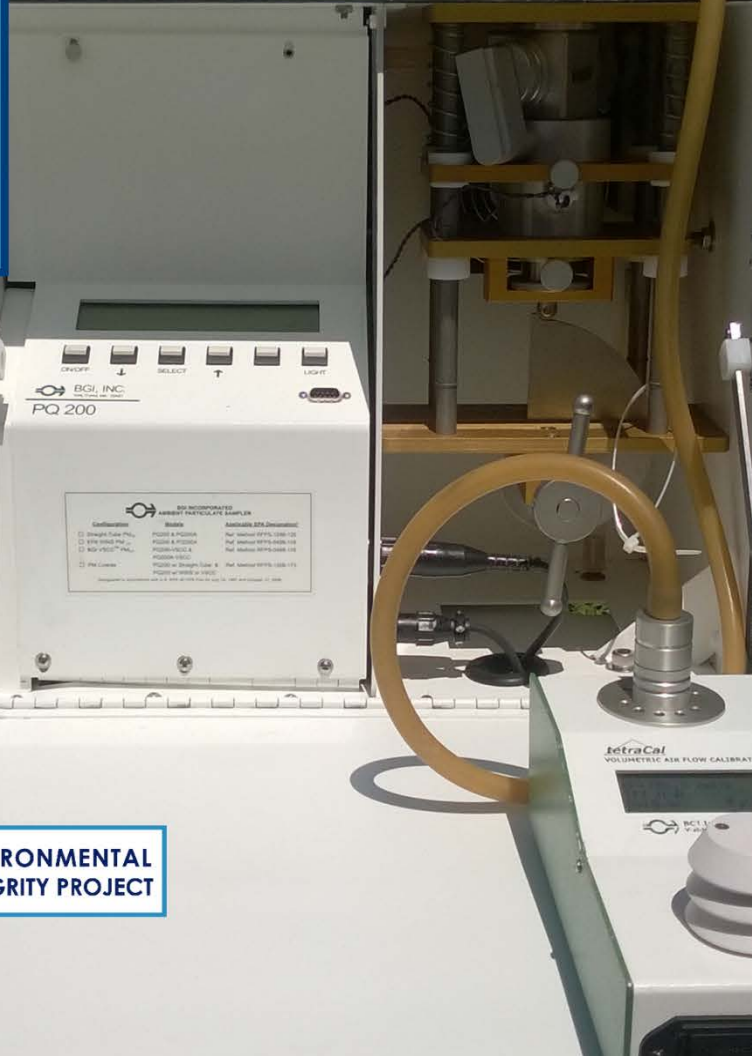




# PM<sub>2.5</sub> Citizen Sampling Guide

June 2016



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## I. Introduction

This document provides guidance for citizens who want to conduct their own fine particle (PM<sub>2.5</sub>) monitoring project using the same equipment and general procedures that the Environmental Integrity Project (EIP) employed while monitoring in Baltimore City, Maryland in 2015. This guidance is based on our experiences and incorporates informal advice received from the Maryland Department of the Environment and the U.S. Environmental Protection Agency (EPA). It also incorporates guidance and a protocol from RTI International, a lab that provided filters to EIP and analyzed our samples, and documentation from MesaLabs, the manufacturer of the monitor that we used (the BGI PQ200 Ambient Air Particulate Sampler). This guidance should be used along with the official manuals for the respective instruments.

EIP conducted our air monitoring project in Curtis Bay and Brooklyn, neighborhoods in the southern part of Baltimore City that are located adjacent to a heavily industrialized area, between the spring of 2013 and the summer of 2015. The goals of the project were twofold: to evaluate ambient air concentrations of PM<sub>2.5</sub> in these communities and to develop a relatively cost-effective sampling approach that produces high-quality data and could be replicated by citizen groups in other locations. A report, *Citizen Air Quality Monitoring in Curtis Bay, Baltimore*, summarizing EIP's findings and describing our project in more detail is being issued with this guidance and will be available on our website: [www.environmentalintegrity.org](http://www.environmentalintegrity.org). As described in that report, our monitoring project evolved over time. This guidance reflects the procedures that we used during 2015, the last year of the project.

EIP adhered as closely as possible in our project to federal requirements established by EPA for regulatory sampling of PM<sub>2.5</sub>. These regulations are complex and can be difficult for citizens to fully meet. The recommendations in this guidance document are intended to assist citizens with obtaining high-quality data but not to meet every federal requirement. Anyone who wishes to obtain legally defensible data, which must meet all federal requirements, should consult EPA's regulations. More information regarding federal regulatory monitoring, including key regulations for PM<sub>2.5</sub>, is also in our report at pages 3-4.

