

Hydroponic System Design: Adding a Sanitation Isolation Reservoir Part II

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Part I of this article appears in GPN (Greenhouse Product News) magazine at [web link](#). It concludes with a list of benefits a second reservoir, described as a sanitation isolation reservoir, could offer a nutrient film channel hydroponic system.

Sanitizer solution will always be available to the system, both between and during crop cycles, without risk of overexposing crops. Sanitizer can be held in reserve at pulse concentration for in-crop treatment or shock concentration for between crop sanitizing.

The sanitizer reservoir will always be clean with a cool bonus. Flipping the reservoirs during the crop cycle will keep both clean and can be as simple as valving the two pumps to allow for exchange.

An option to install a new line to deliver sanitation solution directly to the return line at its farthest point. Bypassing the crop creates an opportunity to keep the return line clean without crop exposure. Think night time shock of the return leg followed by resumption of nutrient solution circulation.

Continuing, Part II presents additional detail in diagrams describing installation of a second reservoir, calculations of solution volume of the system needed to maintain separation between the solutions in each reservoir, and suggestions for how the two reservoirs could be used during and between crop cycles.

Second reservoir installation

There's not a lot of infrastructure required to retrofit a small to medium size system with a sanitation isolation reservoir. To help visualize, consider a 30 ft x 100 ft Quonset greenhouse in nutrient film channel production. Individual zones are sized to be served fifty gallon drums. Oriented on their side to better serve a gravity return design, these barrels are affordable, durable, and versatile. Pictured in Figure 1 is an experimental four zone flood and drain system where each zone/tray is served by a dedicated reservoir.



Figure 1

Other parts and equipment needed include a pump matched to that in the main nutrient solution reservoir, additional delivery and return line piping, and additional valves. As system size increases so too do reservoir volume and pump capacity, supply and return line material, and valve size.

Figure 2 presents a conceptual diagram of a dual reservoir setup. The twin reservoirs include the daily fertilizer solution reservoir on the left and sanitation reservoir on the right, each with a dedicated pump. The blue lines indicate outgoing solution which can be either the fertilizer solution or sanitation solution depending on which is desired. The green lines indicate either solution's path back to its reservoir.

