

LISST-Infinite / LISST-Hydro

Particle Size Analyzer

User's Manual

Version 3.1

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A list of local Sequoia distributors can be found at our website <http://www.sequoiasci.com/about/contact/>

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Section 1: Introduction

1.1 Overview

	The LISST-Infinite and Hydro are two distinct on-line suspended sediment instrument systems. They measure the detailed size distribution and concentration of sediment particles suspended in water. The LISST-Hydro is used in applications with lower sediment concentrations, up to ~3,000 mg/L (ppm). The LISST-Infinite has an auto-dilution system so that it can analyze water with higher sediment concentrations. This automatic dilution enables the accurate measurement at concentrations up to approximately ~30,000 ppm. These limits are approximate because the exact limits depend on grain size. For more details, see http://www.sequoiasci.com/article/lisst-concentration-limits/.
Operations	Both instruments require a local, filtered clean water tank to 'zero' the instrument before each sample. The turbid sample water (from turbine, or river) is either pumped or piped to the instrument. A mix of these instruments can be installed at a power plant or at other facility.
Software	The LISST-Infinite and Hydro are operated by common software. Two software programs serve these separate functions: (i) scheduling of data collection, and writing of data and log files, and (ii) reading of data and log files to display data in a strip chart. The scheduling software is called Master Controller (MC), the display software is called Viewer.
Warnings and Alarms	Viewer charts can be displayed on multiple computers that can access common datafiles on a network, or in a cloud, e.g. Dropbox. In this case, the Viewer also generates warnings at each viewing station. Warnings are for high sediment concentrations, or auxiliary functions. The auxiliary function warnings are generated by the MC. The MC writes warning messages in the log file and these are read by the Viewer and displayed. Only the high sediment concentration alarm is set locally at the Viewer.
Data Archive	Data are archived at the end of each month for report preparation. Archive files can be opened by Viewer software for review and report preparations, etc.
Modbus Interface Option	Operators with SCADA systems can interface to the instruments through an optional Modbus-Ethernet module. In this case, the Sequoia Windows software is not used. <i>Operators using Modbus are responsible for programming their own SCADA system to collect, display and interpret data.</i>

1.2 Technology

The instruments measure multi-angle scattering of laser light, from which the particle size distribution is computed.

Laser Diffraction Water passes between two windows of a test cell. Laser light is scattered by particles between the windows. This scattered light is detected by a 32-element detector. Some light is also scattered by the glass walls of the cell, which constitutes a 'background' measurement. This background scattering is measured by passing clean water through the cell. This background is used to zero the measurement. A micro-computer in the instrument reads the detectors and other parameters, and transfers the data to the Master Controller.

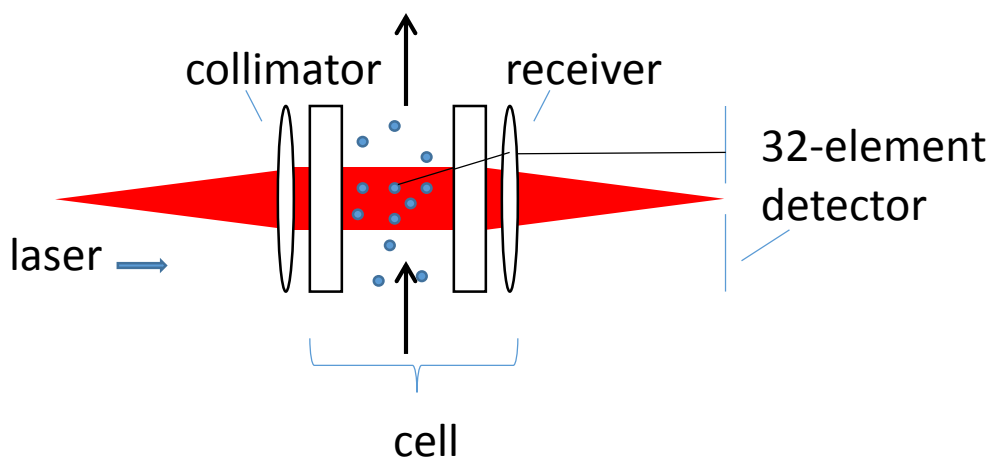


Figure 1. LISST-Infinite/LISST-Hydro optics. Water flows through a test cell. A laser beam crossing the cell causes particles to scatter light. The scattered light is collected by the receiving lens and sensed by a 32-element detector at its back focus.

The LISST-Infinite/Hydro system consists of (i) the main instrument containing the optics and electronics; (ii) a water feeder (either a tube from a turbine, or a submersible pump to lift water from a river, power-plant intake, or elsewhere; (iii) a clean water tank; (iv) a power conditioning unit; and (v) a Windows based PC to control instrument operations, receive, store, and display the data. A version for SCADA based operation is offered. Please contact factory for details.

Particle Size Distribution This technology is commonly known as Laser Diffraction or multi-angle laser scattering. It is the only technology available at the time of this writing (June 2014) that can (a) measure sediment concentration accurately over a 200:1 size range of sediment grains; and (b) obtain size distribution with a high resolution in sizes. Thus, these instruments provide concentration of sediments in 3 size ranges, fine ($<75\ \mu\text{m}$; medium ($75\text{--}200\ \mu\text{m}$) and coarse, $>200\ \mu\text{m}$.) High resolution data is saved.

1.3 Subsystems

The LISST-Infinite instrument consists of the following component systems (Fig.2):

- A flow-through cell and laser diffraction optics (Fig.1)
- Electronically controlled valves to control the flow of clean and turbid water
- Dilution Chamber and mixing pump (LISST-Infinite only)
- Valve controller and main electronics boards.

Figure 2 shows more details.

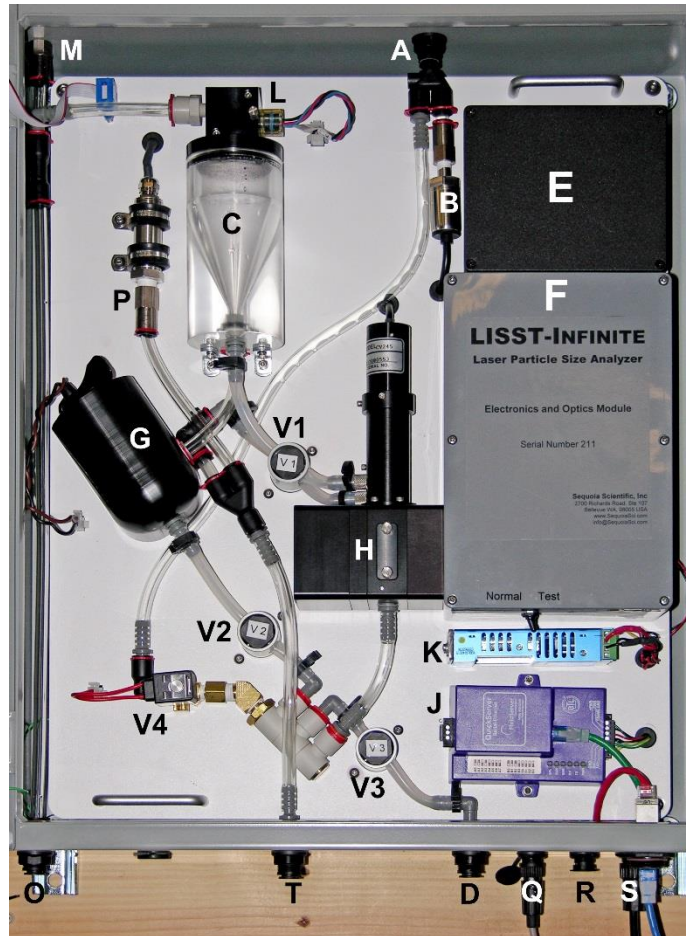


Figure 2. LISST-Infinite Subsystems

A: Clean water input; B: Clean water pressure sensor; C: Dilution chamber; D: Drain; E: Ultrasonic controller electronics; F: Electronics and optics module; G: Mixing pump; H: Optics cleaning port; J: Optional modbus interface (not present on all units); K: Optional power adapter (not present on all units); L: Dilution tank fill sensor; M: Air vent; O: Overflow drain; P: Turbid water pressure sensor; Q: Serial data connector; R: Pump controller connector; S: DC power input connector; T: Turbid water inlet

The LISST-Hydro instrument consists of the following component systems (Fig.3):

- A flow-through cell and laser diffraction optics (Fig.1)
- Electronically controlled valves to control the flow of clean and turbid water
- Valve controller and main electronics boards.

Figure 3 shows more details.

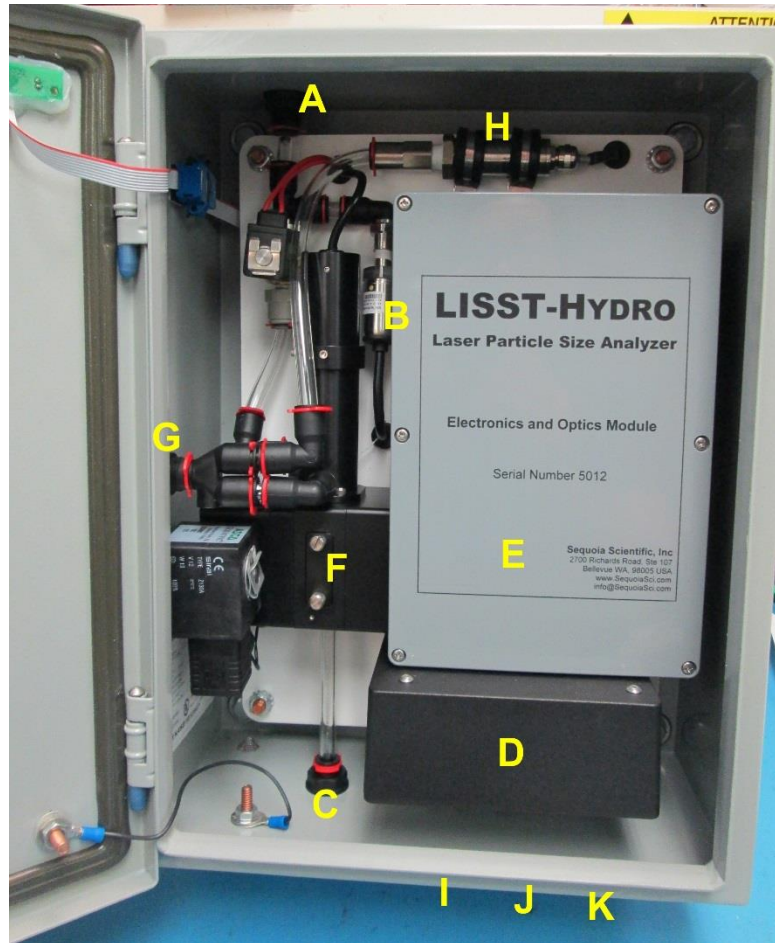


Figure 3. LISST-Hydro Subsystems

A: Clean water input; B: Clean water pressure sensor; C: Drain; D: Ultrasonic controller electronics; E: Electronics and optics module; F: Optics cleaning port; G: Turbid water inlet; H: Turbid water pressure sensor; I: Serial data connector; J: Pump controller connector; K: DC power input connector;

1.4 Data Acquisition Sequence

There are 5 steps in data acquisition for a single sample of river water.