Prior to undertaking a PM<sub>2.5</sub> monitoring project, we highly recommend that you consult with the lab that you choose for sample analysis and the vendor or manufacturer of the air monitor. You should also confer with the local or state agency that is responsible for ambient air monitoring in your area, particularly if you wish to compare your results to those from an agency-operated monitor or to co-locate your monitor with an agency's monitor.

## 2. Planning Your Project

### a. Sampling Location Considerations

Site selection is an important part of developing a sampling project, and there are a number of factors that should be considered when choosing a sampling location. We recommend considering the following:

- *Site accessibility.* How often and how easily you can access the instrument is very important because you will need to visit the monitor frequently.
- *Security.* The site should also be secure, meaning that you can leave your monitor there unattended without it being stolen or damaged. You can lock your monitor to an immovable object using chains, as we did, or bolt it to an appropriate and secure surface (e.g. concrete).
- *Power source.* When choosing a site, you should also consider how you will get electricity to your monitor. It is easiest to plug the monitor into an AC power outlet. However, for locations that lack an outlet, the BGI PQ200 can be powered by a marine battery or solar panel.

In addition, EPA has siting requirements in its regulations at [40 C.F.R. Part 58, Appendix E, Sections 4\(b\), 5\(a\), Table E-4](#). It can be very difficult to find a site that meets these requirements, and EIP's monitoring project in Baltimore did not conform to these restrictions largely because of concerns regarding security.

### b. Creating a Project Schedule

#### *Creating a schedule for your project*

It will help to streamline your project if you create a project schedule before you even receive any filters or equipment. A template project schedule developed by EIP is attached to this guidance (see Templates, Section 7.a, page 14). In general, you should consider the following factors when developing your project schedule: equipment limitations (at most the BGI PQ200 can collect a sample every other day), staff/volunteer availability, and filter expiration dates. We recommend that you include the following events in your schedule:

- Equipment shipment and arrival dates,
- Filter shipment and arrival dates,
- Monitor set-up date,
- Sampler run dates,
- Sample collection days,
- When you will ship filters to the lab,
- When you will order more filters, if necessary,
- Breaking down equipment,

- Shipping equipment (if rented) back to vendor, and
- If you have more than one person running the sampler, your schedule should also include staffing for each task.

Your schedule may also need to accommodate filter expiration dates. You have 30 days to use a filter after the date on which it is first weighed (pre-weighed) at the lab, and another 30 days to return it to the lab after you collect a sample (when the filter is kept at a temperature at or below 4°C/39.2°F). See Section 5.c, page 12, for more about filter handling. If you plan to monitor for a long period of time, you should plan to send some of your samples back to the lab before they expire and order new filters. You should discuss this issue with the lab when ordering filters. In order to maintain your used filters at a cool temperature during shipping, return the filters to the lab in a cooler with ice packs via overnight shipping.

### *Comparing your data with data from a government-run monitor*

In EIP's project, we compared our data with data obtained by official monitors run by the state environmental agency in the Baltimore area in order to see whether PM<sub>2.5</sub> levels were higher at our sites. If you plan to compare your data to data gathered by an official monitor, you should sample on the same days as the official monitors because PM<sub>2.5</sub> levels tend to rise and fall together day by day if they are in the same area (though concentrations may be different at different sites). Thus, you will need to know the monitoring agency's sampling schedule. In our experience, it is not likely that the sampling schedule will be public and you will likely have to contact the agency to request their sampling schedule. Many state PM<sub>2.5</sub> samplers run on an every-third-day schedule.

In addition, if you have a cooperative state or local agency, they may allow you to "co-locate" your monitor with one of their monitors. This is a way of checking the quality of your data by seeing how closely it compares to data gathered by a monitor that meets federal regulations when sampling in the same place at the same time. If you are planning to co-locate with an official monitor, you will need to gain permission in advance to access the site and will need to learn the agency's sampling schedule for the monitor that you will be co-locating with.