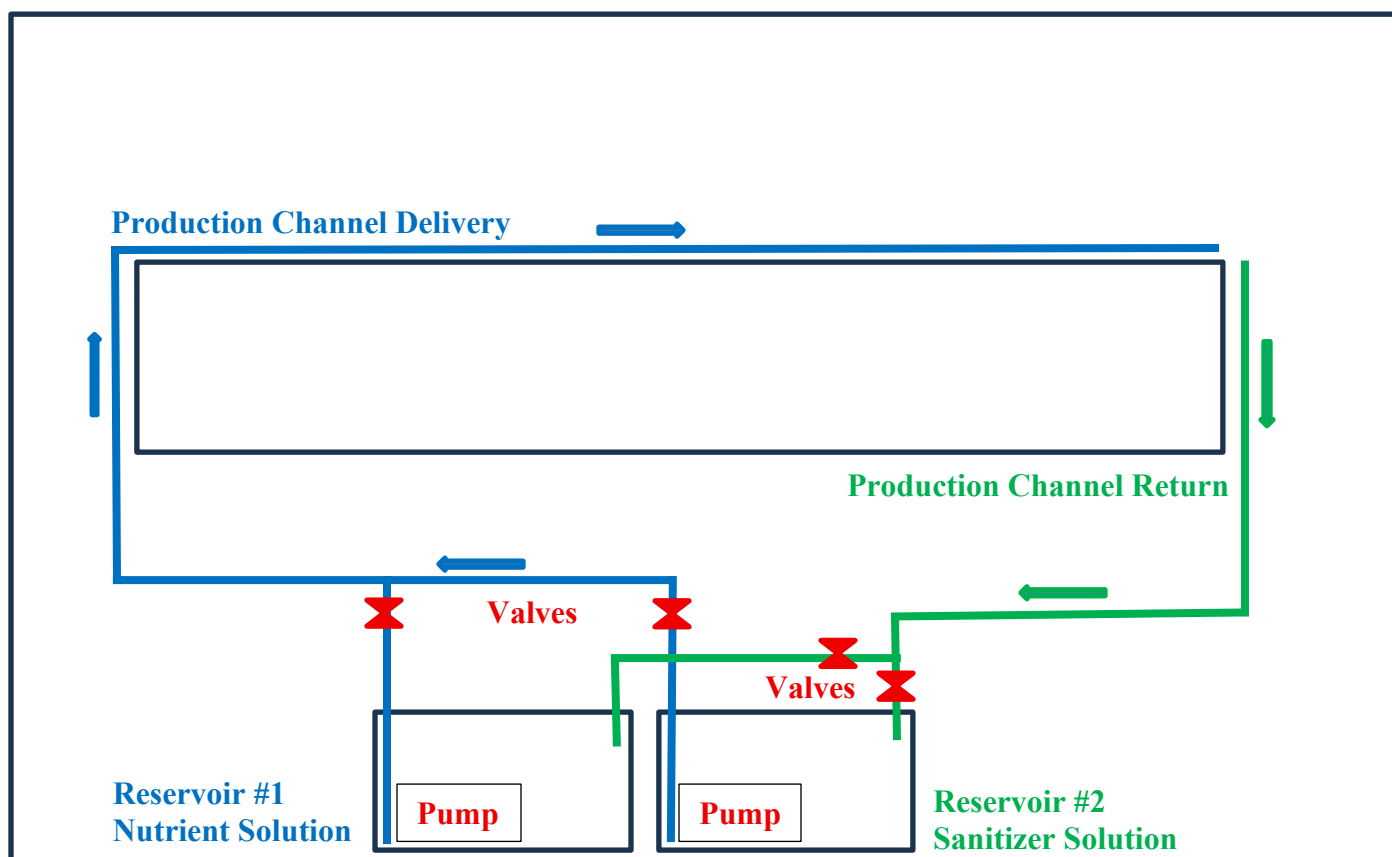


Figure 2. Diagram of a dual reservoir setup.

Properly valving the system allows for selection of either reservoir. Choosing one reservoir solution to send out to the crop involves opening that reservoir's supply side valve while closing the other's. These two valves are shown directly above each reservoir's pump and would include the task of shutting off power to the idle reservoir's pump unless equipped with a bypass loop.

As either solution circulates through the system its reservoir's return valve is opened while the other reservoir's return valve is closed. These two valves are located in the return line shown above the sanitation reservoir in the diagram. It is assumed in this Quonset example that the system will be operated manually regarding the opening and closing of valves. All valves can be installed in the reservoir area for convenience of operation, both physically and visually.

Automating such a setup is not terribly complicated as solenoid valves and timers could be incorporated. The concept of normally open/normally closed switching can be used to allow a single switch to control both pumps insuring only one of the two will be on at any given time. This step up the technology ladder will be revisited in a future discussion.

Figure 3 shows a closer view of the twin reservoirs with a slight modification to supply and return line valve positioning to simplify discussion about their operation.