- Acquisition of clean water background measurement
- Acquisition of laser scattering data from turbid water.
- Dilution (if needed) and re-acquisition of scattering data (LISST-Infinite only).
- Transmission of data to MODBUS or PC for display and storage
- System flushing and preparation for next sample.

Clean Water Background

The first step is to acquire a measurement of light scattering from optics cell windows. The sample cell is filled with clean water. Laser is turned on and scattering from cell windows is stored. This background measurement effectively “zeros” the instrument and compensates for any window fouling (build-up of particles on the optical windows).

Since a background is obtained before each sample, drifts due to fouling of the optical windows are eliminated. The background scattering for each sample is also saved in data files so that a history of window fouling is available.

Turbid Water Sample

The pinch valves in the instrument are activated to allow the turbid water to flow through the optics cell. A long flush time is used to replace the clean water with turbid sample, and to equilibrate the temperature of the optics cell. Next, the laser beam is turned on and a determination is made if dilution is required. If no dilution is required, the light scattering on ring detectors is measured, and transmitted to MODBUS or PC. If a dilution is required, a sample of turbid water is captured, and it is diluted by a fixed factor, by mixing with water from the clean water tank. Next, laser scattering on ring detectors is measured and transmitted to MODBUS or PC.

The LISST-Hydro does not have a dilution capability.

System Flushing and preparation for next sample

After obtaining a measurement the system must reset itself before the next sample can be measured. The entire instrument is drained and flushed as needed. All particles from previous measurements are drained. A reading of clean water tank level is taken and stored in the datafile.

The system is now ready to accept commands from LISST-Infinite Master Controller for the next sample.

1.5 Data Display

When the Viewer software is set up, i.e. number of instruments at the installation and file locations are entered, the Viewer displays data saved in files. The Viewer constantly looks for file updates. When new data are written to files, the display is updated. On MODBUS based installations, display and warnings are generated by the plant operator.

The Viewer software launches automatically **on user login**, using the last settings for file locations. This ensures always being ready to generate warnings and alerts. The automatic start may be disabled in the Settings. Note also that if you close the software window, the Viewer, when restarted, will not load the files automatically.

At least one user MUST LOG IN before the software can start.

Section 2: Software Setup and Operation

2.0 Overview

Your instruments and software should be installed by Sequoia trained technicians. You will receive training at your installation on the use of this software. You will not need to install the software.

However, In the event that you do need to reinstall the software on a new computer or to install a new version, we include instructions for installation of software here.

The LISST-Infinite/Hydro instruments are controlled by two separate stand-alone programs: Master Controller, and Viewer.

Special Setups

Some users will collect data through Modbus or 4-20 mA interfaces to their SCADA systems. Modbus installations will not use the Sequoia software. 4-20 mA installations use

Master Controller

The first software is **Master Controller** (MC). It commands instruments to collect data, processes the data, and stores data files. It also displays the *current* data on the computer where the software is running. The MC also monitors instrument health and displays warnings. It writes error messages in log files for the Viewer to display them.

The MC can be setup to control up to 5 instruments.

Viewer

The second software is the **LISST-Viewer**. The Viewer reads the files created by the MC and displays a history in strip chart format. The Viewer is a stand-alone software so that it may be installed on remote computers. If the data files can be read by these remote computers on a network or on a cloud (e.g. Dropbox), any number of people may view the data on their computers. For example, the MC may run in the Turbine control room, whereas the Viewer may run there, at the office of the Plant Manager, and in Corporate offices for those who wish to monitor sediments.

The Viewer can also display data from up to 5 instruments.

The Viewer reads log files written by MC and displays the same warnings. Unlike the MC, it generates Alarms (see Section 3).

Warnings and Alarms

The software generate two types of alerts. Warnings are those that do not disrupt instrument operation, but must be attended. Alarms are those that require urgent attention. Alarms are displayed in bright orange ('Flamboyant') boxes, with audible noise. There are around a dozen Warnings that are displayed by the Viewer. Only Alarms are displayed in the flamboyant dialog box

2.1: LISST-Infinite Master Controller Software Installation and Use

2.1.1 Installing Master Controller

The LISST-Infinite Master Controller would be installed by Sequoia trained technicians at commissioning. If so, skip sections 2.1.1, and 2.1.2. If installing the software for the first time, or for an update, follow steps 2.1.1 onwards.

Software is provided on a USB card with each LISST-Infinite. This contains the software necessary to operate the LISST-Infinite. An installer is included that extracts the files into the proper locations. To start the install process, run the SetupInfinite.EXE program on the CD. You will be prompted to select a location to install the program. The default folder is C:\Program Files\ Sequoia\ LISSTMstController (for 32-bit Windows) or C:\Program Files (x86)\ Sequoia\ LISSTMstController (for 64-bit Windows). Other folders may also be selected. However, it is recommended that the default folder be selected.

2.1.2 Master Controller Setup

The installation creates a short-cut to Master Controller on your desktop. This short-cut can be used to launch the software. Alternately, the LISST-Infinite software can be started from the Start menu.

The Master Controller setup is not necessary unless you are installing the software for the first time, or installing a software update.

After installing the software on a PC, but before start of data collection, the MC needs information on how many instruments are to be controlled and monitored, what type of instruments they are, where the files are to be saved, and Com Port to use.

Launch the Master Controller software by double-clicking its icon on the desktop. Begin by choosing the Settings menu, then select the Instruments tab. The Instrument Master Controller Settings dialog box will open.

Select
Instruments to
Display in Current
Values Display

LISST Instrument Master Controller Settings

Instruments | 4-20 MA Output | File Location | Serial Port

Instrument #1 Location: Infinite206
Instrument #1 Type: LISST-Infinite
Instrument #2 Location: Hydro 3031
Instrument #2 Type: LISST-Hydro
Instrument #3 Location: Hydro 3032
Instrument #3 Type: LISST-Hydro
Instrument #4 Location: Hydro 3033
Instrument #4 Type: LISST-Hydro
Instrument #5 Location: Hydro 3034
Instrument #5 Type: LISST-Hydro

Time Between Samples: 20 Minutes (10 is minimum)

OK Cancel

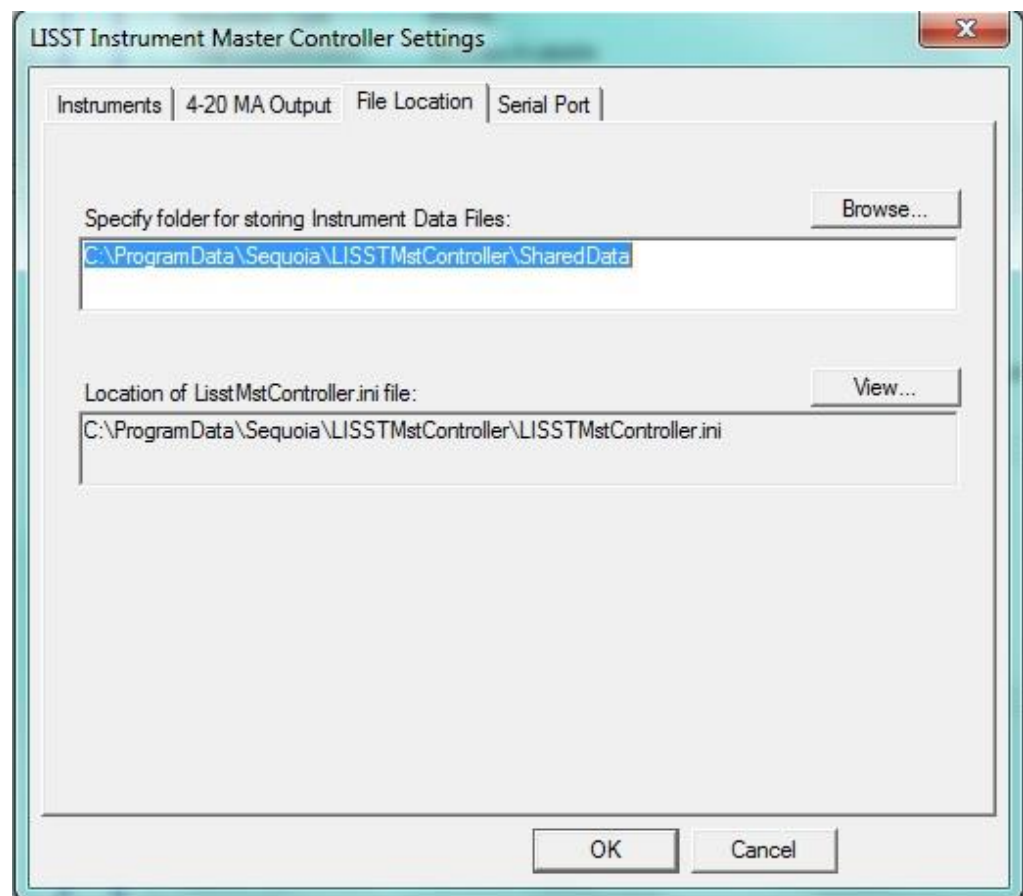
In the text box that reads 'Instrument #1 Location, enter a descriptive name e.g. Turbine #1 Intake. Then use the drop down menu to select the instrument type for Instrument #1. Your choices are LISST-Infinite, LISST-HYDRO, or None. Select the appropriate instrument. If you select '[None]', no instrument will be displayed in the space for that instrument in the Current Values Display. Continue labeling as necessary for the remaining instruments.

Disabling an instrument If you need to disable an instrument display (e.g. while it is in service) enter None for that Instrument Type.