### *Weather*

Certain kinds of weather can make monitoring very difficult. Rain and snow complicate field activities due to the need to keep equipment dry during initial set-up, sample collection, and break-down. In addition, cold weather makes it harder to handle and adjust equipment. However, you may want to sample during the peak of winter when PM<sub>2.5</sub> levels may be elevated in certain parts of the country because of increased energy usage. We recommend that you consider both seasonal and daily weather fluctuations in developing your project schedule. If this is your first time conducting a monitoring project, we recommend starting in the spring or summer when equipment set-up and handling will be easier than in cold

weather. We also recommend that, as you implement your project, you keep an eye on daily weather changes in order to be fully prepared.

### c. Obtaining a BGI PQ200 PM<sub>2.5</sub> Air Sampler and a Flow Calibrator

Once you know when you will need an air monitor, you can make plans to rent or purchase one. EIP rented our monitors from Clean Air Instrument Rentals. The BGI PQ200 with Very Sharp Cut Cyclone (VSCC) is the model that we used, and it is also available for purchase from the manufacturer, MesaLabs (formerly BGI). We recommend obtaining a tetraCal Air Flow Calibrator as well for performance checks, specifically to calibrate and verify the flow of air through the monitor. Contact information for Clean Air Instrument Rentals and MesaLabs is provided below:

#### Clean Air Instrument Rentals

<http://rental.cleanair.com/>

##### **Houston, TX**

321 Century Plaza, Ste. 110  
Houston, TX 77073  
Tel: (888) 553-8811  
(281) 443-6941  
Fax: (281) 443-8704

##### **Pittsburgh, PA**

110 Technology Dr.  
Pittsburgh, PA 15275  
Tel: (855) 553-5511  
(724) 227-0056  
Fax: (412) 787-0204

##### **Chicago, IL**

500 W. Wood St.  
Palatine, IL 60067  
Tel: (855) 553-5511  
(724) 227-0056  
Fax: (847) 934-8260

#### MesaLabs

<http://bgi.mesalabs.com/>

10 Park Place  
Butler, NJ 07405  
Tel: (973) 492-8400  
(800) 663-4977  
Fax: (973) 492-8270

## d. Choosing a Lab and Obtaining Sample Filters

### *Filter type*

If you wish to comply with EPA requirements for filter-based PM<sub>2.5</sub> sampling, you will need filters that meet certain specifications. Those specifications are listed in federal regulations at [40 C.F.R. Part 50, Appendix L](#). Filters meeting these requirements, in our experience, can be provided by at least a few different labs.

However, as discussed more below, we recommend being very selective regarding the lab that you choose to conduct your filter weighing analysis. Depending on the lab you use, your filters may come in cassettes (Figure 1) that will be stored in a transport case (Figure 2), or in cassettes covered with metal caps that snap onto the top and bottom of the cassette. It is also a possibility that the lab will send you only the filters. If this is the case, you could use the one cassette provided with each monitor and purchase additional cassettes and stabilization devices (like metal caps or a transport case) for each filter. We recommend that you select a lab that will send the filters already loaded into cassettes and provide an additional stabilization device.

### *Number of filters*

We recommend determining the number of filters that you will need based on how many monitors you will run, how many samples you wish to collect, and how frequently your staff or volunteers can visit the monitor(s). You should also order at least two spare filters per monitoring site for each batch of filters ordered: one field blank and one trip blank. According to EPA, blanks are a quality assurance measure used to identify contamination that may be introduced to the sample filters at times other than during the actual sampling. Both field blanks and trip blanks are taken to the sampling site. Field blanks are exposed to routine sampling procedures (loaded in the air monitor for 10 seconds, but not while the monitor is drawing in air, then placed back with the other used filters) to measure potential contamination from the sampler. Trip blanks are taken to the site but are not placed in the sampling equipment in order to measure potential contamination from transportation to the field and lab.

You will also need a spare filter and filter cassette that you can use during performance checks (see Section 4.b, page 10). However, some vendors will ship a monitor to you with a filter and filter cassette already installed in the monitor. You can use this filter for performance checks if it is in good condition (no tears, no debris).

Figure 1. Filter cassette (filter not shown)



Figure 2. Filter cassette transport case



### Choosing a lab

We strongly recommend that you select a lab that already performs PM<sub>2.5</sub> filter analysis (known as a “gravimetric analysis”) for regulatory purposes, i.e. for a state or local environmental agency or for EPA. Any such lab will almost certainly follow all federal requirements for labs that analyze PM<sub>2.5</sub> samples. As discussed our report titled *Citizen Air Quality Monitoring in Curtis Bay, Baltimore*, the quality of EIP’s data improved markedly after we switched our labs and began using RTI International. Contact information for RTI International is below:

#### [RTI International](http://www.rti.org/)

<http://www.rti.org/>  
3040 East Cornwallis Road, PO Box 12194  
Research Triangle Park, NC 27709  
Tel: (919) 541-6000

Ideally, you should choose a lab that will also provide you with a cooler and ice packs for preserving and shipping your samples back to the lab for analysis and, as discussed previously, will ship the filters to you already inserted (after pre-weighing) into closed filter cassettes. RTI International did this for EIP during our monitoring project.

