Standard Operating Procedure for a Plastic Spike Test of the Pump-Filter System

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I. Materials

Per replicate (control and sample):

- 6 - 64 oz. mason jars labeled with white electrical tape (3 environmental, 3 control)
- 1 - 64 oz. mason jars filled with Milli-Q water
- 6 - 32 oz. gatorade squeeze bottles filled with Milli-Q water
- 6 - Spaghetti jars each containing their respective filters (280um, 100um, 10um)

28 gal. metal tub
300 um and 50 um sieve for outflow monitoring
Flathead screwdriver for prying open the filter housing
5.5 qt metal bucket for catching spill when removing filter cartridge
2 squeeze bottles filled with Milli-Q (one with small tip and another with a cut tip)
Jar (4 oz. mason) containing pre-counted quantity of beads suspended in milli-Q water
2 funnels, 1 for priming gas pump and another for pouring beads through
Filter pump system
4 accompanying hoses:

- Intake hose (reinforced hose with 1 wide attachment end and 1 threaded end)
- Backwash filter hose (short reinforced hose)
- Filter to pump hose (longer reinforced hose)

Outflow hose (normal gauge, non-reinforced hose)
Gas powered pump
WD-40
2 clamps

II. Setting Up the System

1. Unpack all materials from metal tub upon arrival at field location.
2. Lift pump frame off the tan cart.
3. If windy, place the tan cart at the back side of the metal frame as seen in figure 1.
4. If at CBLS, get the black hose and faucet key (has square hole at tip), this is on a cart on your left as you go inside CBLS loading dock. Attach the black hose to the hydrant faucet just to the left of loading dock door.
5. Attach freshwater source hose to stand alone 1 um filter housing and turn on hose water to fill metal tub.
6. Attach hoses as seen in figure 1. Make sure the hose going to the 1 um filter is part of the flow loop so all water gets filtered first as it goes into system.

Figure 1. Pump filter set-up for with hose connections made to direct water from the metal tub, through the 1 um filter on the metal frame, through the metal frame, through the gas pump, and then out the outflow hose (coiled at bottom of picture).

III. Backflow

1. Change valves to positions in seen in figure 2.
2. Place the 300 um sieve at outflow hose and place outflow hose by the drain, have one person hold the outflow hose over the sieve.
3. Prime the gas pump with water from the metal tub using on the 5.5 qt buckets. Water will go in the top of the gas pump, unscrew the opening to access.
4. Start the gas pump and set it to 100% full throttle (as shown in figure 3).
5. Allow pumping to continue for 15 gallons, flowmeter will count down so stop flow 15 gallons from the starting reading.
6. Turn the 2 side valves off at the same time and then turn the center valve.
7. Turn off the gas pump.

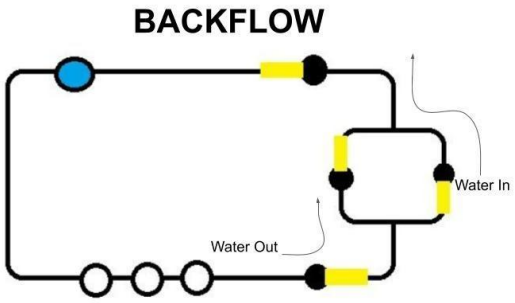

Figure 2. Backflow valve positions. Diagram credit: Jacquline Roush.

Figure 3. Throttle (longest metal lever) of gas pump set to 100% power for use with backflow pumping.

IV. Control Forward Pump

1. Load the control cartridge filters
2. Clamp the outflow hose to side of the metal tub so that it does not touch water.
3. Switch the valves to forward flow as seen in figure 4.
4. Switch gas pump to 75% throttle as seen in figure 5.
5. Clamp outflow hose to the side of the tub and place outflow hose near center of tub as seen in figure 6.
6. Turn the gas pump on and allow it to run for 40 gallons.

7. Turn both side valves off then turn the middle valve.
8. Turn off the gas pump.
9. Place the 5.5 qt bucket under the 280 um cartridge filter canister.
10. Remove the 280 um filter cartridge by unscrewing the canister ring at the top and wedging the screwdriver in the opening as seen on the right hand side of figure 6. Turn the screwdriver slowly to pry the suction seal open.
11. Place the filter cartridge in the appropriately labeled spaghetti jar
12. Pour the canister water in the appropriately labeled half gallon mason jar.
13. Rinse the sides canister with a 32 oz (946 ml) Gatorade squeeze bottle until the water level is just below the top of the metal spring at the bottom of the canister. Swirl this water and pour out the side of the canister with the label on it. Repeat this 4 times and start pouring water into the spaghetti jar when the mason jar fills up.
14. Hold the canister upside down over the spaghetti jar and use 250 mL from sniped tip squeeze bottle to rinse contents from bottom of canister into spaghetti jar.
15. Rinse the O-ring and area canister was attached to using the sniped tip squeeze bottle into the bucket below. Then rinse the bucket contents into the spaghetti jar using the sniped tip squeeze bottle.
16. Load the 280 um filter cartridge for the spiked forward pump into the canister and load the canister back into the metal frame. This is best done with one person pushing the frame down while the other pushes the canister up.
17. Repeat steps 8 through 15 for the 100 um and 10 um filter cartridges.