Select Location of Files To specify the location where the data files from the instruments are to be saved, select Settings, and then click the File Location tab. The File Location dialog box appears.

Use the browse button to select the Folder where you want the data from the instruments to be stored, and then click OK.

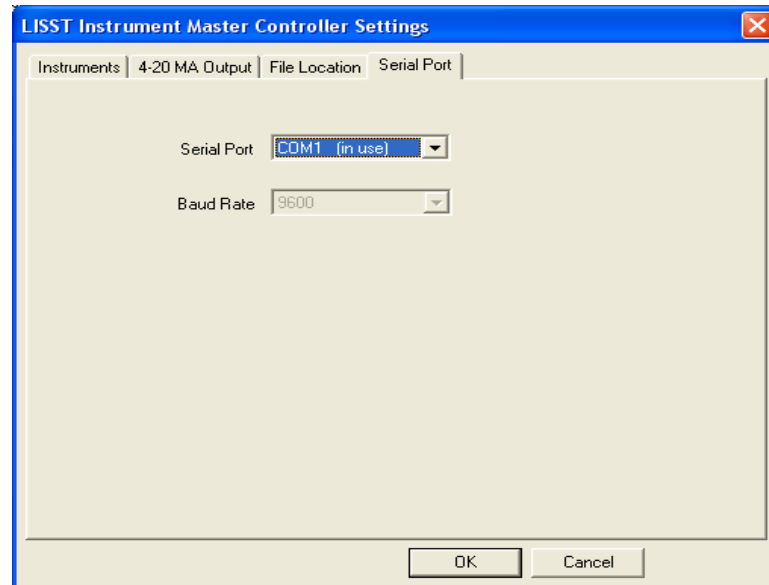
Note that the location of the LisstMstController.ini file is also displayed here. The instruments obtain their calibration constants from this file. The user cannot change this location; it is displayed only for informational purposes. In order to open and view the content of the .INI file, click the View button.



Factory Background files are always stored in the same location as where the .exe was installed. The user has no option to change this, and that is why there is no selection ability on the dialog box. On 32-bit Windows, they would be stored in: C:\Program Files\Sequoia\LISSTMstController. On 64-bit Windows, they would be stored in: C:\Program Files (x86)\Sequoia\LISSTMstController.

Select Serial Port

As the last setting to be completed before we can start sampling, we must select the serial port that the instruments are connected to. Select Settings, then click the Serial Port tab. In the dropdown menu, select the Serial Port the instruments are connected to. Then click the OK button.

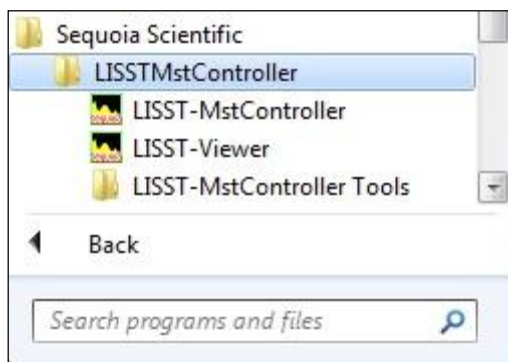


Setup is Complete

All essential information for the MC is now entered. You are ready to start collecting data.

2.1.3: Start Master Controller

Launch the MC by double-clicking the short-cut icon. Alternately, you may launch the LISST-Infinite Master Controller Software by selecting Start / All Programs / Sequoia Scientific / LISSTMstController, then select the LISST-MstController to start the program:



2.1.4 Start Data Collection

If the instruments have both been installed according to the installation instructions (see separate installation manual), the clean water tank is filled, the instruments are connected to the turbid source, and all settings are as desired, one more setting is remaining. You will see the LISST Instrument Master Controller Settings window. (see previous page).

Set Time Between Samples

On the LISST Instrument Master Controller Settings you need to select the time between samples. This cannot be less than 10 minutes. This minimum time is needed to receive data from all instruments.

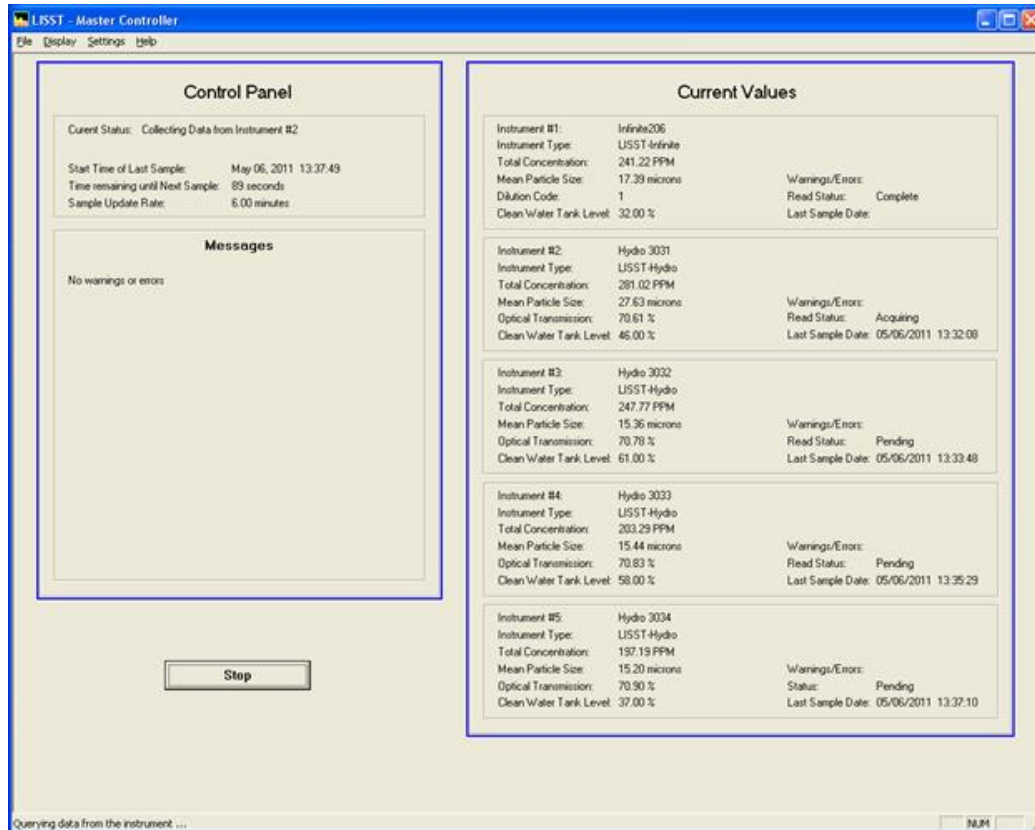
During 'off-season', i.e. a season when low sediment concentration are expected, you may choose 12 hours as sample interval. During active rainfall/snowmelt periods, we recommend an interval of 1 hour. This is because some rivers can see sediment concentration increase from baseline to high values in just 4 hours.



To start sampling, click the Start Button below the Control Panel display in the LISST-Infinite Master Controller Software.

The Start button is the only way to start sampling with the LISST-Infinite Master Controller Software.

MC Display



When the sampling has been started, the Current Values Display will update with the data from each instrument as they have been received and processed by the monitoring PC.

The system will display warning symbols and messages as needed (see Section 3, Errors and Maintenance).

2.1.5 Viewing Data History

The last sample obtained from each instrument is available for viewing on the Current Values Display. In the example, Instrument #1 has completed its data collection, Instrument #2 is currently acquiring data, and instruments #3-5 are pending.

To view details of past data in strip-chart format, LISST-Infinite Viewer software is provided. This is described in the next section, 2.2.

2.1.6 Stop Data Collection

To stop data collection, press the STOP button on the MC display.

...

Optional: Select 4-20 mA output

As an optional feature, the LISST-Infinite can output the total concentration and average particle size as a 4-20 mA signal, for easy incorporation into an existing SCADA system. This requires optional hardware

The screenshot shows a software window titled "LISST Instrument Master Controller Settings" with a close button in the top right corner. Inside the window, there are four tabs: "Instruments", "4-20 MA Output", "File Location", and "Serial Port". The "4-20 MA Output" tab is currently selected. This tab contains a table with two main columns: "MIN - 4 MA (>=0) :" and "MAX - 20 MA :". Each column has eight rows of input fields. The rows are labeled as follows: "Instrument #1 Concentration:", "Instrument #1 Mean Size:", "Instrument #2 Concentration:", "Instrument #2 Mean Size:", "Instrument #3 Concentration:", "Instrument #3 Mean Size:", "Instrument #4 Concentration:", and "Instrument #4 Mean Size:". Each of these eight labels is followed by two input fields, one for the MIN column and one for the MAX column. All input fields currently contain the number "15". At the bottom of the dialog box, there are two buttons: "OK" and "Cancel".

	MIN - 4 MA (>=0) :	MAX - 20 MA :
Instrument #1 Concentration:	15	15
Instrument #1 Mean Size:	15	15
Instrument #2 Concentration:	15	15
Instrument #2 Mean Size:	15	15
Instrument #3 Concentration:	15	15
Instrument #3 Mean Size:	15	15
Instrument #4 Concentration:	15	15
Instrument #4 Mean Size:	15	15

In each of the MIN fields on the 4-20 mA tab, enter the value for concentration and particle size that you would like to correspond to a 4 mA output. For example, it makes sense to have a concentration of 0 $\mu\text{l/l}$ and a particle size of 0 μm correspond to the minimum output signal of 4 mA. A loss of signal would then result in negative concentrations and particle sizes, which is physically impossible.

Likewise, in each of the MAX fields on the 20 mA tab, enter the value for concentration and particle size that you would like to correspond to a 20 mA output.

2.2. LISST-Infinite Viewer Software

2.2.1 Features

The LISST-Infinite Viewer software should have been installed on your computer by Sequoia's factory trained technicians. If so, you can skip the Viewer Installation step 2.2.2. Below, we describe the features of, and how to use the Viewer.

The LISST-Infinite Viewer software is provided for viewing a running history of the data [recall, the Master Controller displays only the last data point]. It has the following features:

- View on-line or archive (earlier) data.
- AUTOSTART: Starts automatically after user log-in, to avoid skipping warnings if user forgets to launch Viewer program. However, at least one user must be logged on.
- Multiple users may view a single set of files on remote machines .
- Up to 5 instruments displayed on as many tabs.
- Summary of all instruments and comparison of all instruments displayed.
- Strip Chart display duration can be set from 12 hours to 6 months.
- Fault warnings and Alarms
- User selectable alarm settings for excessive sediment levels.
- Auxiliary data display - clean water tank levels, etc.
- Detailed history of particle size distribution; instrument health.