### e. Sample Identification and Keeping a Chain of Custody Form

It is important to keep track of which filter corresponds to information regarding the sampling run, including sampling date, sampling site, and the operating data that you will have to download from the monitor. This is tracked using a chain of custody form, which will likely be provided to you by the laboratory. If you use RTI International as a lab, the chain of custody form will identify each filter by an ID number that can be linked to its initial, pre-sampling weight. RTI also assigns each filter cassette an ID number, which is typically shorter than the filter identification number and also included on the chain of custody form. This number is written in permanent marker on the plastic part of each filter cassette. You will need to complete the chain of custody form and return it to the lab with the filters when you send them for analysis.

You may also wish to employ your own sample identification system. EIP created sample IDs that combined the sample date (YYMMDD) with initials for the sampling location, so we could easily associate the sample results with the data download files from our monitors. For example, the sample that we obtained on 8/1/15 at the Filbert Street garden was identified as 150801FS. All three numbers - the lab’s filter number, the lab’s filter cassette number, and EIP’s identification number - were recorded on a chain of custody form created by EIP. See Templates, Section 7.b, page 15.



## 3. Preparing to Sample

### a. Setting Your Laptop Up to Collect Monitor Operating Data

The monitor records operating information during each sample run, such as ambient temperature, filter temperature, and total air volume. This information is important as it shows whether the instrument is running properly. You will also need some of this data to complete your chain of custody form.

You will need to install software from MesaLabs on your computer in order to download this operating data from the monitor. Install the PQ200 software on a laptop with a Windows operating system before going out into the field to collect your first sample. You can use the CD-ROM provided with the monitor, or download the software from MesaLabs' [BGI PQ200 website](#). Detailed information about running and installing the software can be found in the PQ200 manual. This software enables you to download the data, and it also creates a summary sheet like the one shown in Figure 7 (page 11).

Tip: Name your data download files so you can easily find the run information for samples from a specific date and location. EIP used the format: YYMMDD[2-character site ID].

### b. Equipment List

Before heading into the field for the first time, we recommend that you consult the equipment checklist below. In addition, before going into the field for initial set-up, we recommend setting the monitor up at your home base in order to make sure that everything works. It is disheartening to discover that there is equipment missing or malfunctioning while already in the field, especially if you have to travel some distance to your sampling site. Be sure to bring relevant contact information in case you run into problems in the field (e.g. MesaLabs, owner of monitoring site).

#### *For initial set-up*

- BGI PQ200 air monitor (with legs, if necessary)
- Power source options:
  - Outlet: Extension cord(s)
  - Marine battery: 1-2 marine batteries, a tarp or large trash bag to keep the batteries dry, and a milk crate or other non-metal platform for keeping the battery off the ground. (Available at AutoZone)
  - Solar panel
- Security devices (chains, padlocks, bike locks)
- Flow calibrator with extra batteries (uses 4 AA batteries)
- Vehicle for transporting the monitor to and from the monitoring site

- Hand truck or dolly (for transporting monitor)
- Latex gloves
- Non-static bags (available on Amazon.com or at an electronics store)
- Chain of custody form
- Pen or pencil
- Permanent marker

*If data/filter will be retrieved*

- Laptop computer (Windows OS) with BGI PQ200 software installed
- USB to RS-232 cable adaptor to connect laptop to air monitor (if needed)
- Filter cassettes pre-loaded with filters in a transport case or capped\*
- Cooler\*
- Frozen ice packs\*

\* Items provided to EIP by RTI International

## 4. Setting Your Monitor Up and Sampling

### a. Initial Sampler Set-up

You will receive a manual along with the BGI PQ200 monitor that includes detailed instructions for monitor set-up and sampling. Follow these instructions to set the sampler up. The completed assembly is shown in the image to the right (Figure 3). The rear and inside of the sampler are shown in the images below (Figures 4 and 5).