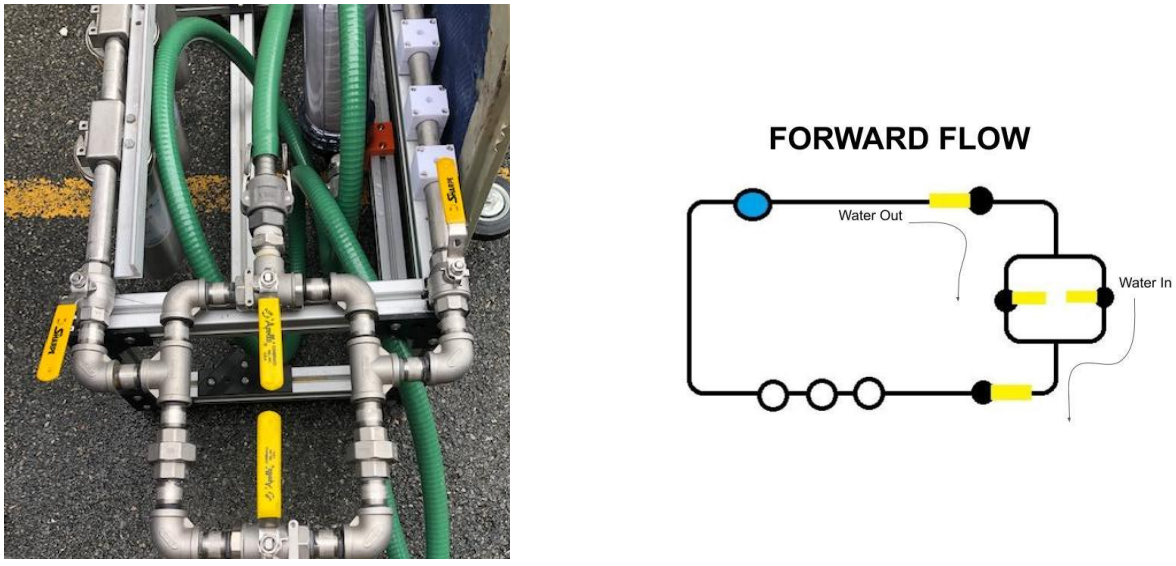

Figure 4. Forward pump valve positions. Diagram credit: Jacquline Roush.

Figure 5. Throttle (longest metal lever) of gas pump set to 75% power for use with all forward flow pump runs

Figure 6. Picture on the left shows placement of intake hose near the center of the tub and the outflow hose clamped on side of tub pointing down to prevent circular current from forming for all forward flow pump cycles. The intake hose need only be held while beads are being fed into it during a spiked forward flow cycle. Picture on the right shows where to wedge the flathead screwdriver above canister holding the filter cartridge so suction pressure can be gently released.

V. Spiked Forward Pump

1. Switch hoses so water no longer goes through the 1 um filter loaded on the frame as seen in Figure 7.
2. Turn on the gas pump with throttle still at 75%.
3. Take note of where flowmeter starts and wait until flow meter starts moving.
4. Have one person hold the intake of the hose under the water in the metal tub with one hand and hold the plastic funnel just over the intake hose with the other. Make sure a whirlpool of suction was present over the hose before funnel was placed over it.
5. Pour beads from 4 oz. mason jar into the funnel, then rinse the inside of the jar 5 times using the sniped tip squeeze bottle. Rinse outside of jar as well. Use small tip squeeze bottle to rinse the rim of the jar and the lid. Inspect jar for any remaining beads.
6. Rinse the funnel with the sniped tip squeeze bottle.
7. Allow pumping to continue for 10 gallons then take the outflow hose and sieve out of the tub so water level of the tub begins to drain. Allow pumping to continue until all water is drained from tub. This should come to a total of 30 gallons of water pumped after the beads have been put in system.
8. Turn both side valves off and then turn the center valve.
9. Turn off the gas switch on the gas pump and allow it to run until it burns leftover gas in main compartment out.
10. Repeat steps 8 through 15 from the above “Control Forward Pump” section for each of the 3 canisters to collect sample.

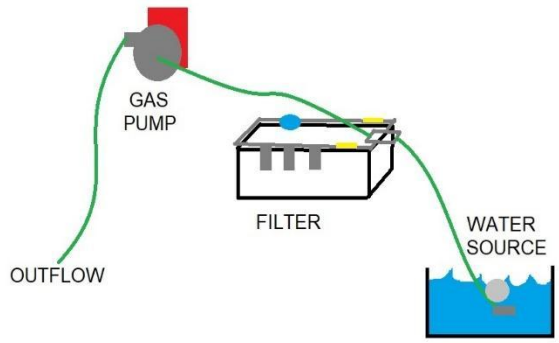

Figure 7. Hose set-up for forward bead spike pump (does not go through 1 um filter).

VI. Clean Up

1. Disconnect all hoses but catch water that comes out with the 50 um sieve to check for any particles or fibers that got left in the system.
2. Tip the system forward and open valves to drain water out through the 50 um sieve.
3. Open drain at bottom of gas pump and till it forward to drain it into the 50 um sieve.
4. Lift the pump frame onto the tan cart.
5. Coil and tie all green hoses place all of them except the intake hose between the pump frame.
6. Spray gas pump with WD-40
7. Put the green intake hose and the gas pump back in the metal cage.
8. Coil the black freshwater hose and place it back on the cart in the loading dock.
9. Place metal tub on the long cart and pack all other materials into it.