2.2.2 Viewer Installation

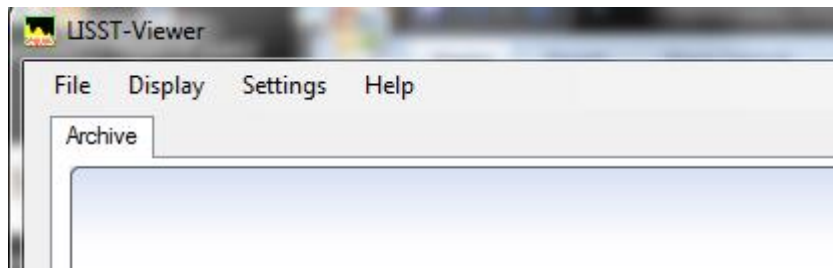
[Skip this section if the Viewer is already installed by factory technicians.]

Autostart A LISST-Infinite software CD is provided with each LISST-Infinite. An install program is included on the CD that will extract the files into the proper locations. To start the install process, run the Setup_MasterNViewer.exe program on the CD. You will be prompted to select a location to install the program. The default folder is C:\Program Files\Sequoia\LISST-Infinite or C:\Program Files (x86)\Sequoia\LISST-Infinite. For 32-bit Windows the location is: C:\Program Files\Sequoia\LISSTMstController. For 64-bit Windows, it is: C:\Program Files (x86)\Sequoia\LISSTMstController. A short-cut to the Viewer will automatically be created on your desktop.

The Autostart feature is provided so that the software is always running when any user is logged in. This ensures that all warnings and alarms remain active.

If the software is stopped, it can be launched from the desktop icon. However, the operator will need to restart the display by choosing File>View On-line Data (or View Archive Data).

First Display Screen On first installation, launching the software produces a blank full-monitor display, of which we show just the top left corner. A part of the top strip chart can also be seen, though no data are displayed since no data files have been selected yet.



2.2.3 Settings

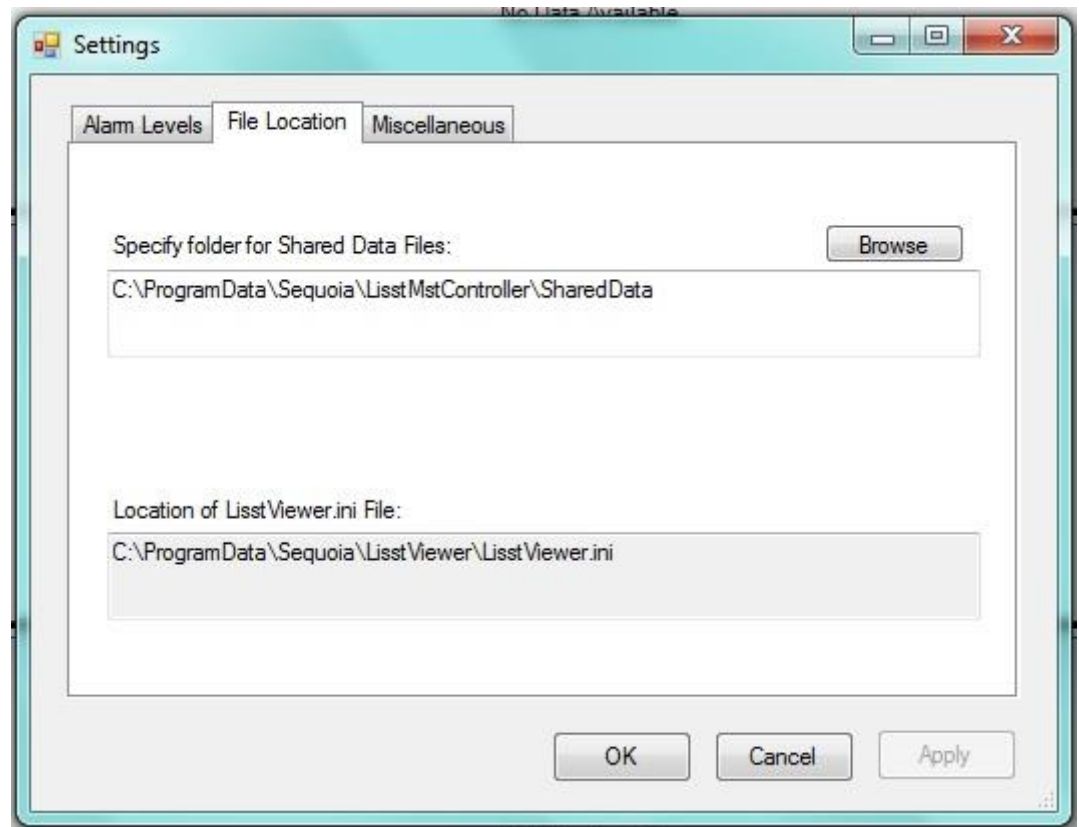
File Locations

This step is only necessary if the software is being set up for the first time.

You may change Locations of data files, display parameters such as alarm levels, and Miscellaneous display features.

To set or change location of data files, choose Settings on the menu bar in LISST Viewer window shown above. The window below will open. Browse to the locations of data files.

Note that the location of data files is defined at the Master Controller. The MC writes the files. The Viewer only reads these files. If not sure, launch the MC software, open Settings > Location of Files, and note the location of data files that is shown there. Insert the same location below.

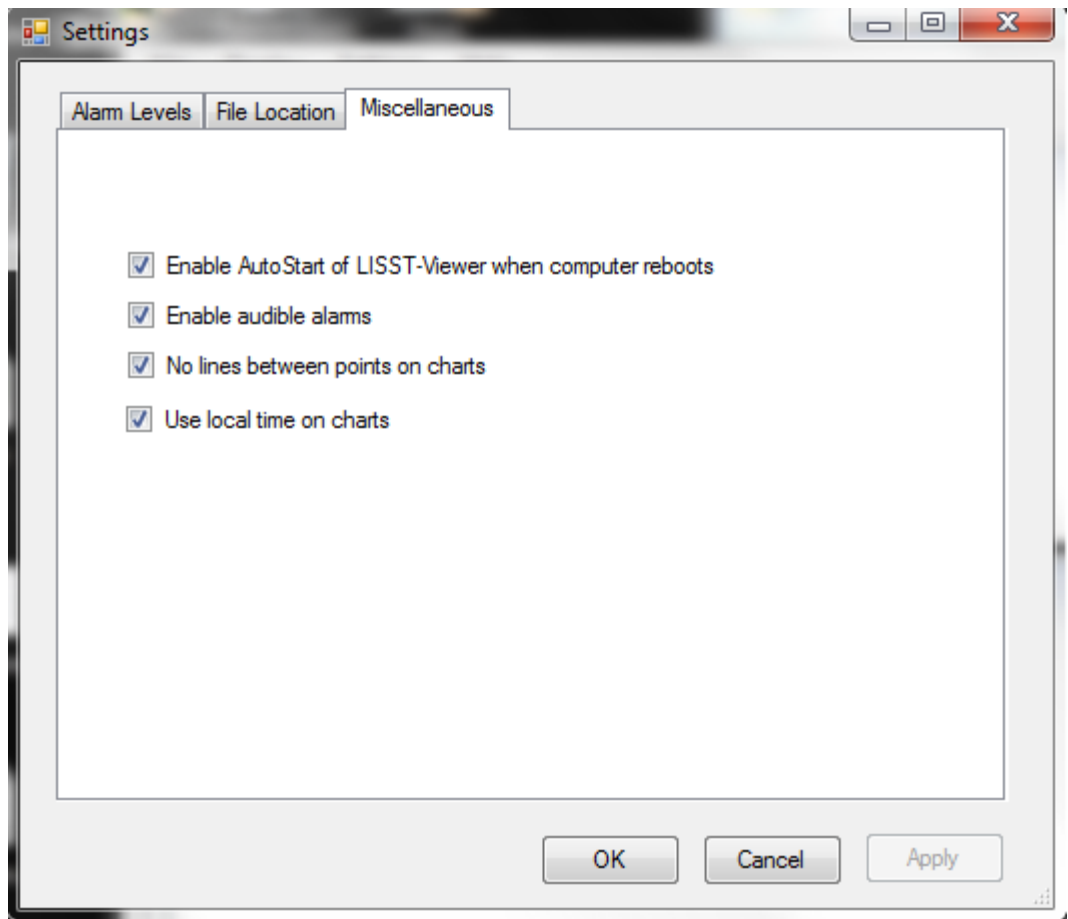


The factory background file and the .ini file are saved in the default folders and cannot be moved. Click ok when done.

Miscellaneous Settings

From the Settings menu, select Miscellaneous tab. You can now:

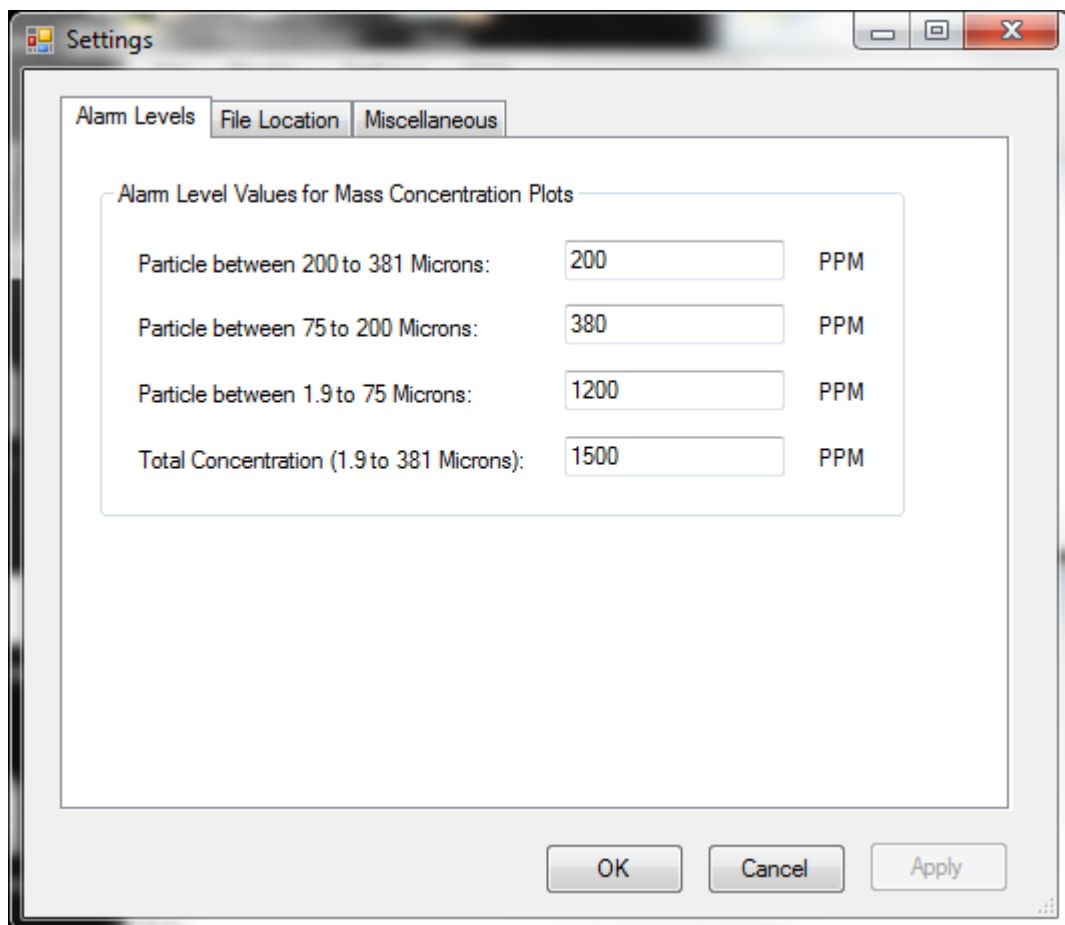
Set Alarm Levels



- autostart of Viewer software on rebooting of computer;
- audible alarms when sediment concentration exceeds safe levels;
- connecting or not connecting data points on strip charts; and
- use of local time on charts(time at Viewer location).

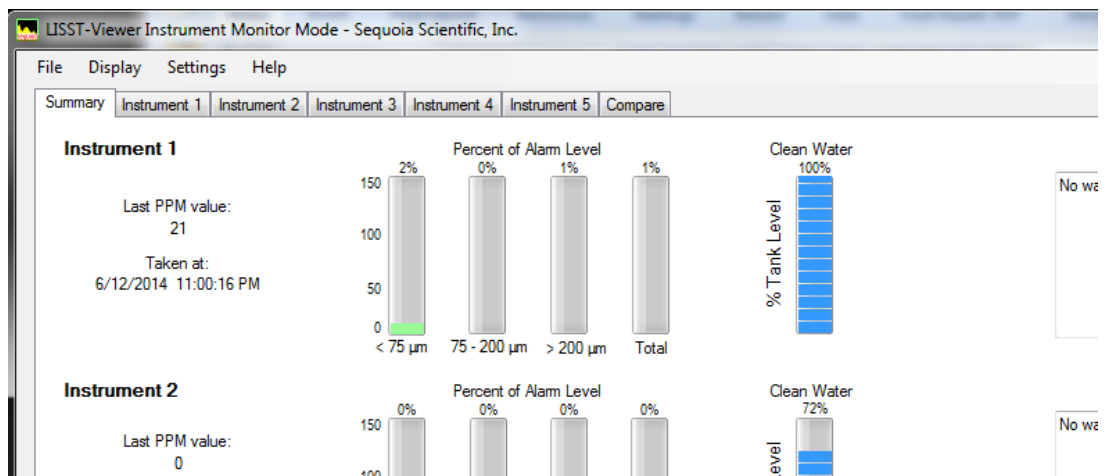
Choose OK when finished selecting.

2.2.4 Viewing Data From the Settings menu, select Alarm Levels. You may set alarm levels for individual size classes independently. All instruments shall use these identical alarm thresholds



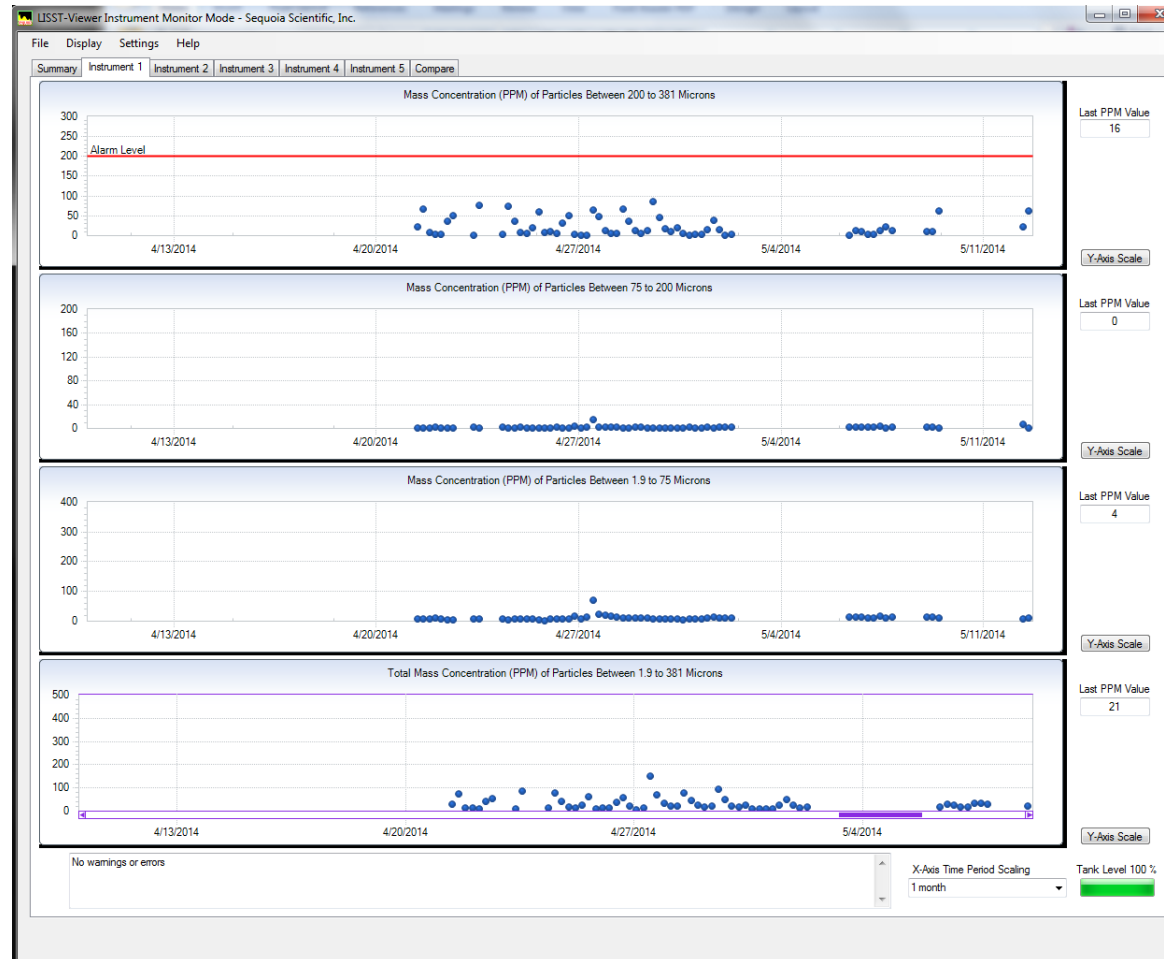
After file locations are specified, choose View On-line data from the File menu. If prompted, browse to the location where you specified saving your data files.

The first screen will appear as below. Again, we show only a top-left part of the screen for clarity. This shows a summary view of all instruments (up to 5). On the left, under each instrument, the last value of sediment concentration is displayed, along with the time of data capture. Next to it, in 4 columns, the current



concentration in 4 size classes is shown as % of alarm level. The size classes are shown below each column. On right, the blue bar shows status of clean water tank. Any warnings would appear in a box that is barely visible on top right.

To select the time history of any one instrument, select its Instrument tab. The following display will appear. It is a rich display, including data gaps. Note:

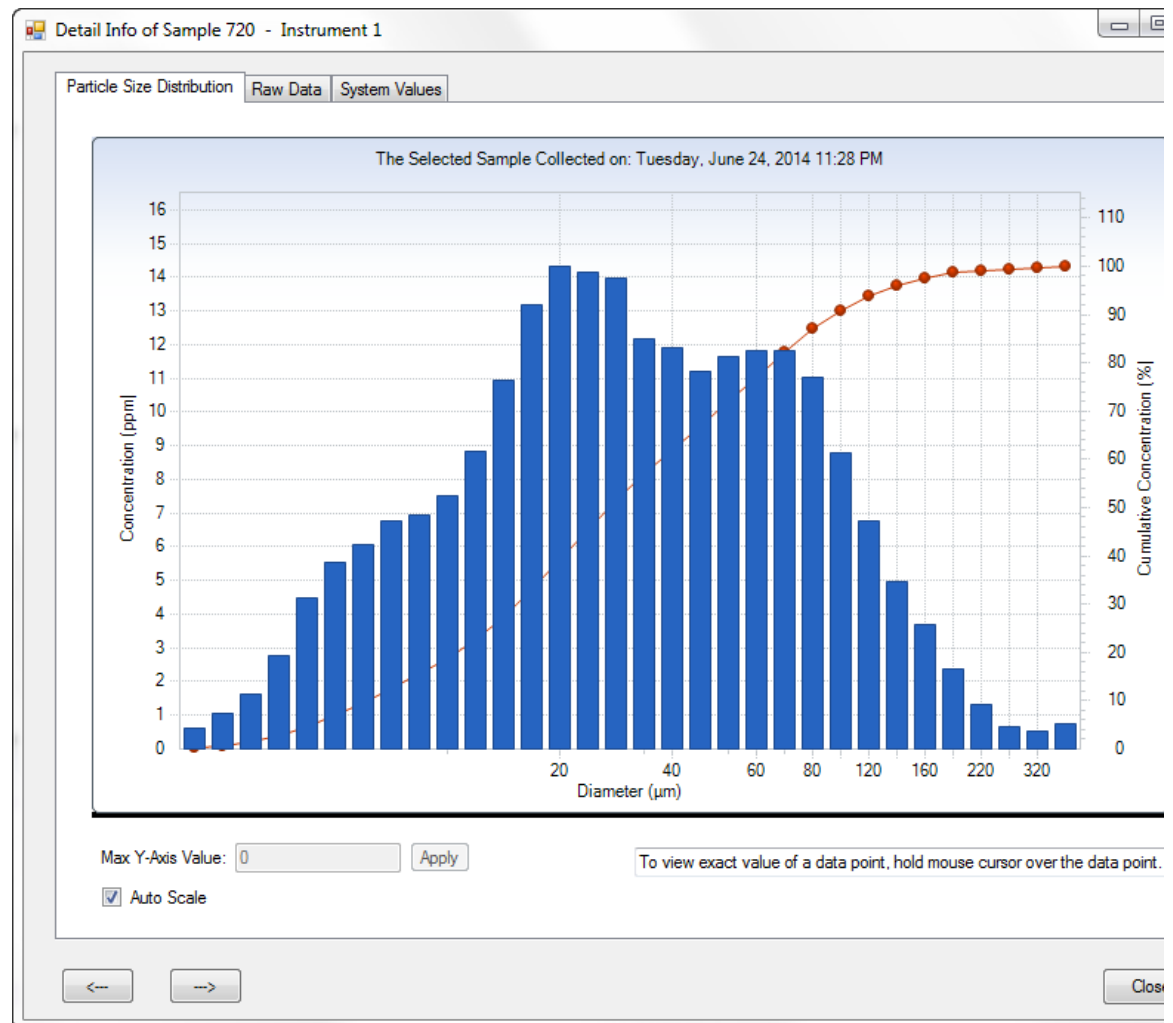


- There are 4 strips; bottom is total suspended concentration, next up is from 2-75 microns, next up is 75-200, and top one is 200-400 microns.
- A red line in a strip chart is the currently set alarm level. [change it from Settings]
- Last sample values of each strip are shown on right of strip.
- The Y-axis scale select button. Choose autoscale or user selection.
- Bottom right, green bar shows clean water tank level for this instrument.
- Purple slide bar at bottom of lowest strip allows changing time of display.
- Box below strip charts displays any errors or warnings.
- Small Box to left of green bar lets choose duration on strip display.

2.2.4 Details of A Data Point

By double-clicking any point on the strip charts, the PSD, raw data and system parameters for it can be viewed in a separate window. The first display is the PSD shown below. It includes a cumulative curve (i.e. %below a size).

PSD

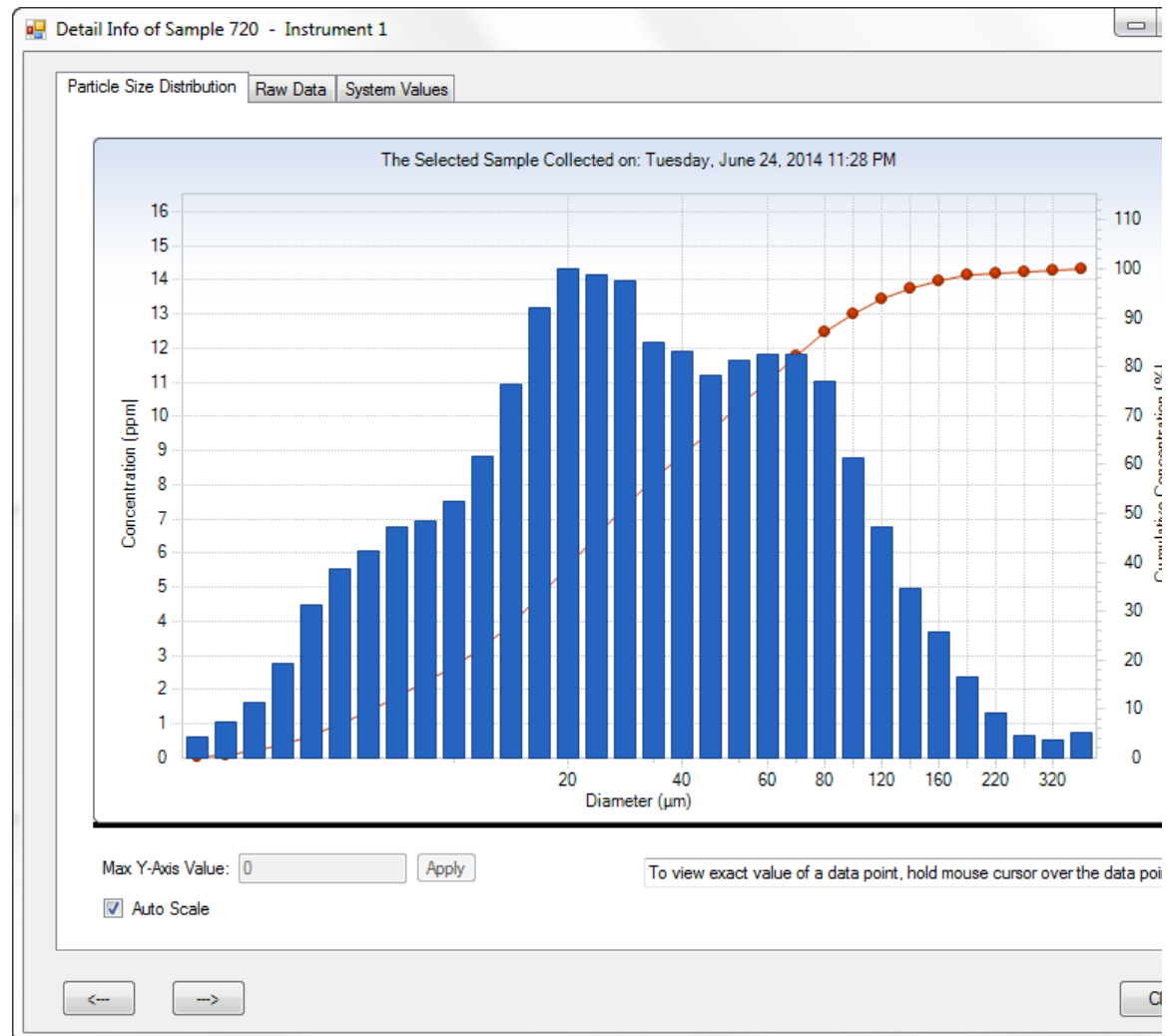


Selecting the Raw Data tab displays 3 pieces of information: the raw output of ring detectors (blue bars), the background acquired prior to this data (red line), and the factory background (green). A comparison of the latter two indicates the level of fouling of windows. When the windows are severely fouled, an automatic warning is generated for the operator. See Section 3.2. It is recommended that windows in the test cell be cleaned approximately 6-months apart even if the warning has not yet been displayed.

View Raw Data

The raw output of the ring detectors can be seen by choosing the Raw Data tab in the Detail Info of Sample window (below). It shows 3 sets of data. The blue bars are the current output of ring detectors for turbid water. The red line shows

the most recent background scattering measured preceding this sample. The green line shows the background measured with clean windows at the factory.



System Values Finally, for a check on instrument health, the System Values tab is offered. In this window, the following parameters are displayed (Top to bottom)

Note: both Master Controller and Viewer have a System Values display. And the behavior in regards to whether warnings are given may differ slightly. We are only dealing with the Viewer here.

Laser Power: Indicates power in laser (mW) after crossing the sample volume;

Dilution Code: A value of 1 means no dilution was carried out; a single dilution corresponds to a value of 2 [only applies to LISST-Infinite].

Laser Reference: This indicates health of the laser. The factory value is set to 1.0mW. The instrument will continue to function normally for this value as low as 0.15mW.

Clean Water Tank Level: As noted, this is important to ensure a measurement of current background scattering from windows. An

automatic warning is generated at Master Controller and at the Viewer if water level runs low. A warning is generated for low water level, but is not displayed on the System Values dialog box. It's displayed in the general warning area of both the MC and Viewer the software.

Transmission: indicates fraction of laser power transmitted through sample volume. Value of Transmission < 0.3 is used to trigger dilution.

Date and Time: These are shown in obvious format.

Transmission: This is the ratio of laser power transmitted through the turbid water and its value for clean water. On the LISST-Infinite only, when transmission drops below 0.3, it triggers a dilution cycle.

Scrolling Through
Raw Data Views

Detail Info of Sample -1

Particle Size Distribution Raw Data System Values

Sample Collected on: Friday, May 31, 2013 9:27:13 AM

Laser Power	1.144	mwatts
Dilution Code	1.000	
Laser Reference	1.251	mwatts
Clean Water Tank Level	198.0	%
YYYYMM	201305	year, month
DDDDH	15109	day, hour
MMSS	2713	min, sec
Transmission	0.996	

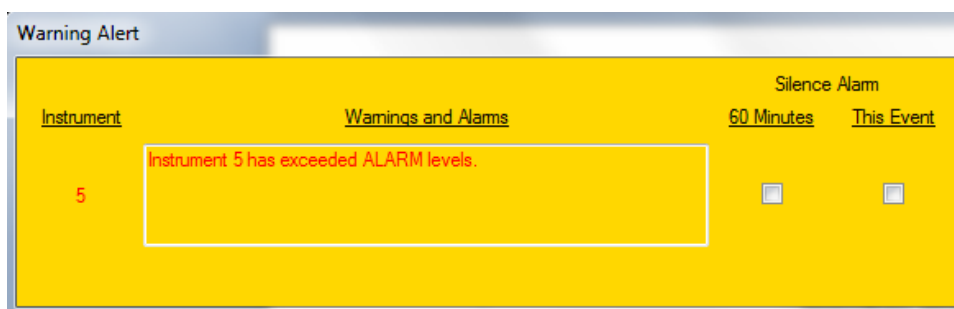
Note the arrows in bottom left of the Raw Data display. These arrows permit you to scroll through previous or next data points.

3 Error Messages and Maintenance

3.1 Overview

The instruments provide two types of error messages. **Warnings** are provided to alert operator to prevent an upcoming error, such as a low level in the clean water tank. **Alarms** are provided when immediate attention is required.

To draw attention to Alarms, we open an orange, high visibility window which cannot be closed except when the alarm conditions go away. Shown below is the orange Flamboyant Alarm box. This box can only be closed by closing the Viewer. However, by checking the boxes on right, the alarm can be silenced. We provide two modes of silencing the alarm. The silenced for 60-minutes option permits an operator to set a reminder in case he/she is distracted and intends to attend to the alarm 'later'. The 'This Event' silence box will stop the audible alarm for the entire duration of the current alarming situation. However, neither of these buttons will close the Flamboyant Alarm Box.



Below is a listing of warnings and alarms, and required actions.

