pumping flow rate can be set from 15000 to 25000 ml/min (15L/ - 25L /min). Using the flow meter reduces the maximum flow rate to 16L/min.

Deployment Programming Settings

The screens that follow show deployment settings when the 30L/min pump is installed.

```
_____________________________________________________________________
Configuration: LV-30G_TR                CF2 V2_07 of Jan 15 2015

               McLane Research Laboratories, Inc.
                      Large Volume Sampler
                           ML12345-02
               ____________________________________
                           Main Menu
               ____________________________________
                   Tue Jun 16 10:52:47 2015

          <1> Set Time          <5> Deploy System
          <2> Diagnostics       <6> Offload Data
          <3> Manual Operation  <7> Contacting McLane
          <4> Sleep             <C> Configure

          Selection [] ? c  Password: ***


_____________________________________________________________________

Configuration: LV-30G_TR                CF2 V2_07 of Jan 15 2015
               ____________________________________
                        Configuration Menu
               ____________________________________
                   Tue Jun 16 10:52:53 2015

          <A> Pressure Sensor               [No]
          <B> Pump                          [Gearhead  30 L/Min.]
          <C> Rechargeable Battery          [No]
          <D> Trigger                       [Enabled]

          <X> Save & Exit          <^C> Cancel & Exit


          Selection [ ] ? x

          Configuration successfully stored
```

Figure F-2: WTS-LV Configuration Settings

The WTS-LV is expected to stop pumping on minimum flow rate due to accumulation of the sample on the filter. The sampler will also stop pumping if the sample volume or time limit is reached or the battery drops below 18 V.

```
_____________________________________________________________________

Configuration: LV-30G_TR               CF2 V2_07 of Jan 15 2015

               McLane Research Laboratories, Inc.
                      Large Volume Sampler
                           ML12345-02
               _____________________________
                           Main Menu
               _____________________________
                   Tue Jun 16 10:58:01 2015

          <1> Set Time          <5> Deploy System
          <2> Diagnostics       <6> Offload Data
          <3> Manual Operation  <7> Contacting McLane
          <4> Sleep             <C> Configure

          Selection [] ? 5

Clock reads 06/16/15 10:58:06.  Change [N] ? y

Format is mm/dd/[yyyy or yy] hh:mm:ss

Enter correct time [06/16/2015 10:58:09] ? 06/16/2015 10:58:15

Clock reads 06/16/15 10:58:15.  Change [N] ?

_____________________________________________________________________

 Header 1|
        2|
        3|

 Sample 4| Sample volume     =      100  [liters]
        5| Initial flow rate =    20000  [ml/min]
        6| Minimum flow rate =    10000  [ml/min]
        7| Time limit        =        9  [minutes]

 Data   8| Pump data period  =        1  [minutes]

 Start  9| Countdown timer:    01:00:00  [HH:MM:SS]

        D| Done.  Continue pre-deployment set-up.

        Selection [] ? 1

> Test, 6-16-2015
```

Initial Flow Rate 15000 – 25000 mL/min

Figure F-2: WTS-LV Deployment Settings

Battery Endurance Example Calculation

Battery life for a planned WTS-LV upright sampler deployment can be estimated using the instrument current consumption values provided here. These values apply to the CF2 microcontroller. A 30L/min pump operated at 25L/min is used for the example. In addition to pumping time, many other deployment conditions can affect the battery duration. Use this example for estimation only.

- The pre-deployment pumping time assumes initial setup steps and does not include bench testing or running diagnostics.
- Pumping assumes an unrestricted flow.

Battery Estimate – A72-1000 Battery

The WTS-LV Upright model uses an A72-1000 battery with a 30,000 mAh capacity.

Pre-deployment	
Controller (1 hour)	1 h x 15 mA = 15 mAh
Pumping (0.2 hour)	0.2 x 2000 mA = 400 mAh
	Subtotal = 415 mAh
Deployment	
Controller (6 hours)	6 h x 15 mA = 90 mAh
Pumping (6 hours)	6 h x 2000 mA = 12,000mAh
	Subtotal = 12,090 mAh
Recovery	
Controller (1 hour)	1 h x 15 mA = 15 mAh
	Subtotal = 15 mAh
Total Power Consumption	**Total = 12,520 mAh**

In this example deployment, the estimated battery drain totals 12,520 mAh. This is less than the 30,000 mAh capacity of the A72-1000 battery.

Notes