The monitor has an internal battery, but we recommend supplementing this with an external power source. When fully charged, the internal battery can last only 24 hours. Additional power can be supplied to the monitor from an outside power source, such as a wall outlet, a solar panel, or a marine battery. If using a battery, make sure to elevate the battery off of the ground (for example, on top of a milk crate) and cover with a tarp or trash bag to keep the battery dry if it rains or snows. Make sure to connect your power source to the power adapter *before* connecting the power adapter to the low voltage cable inside the sampler to avoid shorting the monitor.

Figure 3. Assembled BGI PQ200

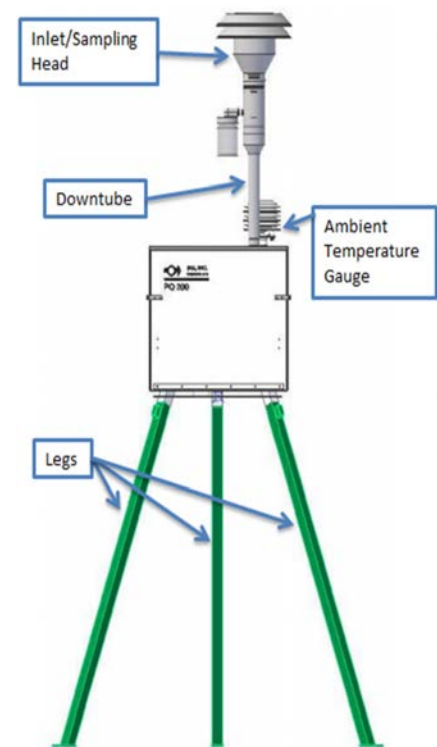


Figure 4. Rear View of BGI PQ200

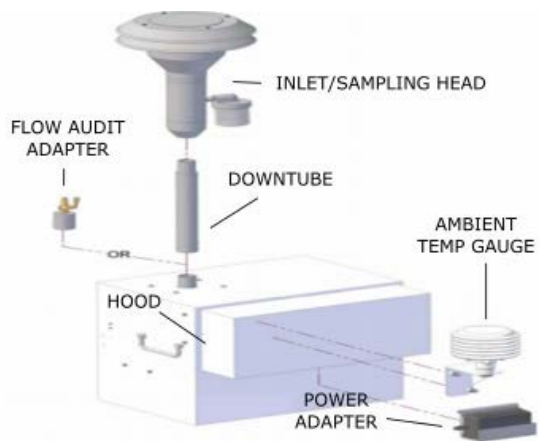
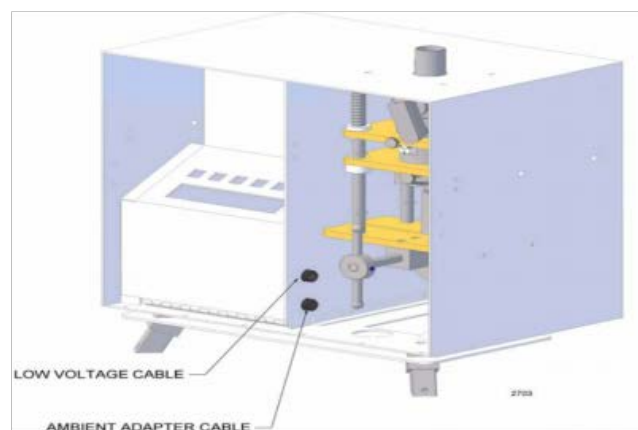