The Caution icon on left is displayed for warnings, both in the Master Controller, and the Viewer.

3.2 Alarms and Warnings, and What To Do

Flamboyant Alarms	What To Do
Instrument 1 has exceeded ALARM levels.	Check with supervisor if to shut down power generation.
Communication failure. Readings will resume automatically after instrument responds.	Check if com cables are in order.
Turbid inlet pressure is too low to collect valid data. Check for pump malfunction or obstructed tubing. No data is collected or transmitted.	Check if pump is working properly. Not enough flow is reaching the instrument.
Turbid inlet pressure is too high to collect valid data. Check for leaks or disruption of plumbing. No data is collected or transmitted.	Check for blocked drain tubing.
Very low level in Clean Water Tank, is less than 1%. Fill the Tank. Readings will resume automatically after Tank is filled.	As indicated on left, fill tank urgently to avoid loss of data.

Warnings	What to do
No data received from instrument. Readings will resume automatically after instrument responds	Check com cables and power supply to instrument.
Instrument windows appear to be dirty. Cleaning is recommended. To clean windows, follow instructions in Manual. If not cleaned, instrument will continue to operate, but data quality will suffer. After cleaning, this warning will disappear automatically.	See Section 3.2 of Manual for cleaning Windows.
LISST-Infinite Dilution Chamber did not fill. Clean Water Tank may be empty. Readings will automatically resume after Tank is filled.	Check clean water tank. Fill to resume data collection.
Dilution Chamber error. Optical Water Level Sensor may require cleaning. System will function normally but use additional clean water.	The optical water level sensor in the dilution chamber must be cleaned. No action. If problem persists, contact the factory, info@SequoiaSci.com

Very low level in Clean Water Tank, is less than 1%. Fill the Tank. Readings will resume automatically after Tank is filled.

Urgently fill the clean water tank.

Low level in Clean Water Tank, is less than 10%. Fill the Tank to ensure that readings will not stop.

Fill the clean water tank.

Turbid inlet pressure is low, indicating possible problem with the pump or plumbing. Data are transmitted but could be compromised.

Check if pump is operating properly. Measure water discharge rate from drain. It should be greater than 1 liter per minute.

Turbid inlet pressure is too low to collect valid data. Check for pump malfunction or obstructed tubing. No data is collected or transmitted.

Urgently check pump malfunction and flow rate. Pump may need replacement.

This error can stem from 2 factors:

- 1) The dilution chamber is empty because the clean water tank is empty. Check that the clean water tank is full. Check that the hose connecting the clean water tank to the instrument is not obstructed and that it has no kinks. Check that the outflow from the clean water tank is open.
- 2) Upon start of sampling procedure the dilution chamber drains a small amount of water. If it does not drain (e.g. if the drain tubes are plugged, or the pinch valves malfunctioning), it will return this error. Check that the drain hose from the dilution chamber is not obstructed, that it drains freely to atmospheric pressure, and that the pinch valves are working.

Turbid inlet pressure is too high to collect valid data. Check for leaks or disruption of plumbing. No data is collected or transmitted.

Check if plumbing is pinched or blocked. Outlet flow rate should be greater than 0.5 liter per minute.

High turbidity (Optical transmission below 30%). Accuracy may be reduced, see Manual.

This error may appear with LISST-Hydro only. It means sediment concentration upper

limit is passed, causing some loss of accuracy. No action needed.

Could not write to shared data files that are located on the network. Network appears to be down. Check for disconnected cables or other problems.

As indicated, check for cable problems or if network is down.



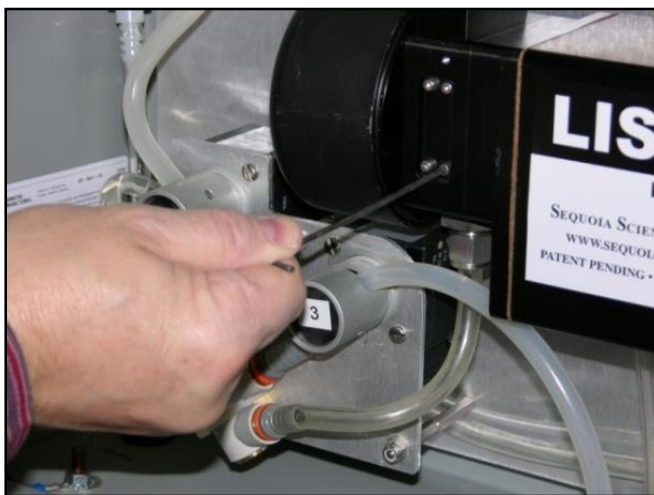
3.2. Maintenance

Window Cleaning (LISST-Infinite)

- Step 1 Disconnect the turbid water supply, so that water will not flow through the system while you clean the optics. Disconnect the power so that the instrument does not attempt to sample while you clean. Then open the front door on the LISST-Infinite.
- Step 2 Drain the water out of the system by pressing in solenoid valve #3.



- Step 3 Loosen the screws holding the optics cell port in place

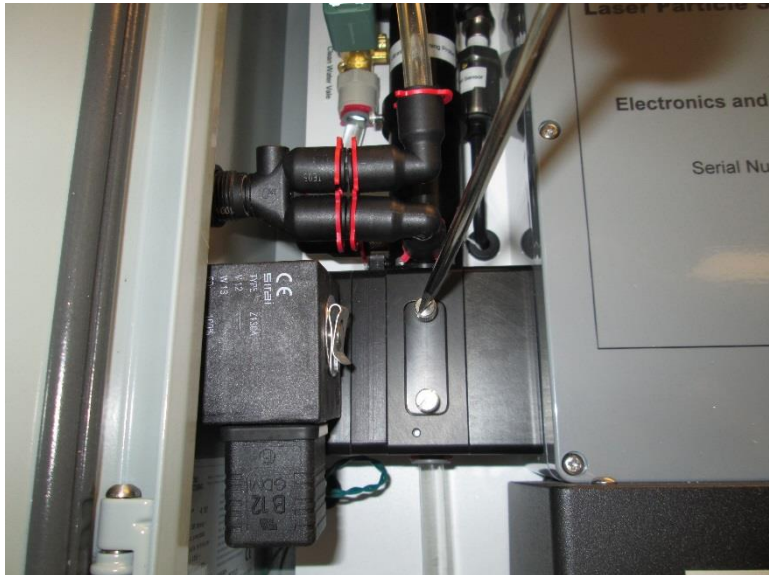


- Step 4 Remove the port. Be careful not to lose the screws!

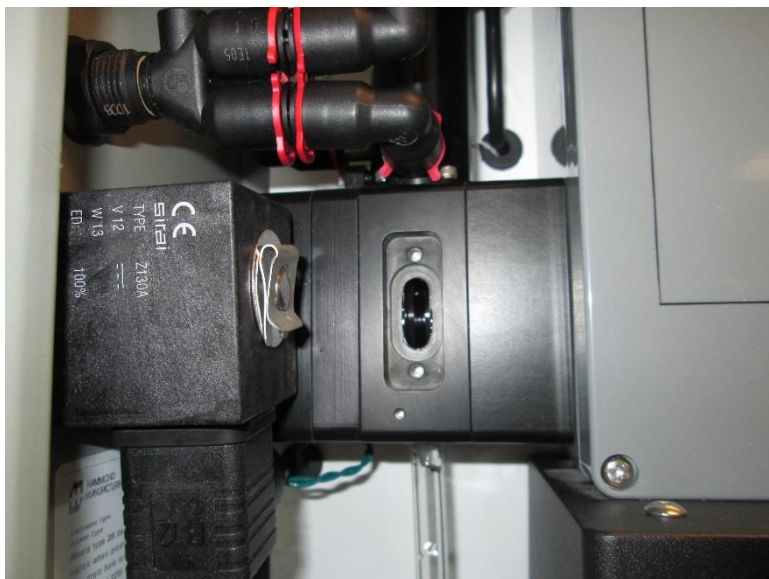
- Step 7 Replace the cotton swabs several times and use water, glass cleaner or mild soap solution to clean the windows until cotton swabs come out clean.
- Step 8 Clean the area around the O-ring and the cleaning plug for sealing purposes.
- Step 9 Re-Install the optics cell port and fasten the screws.
- Step 10 Fill the optics cell with water. The FC command in MotoCross will fill the cell and the dilution tank. Check the background values.

Window Cleaning (LISST-Hydro)

- Step 1 Disconnect the turbid water supply, so that water will not flow through the system while you clean the optics. Disconnect the power so that the instrument does not attempt to sample while you clean. Then open the front door on the LISST-Hydro.
- Step 2 Drain the water out of the system by removing the push-to-connect fitting on the left side of the enclosure. This should allow water flow out of the drain on the bottom of the LISST-Hydro.
- Step 3 Loosen the screws holding the optics cell port in place

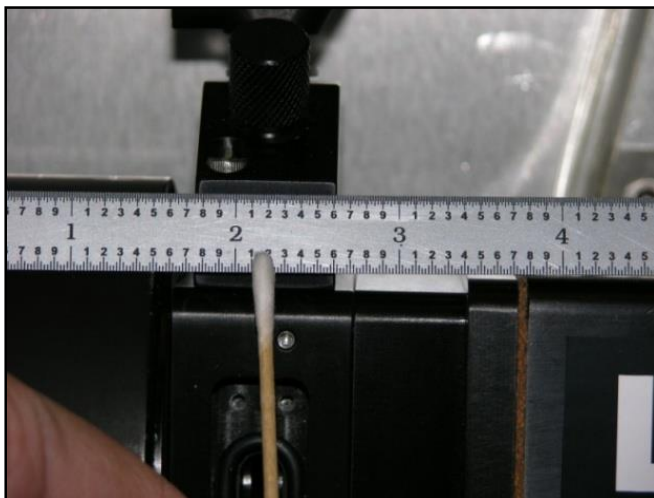


- Step 4 Remove the port. Be careful not to lose the screws or o-ring!



Step 5

Use a 1/8" (3 mm) diameter cotton swab or flat wood stir stick with cleaning tissues wrapped around the end.



Step 6

Insert the cotton swab into the cleaning port and clean the windows on the right and left



Step 7

Replace the cotton swabs or tissue several times and use water, glass cleaner or mild soap solution to clean the windows until cotton swabs or tissue come out clean.

- Step 8 Clean the area around the O-ring and the cleaning plug for sealing purposes.
- Step 9 Re-Install the optics cell port and fasten the screws.
- Step 10 Reconnect the tubing and check the background values.