Figure 5: Inside View of BGI PQ200



## b. Performance Checks

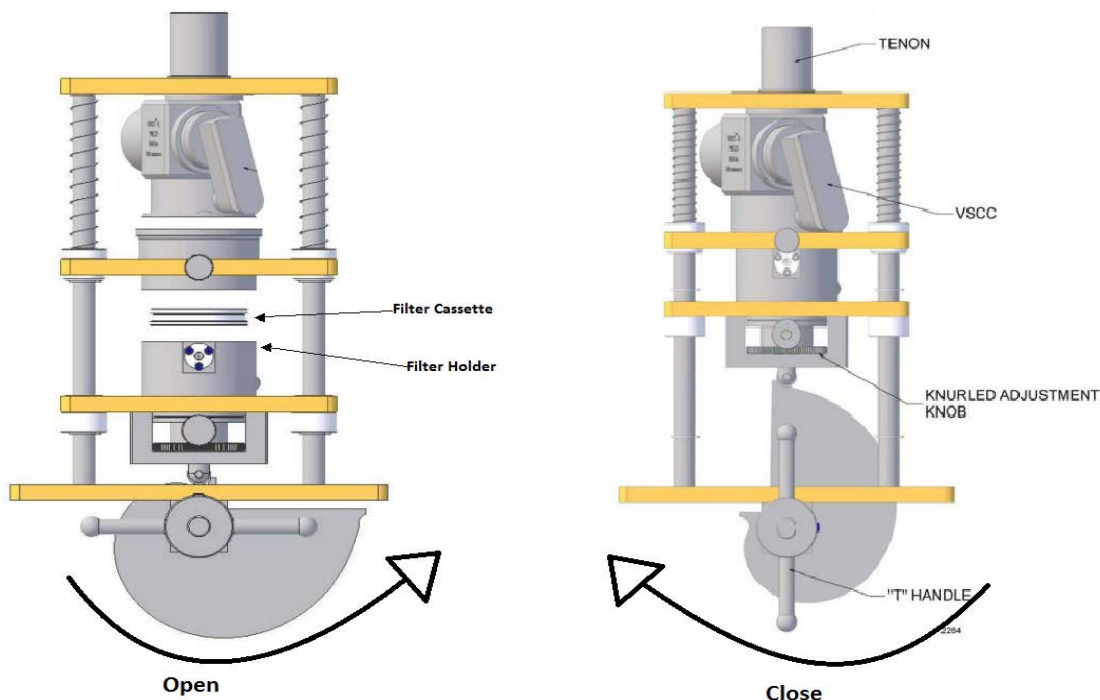
When you first set up the monitor, and before each sampling run, we recommend that you run two performance checks. The first is a leak test and the second is a flow check, which involves calibrating and verifying the flow rate of the monitor. The target flow rate is 16.67 liters per minute (LPM). MesaLabs provides a quick video about how to run these checks on its BGI PQ200 website at the following link: <http://bgi.mesalabs.com/bgi-videos/>. Instructions for running these checks can also be found in the PQ200 manual and in the air flow calibrator manual. Remember to use a different filter for the performance checks, not the filter that you use for the actual sampling run.

To run performance checks, you will need a flow audit adaptor (see Figure 4 for visual), which is usually provided with the monitor, and a flow calibrator. EIP used a tetraCal Air Flow Calibrator, which is manufactured by MesaLabs and can also be rented from Clean Air Instrument Rentals.

## c. Sampling

Once you have finished running the performance checks and have reattached the downtube and sampling head, you can load your new filter into the sampler. The filter and filter cassettes should be handled with latex gloves and carefully placed into the Filter Cassette Holder in the VSCC Impactor as shown below (Figure 6). You should program the monitor to run from midnight to midnight on the day when you wish to sample. Consult the BGI PQ200 manual for detailed instructions on loading the filter and running the sampler.