Appendix A: Size Ranges

Size Ranges

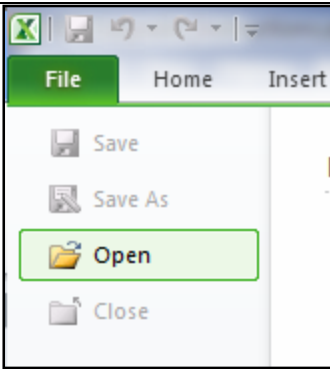
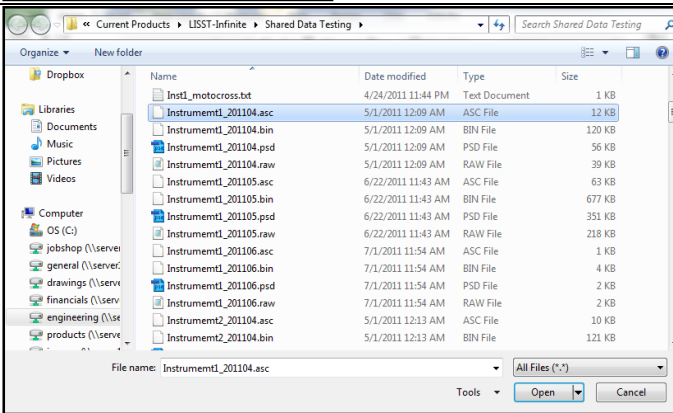
There are 32 size ranges logarithmically placed from 2 - 380 microns in diameter (0.002 to 0.380 mm).

The table below shows the mid-point of each of the 32 size classes. For clarity the table is shown with multiple rows. In the output data file the data for each size class is oriented in one row from small to large.

Size range for the LISST-Infinite and LISST-Hydro instruments (2-380 μ m)

Bin #	1	2	3	4	5	6	7	8
Size	2.06	2.43	2.87	3.39	4.01	4.73	5.59	6.60
Bin #	9	10	11	12	13	14	15	16
Size	7.79	9.20	10.9	12.8	15.1	17.9	21.1	24.9
Bin #	17	18	19	20	21	22	23	24
Size	29.5	34.8	41.1	48.5	57.3	67.7	79.9	94.3
Bin #	25	26	27	28	29	30	31	32
Size	111	132	155	183	217	256	302	357

Appendix B: File Formats

Introduction		The LISST-Infinite stores 4 types of files: .ASC, .BIN, .PSD, and .RAW files. The .BIN and .RAW files are binary files, designed to be read into the LISST-Infinite Monitor and LISST-Infinite Master Controller for viewing of archived data on the PC. However, often the user needs to view the data in EXCEL or another spreadsheet. The .ASC and .PSD files are for this purpose.								
The .ASC file		The .ASC file is a Comma separated file that has 10 columns with data for each LISST-Infinite measurement, as per the table below:								
Column #	1 (A)	2 (B)	3 (C)	4 (D)	5 (E)	6 (F)	7 (G)	8 (H)	9 (I)	10 (J)
Parameter	Year YYYY	Month MM	Day DD	Hour HH	Minute MM	Second SS	MC in largest size range	MC in medium size range	MC in smallest size range	Total MC
		MC is the Mass Concentration (mg/l) of the suspended particles being pumped through the instrument.								
Open .ASC file in EXCEL										
Open EXCEL. Click File, Open										
Navigate to the folder where the LISST-Infinite stores data. Select 'All Files' Then select the .ASC file you would like to open. Then click Open.		 NOTE: If you do not know where the LISST-Infinite stores the data, open up LISST-Infinite Monitor or LISST-Infinite Master Controller								

program and click on Settings in the Menu bar, then Program Settings, then File Location.

The Text Import Wizard Opens up. On Step 1 of 3, choose Delimited file type, then click Next

Text Import Wizard - Step 1 of 3

The Text Wizard has determined that your data is Delimited.
If this is correct, choose Next, or choose the data type that best describes your data.

Original data type
Choose the file type that best describes your data:
☒ Delimited - Characters such as commas or tabs separate each field.
☐ Fixed width - Fields are aligned in columns with spaces between each field.

Start import at row: 1 File origin: 437 : OEM United States

Preview of file O:\Current Products\IISST-Infinite\Shared Data Testing\Instrument1_201104.asc.

```

1 2011,4,27,14,39,29,0,0,1.50101,1.50101
2 2011,4,27,14,59,29,0,0,1.46284,1.46284
3 2011,4,27,15,19,29,0,0,1.50338,1.50338
4 2011,4,27,15,39,29,0.00607645,2.67213,190.203,192.881
5 2011,4,27,15,59,29,0,0.0297875,78.0748,78.1045
  
```

Cancel < Back Next > Finish

Step 2 of 3. Check the 'Comma' box and then click Finish.

Text Import Wizard - Step 2 of 3

This screen lets you set the delimiters your data contains. You can see how your text is affected in the preview below.

Delimiters
☐ Tab
☐ Semicolon
☒ Comma
☐ Space
☐ Other:
☐ Treat consecutive delimiters as one
 Text qualifier: " "

Data preview

2011	4	27	14	39	29	0	0	1.50101	1.50101
2011	4	27	14	59	29	0	0	1.46284	1.46284
2011	4	27	15	19	29	0	0	1.50338	1.50338
2011	4	27	15	39	29	0.00607645	2.67213	190.203	192.881
2011	4	27	15	59	29	0	0.0297875	78.0748	78.1045

Cancel < Back Next > Finish

The data will now open up in EXCEL. Each row is one measurement, and the 10 columns A-J are as described above

	A	B	C	D	E	F	G	H	I	J
1	2011	4	27	14	39	29	0	0	1.50101	1.50101
2	2011	4	27	14	59	29	0	0	1.46284	1.46284
3	2011	4	27	15	19	29	0	0	1.50338	1.50338
4	2011	4	27	15	39	29	0.006076	2.67213	190.203	192.881
5	2011	4	27	15	59	29	0	0.029788	78.0748	78.1045
6	2011	4	27	16	19	29	0	0.189481	54.8889	55.0784
7	2011	4	27	16	39	29	0	0.052228	41.5004	41.5526
8	2011	4	27	16	59	29	0.289089	66.0072	525.345	591.641
9	2011	4	27	17	19	29	0.065086	10.9219	295.594	306.581
10	2011	4	27	17	39	29	0.003792	3.55779	211.222	214.783
11	2011	4	27	17	59	29	0.003716	2.48915	171.133	173.626
12	2011	4	27	18	19	29	0.001651	2.11054	145.689	147.801
13	2011	4	27	18	41	2	0.021015	1.92321	123.159	125.103
14	2011	4	27	18	59	29	0	0.329343	110.775	111.104

The .PSD File		PSD is short for Particle Size Distribution. The .PSD file contains the actual size distribution for the measurement, not just a summary of the concentration in the 3 size ranges being displayed on the LISST-Infinite Monitor software. The .PSD file is opened exactly as described above for the .ASC file. The format of the PSD file is as follows:						
Column #	1 (A)	2 (B)	3 (C)	4 (D)	5 (E)	6 (F)	7-38 (G-AL)	39 (AM)
Parameter	YYYY	MM	DD	HH	MM	SS	MC in size bins 1-32	Optical transmission

Column #	40 (AN)	41 (AO)	42 (AP)	43 (AQ)	44 (AR)	45 (AS)	46 (AT)	
Parameter	Voltage	Dilution factor (1 if no dilutions took place, 2 if a dilution took place)		Clean water tank level in percent	YYYY	DDD*100+HH when sampling ended	HH*100+SS when sampling ended	

Warranty

STATEMENT OF LIMITED WARRANTY AND LIABILITY

This Statement of Limited Warranty applies to all Sequoia Scientific, Inc. ("SEQUOIA") products ("Products"). Any additional or different terms, including any terms in any purchase order, will be of no effect unless agreed to in writing by an authorized representative of SEQUOIA as reflected in a written SEQUOIA quotation.

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SEQUOIA warrants that upon delivery by SEQUOIA (a) the Products will be free from defects in materials and workmanship, (b) the Products will perform substantially in accordance with SEQUOIA's applicable specifications, and (c) any Products (or components or parts thereof) that are manufactured by SEQUOIA do not infringe any U.S. patent or copyright.

2. Correction of Non-Compliance

If, during the twenty-four months after installation, or thirty months after delivery, whichever comes first (the "Warranty Period"), any Product does not comply with the warranties set forth in 1(a) and 1(b) above, SEQUOIA will, at its option, either (a) repair the Product, (b) replace the Product, or (c) refund the purchase price paid by Customer to SEQUOIA for the Product; provided that Customer gives SEQUOIA written notice of the noncompliance within the Warranty Period and ships the Product to SEQUOIA within one month after the end of the Warranty Period. As to any Product repaired or replaced by SEQUOIA, the Warranty Period will end upon the later of the end of the original Warranty Period or 90 days after SEQUOIA's delivery of the repaired or replacement Product to Customer. Any Product, component, part or other item replaced by SEQUOIA becomes the property of SEQUOIA. SEQUOIA may use refurbished components in the repair of Products supplied hereunder.

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SEQUOIA will not be liable for any indirect, incidental, special or consequential damages, any cover, or any loss of revenue, profit, data or use.

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8. Indemnification by Customer

Customer acknowledges that the Products are designed and manufactured for use in non-critical, monitoring situations. If Customer chooses to purchase a Product or Products for use in applications that could result in damages in excess of the price of the Product if the Product does not operate properly or otherwise fails, Customer acknowledges and agrees that it is Customer's responsibility to provide for redundancy and/or other safety or back-up measures sufficient to assure that failure of a Product(s) will not cause such damages. Customer agrees that it will defend and hold SEQUOIA harmless from any and all claims and costs (including but not limited to attorney's fees and other costs of defense against such claims) in excess of the price of the Products arising directly or indirectly from such Customer's use of the Products. Such indemnification is a critical part of the consideration being provided by Customer (over and above the price paid for the Product(s)) for the right to use the Products for such purposes and Customer shall not use a Product or Products for such purposes if it is unwilling or unable to provide such indemnification.

9. Statute of Limitations

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13. Controlling Law

This Statement of Limited Warranty will be governed by the laws of the State of Washington without reference to its rules relating to choice of law for the purpose of applying another jurisdiction's law. The U.N. Convention on Contracts for the International Sale of Goods will not apply.