Figure 6. Drawing of Very Sharp Cut (VSCC) Impactor installed in the BGI PQ200

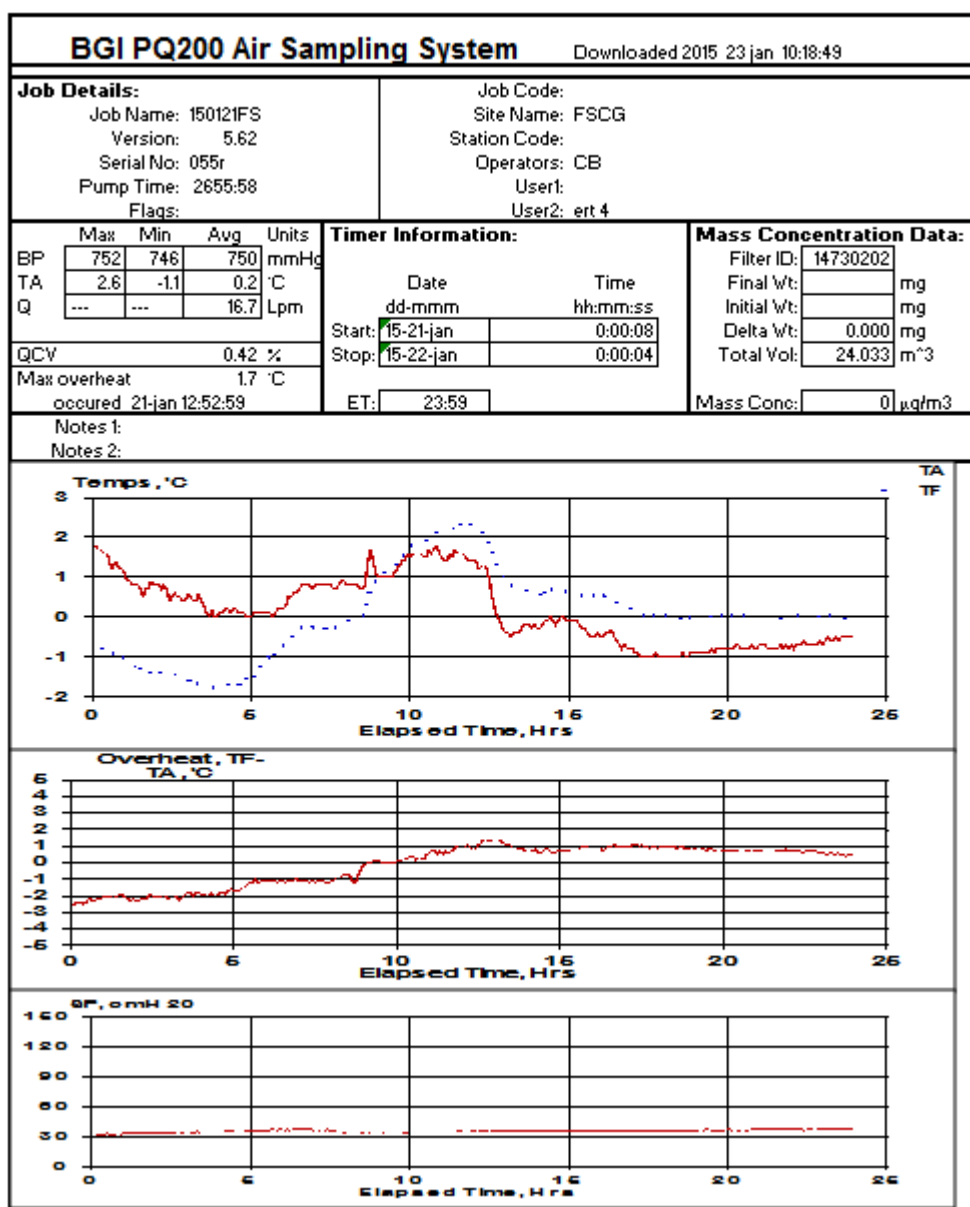


## 5. Collecting Data and Filters

### a. Downloading Monitor Operating Data

When picking up a filter after sampling, we recommend that you first download the operating data to your laptop before removing the filter or running any performance checks. **Programming a new sample run will delete the operating data from the previous run, so you must at least download the data before programming a new run.** Consult the BGI PQ200 manual for detailed instructions about running the software and downloading the data to your laptop. Below is an example of how the data will appear on your laptop when it is downloaded:

Figure 7. Sample operating data downloaded from the monitor onto the laptop



## b. Filter Removal and Re-Setting the Monitor

After you have downloaded the data, remove the used filter and cassette from the monitor and safely secure the sample. Place the filter and cassette in the transport case or replace its metal caps, and place it in a non-static bag, inside a cooler with frozen ice packs. Once your sample is stowed away, you can insert the performance check filter and run the performance checks discussed earlier in Section 4.b, page 10.

After performance checks have been completed, make sure that the downtube and sampling head have been reattached to the monitor before opening the VSCC Filter Cassette Holder and inserting the new filter cassette. Then, set your monitor to run on your chosen sample day from midnight to midnight. Refer to the monitor manual for detailed instructions about sample set-up. Keeping a checklist, such as the template Routine Sampling Checklist in Section 7.c, page 16, will help you to ensure that all steps have been completed.

## c. Storing and Shipping Sample Filters

Unused filters should remain in the filter cassettes in the stabilization device (inside the transport case or fixed with metal caps) until they are used for sampling. Store used filters in non-static bags and at a cool temperature until you send them back to the lab for analysis. The samples should remain in a refrigerator until they are shipped back to the lab. When shipping, package the samples in a cooler with frozen ice packs to keep them below 4°C/39.2°F until they arrive at the lab. Be sure to include a completed lab chain of custody form when returning the samples.

The cooler should be shipped overnight to ensure that the samples are still cool upon arrival at the lab. As discussed earlier in Section 2.b, page 3, each filter has an expiration date and returning the filter to the lab by this date should be built into your project schedule. The lab should email or mail you the results within a few weeks.

## d. Troubleshooting

As with any type of equipment, you may encounter problems or malfunctions with the monitor or calibrator. Instructions for troubleshooting can be found in the BGI PQ200 manual and in the air flow calibrator manual. We have also found the staff at Clean Air Rentals and MesaLabs to be very helpful when we have needed to address equipment problems. We recommend keeping their phone numbers (provided in Section 2.c, page 4) in an easily accessible location when you are out in the field.

## 6. Resources and Hyperlinks

[MesaLabs BGI PQ200 Ambient Air Particulate Sampler:](http://bgi.mesalabs.com/pq200-particulate-sampler/)

(<http://bgi.mesalabs.com/pq200-particulate-sampler/>)

This page provides information about the BGI PQ200. It also contains videos that show how to set up and start your monitor, as well as how to conduct performance checks to detect leaks and calibrate and verify flow rates. Under “Specification Sheets, Manuals, & Documents,” you will find a copy of the BGI PQ200 manual and the downloader software.

[MesaLabs tetraCal Air Flow Calibrator:](http://bgi.mesalabs.com/tetracal-air-flow-calibrator/)

(<http://bgi.mesalabs.com/tetracal-air-flow-calibrator/>)

This page provides information about the tetraCal Air Flow Calibrator used to calibrate and verify the monitor flow rate. Under “Specification Sheets, Manuals, & Documents,” you can find a copy of the tetraCal manual.

## 7. Templates

### a. Example Project Schedule

Hypothetical Monitoring Schedule					
Date	Day	Sample Day	Setup (initials)	Pickup (initials)	Notes
1/2/2015	Friday				Filters and Monitor arrive at EIP
1/3/2015	Saturday				
1/4/2015	Sunday				
1/5/2015	Monday		TS, CB, KB		Set up monitors in field
1/6/2015	Tuesday	Run Sample			
1/7/2015	Wednesday		TS	TS	
1/8/2015	Thursday				
1/9/2015	Friday	Run Sample			
1/10/2015	Saturday		CB	CB	
1/11/2015	Sunday				
1/12/2015	Monday	Run Sample			
1/13/2015	Tuesday		KB	KB	
1/14/2015	Wednesday				
1/15/2015	Thursday	Run Sample			
1/16/2015	Friday		TS	TS	
1/17/2015	Saturday				
1/18/2015	Sunday	Run Sample			
1/19/2015	Monday		KB	KB	Ship Filters To Laboratory
1/20/2015	Tuesday				
1/21/2015	Wednesday	Run Sample			
1/22/2015	Thursday		CB	CB	
1/23/2015	Friday				
1/24/2015	Saturday	Run Sample			
1/25/2015	Sunday				
1/26/2015	Monday		TS	TS	
1/27/2015	Tuesday	Run Sample			
1/28/2015	Wednesday		CB or LK	CB or LK	
1/29/2015	Thursday				
1/30/2015	Friday	Run Sample			
1/31/2015	Saturday				
2/1/2015	Sunday				
2/2/2015	Monday			CB, LK, KB	Pack up monitors, Ship samples to laboratory



## b. Chain of Custody Form

Columns in blue provided by lab. Columns in orange can be filled in when setting up a sample run. Columns in green found in the data download file after a sample has run.

<b>EIP Sample Chain of Custody Form</b>													
Filter ID No.	Cassette No.	Weigh Date	Exp. Date	Set-up (initials)	Pick-up (initials)	Sample/File Name (YYMMDD Site)	Date Sampled	Verified Flow (LPM)	Avg. Flow Rate (LPM)	Total Time Elapsed (h:min)	Sample Vol. (m3)	Avg. Air Temp (deg. C)	Field Notes (ex: battery charge)
14938591	1	7/31/15	8/30/15	CB	CB	150807FS	8/7/15	16.7	16.7	23:59	24.034	22	

### c. Routine Sampling Checklist

Description of Task	Notes (Fill out info below)	Initials
Download data (if picking up a sample)	Use standard file name to save data. Record date sampled, average flow rate, total time, sample volume, and temperature into chain of custody form.	
Remove used filter and properly store in non- static bag and cooler		
Replace used filter with test filter (for performance checks)		
Perform leak test	Pass: Y / N	
Calibrate flow	Target flow rate is 16.67 LPM. Set flow to 16.67 LPM.	
Verify flow rate	Flow rate should be within 5% of 16.67 LPM. Verified flow: _____ LPM	
Replace the flow audit adaptor with the downtube and sampling head		
Install new sample filter	Filter identifier: _____	
Program BGI PQ200 to run from midnight to midnight on designated sample day	Sample run date: _____	
Fill out chain of custody form		