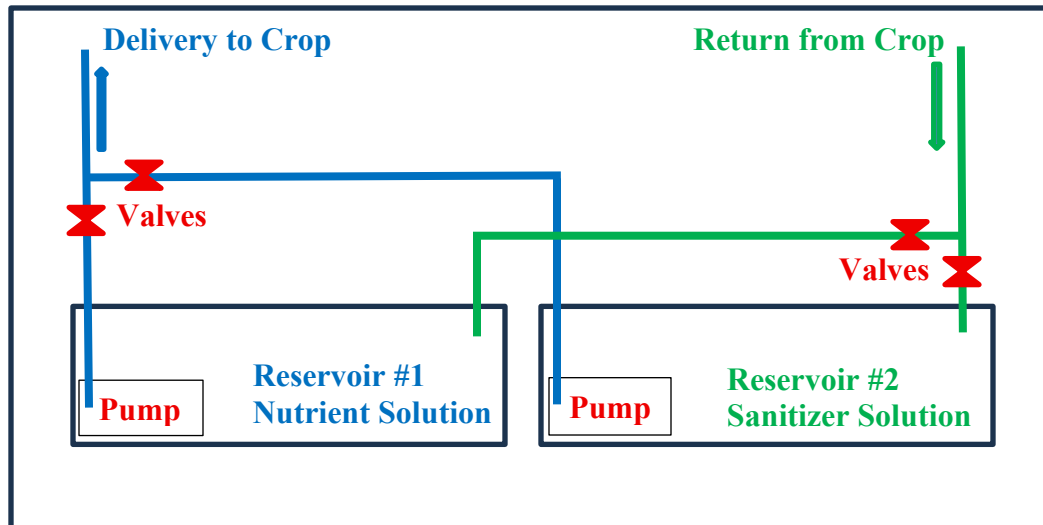


Figure 3

Figure 4 shows how the diagram was used in this project’s research presented in Part I of the article in GPN magazine. Corresponding to the diagram above the left and right blue tubes rise from each reservoir’s pump and are valved into the common supply line. The middle blue tube corresponds to the diagram’s green return line. In the Figure 3 diagram this line is split and valved to direct the flow to the desired reservoir. In the experiment the middle blue tube was manually swung left or right to return circulating solution to the desired reservoir.



Figure 4

Figure 5 shows how the two reservoir pumps would be plumbed to allow for mid crop volume exchange. Flipping the two reservoirs during a crop cycle would address sanitizing both reservoirs during a cycle without exposing the crop to the sanitizing agent. The black lines in the diagram correspond to delivery lines from each reservoir to the other with the use of an additional pair of valves.

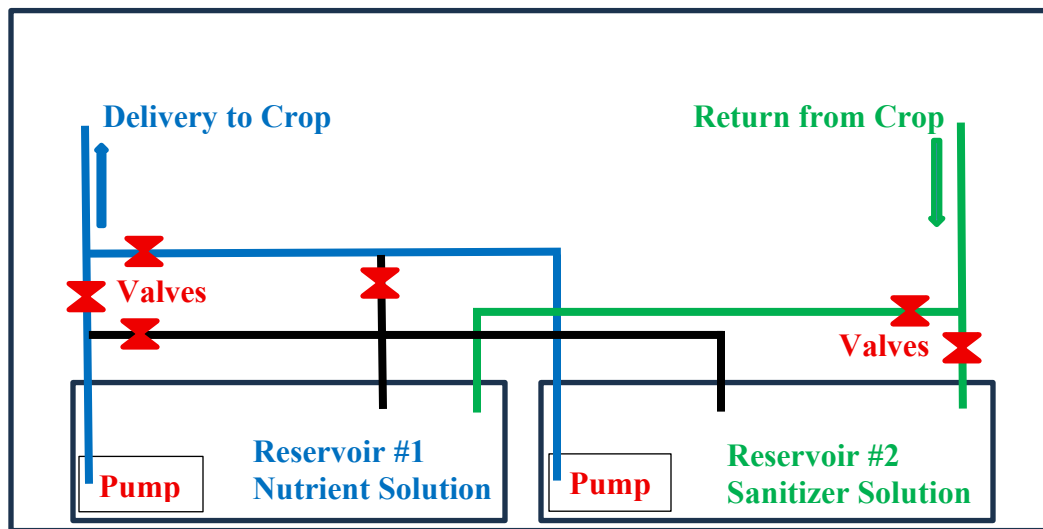


Figure 5

System calculations

Managing a second reservoir and its sanitizer solution will come with a new consideration. Because contaminating either reservoir with the other solution is undesirable we need to know or closely estimate solution volume in different portions of the system.

Determining the volume of the reservoir in gallons is pretty easy. If it's a 55 gallon drum laid on its side a one time procedure begins with the reservoir empty. Add water in 5 gallon increments or less depending on level of accuracy desired, mark its volume on a length of white schedule 40 pvc pipe, and create a handy dip stick that can be used in any identically sized drum.

Larger reservoirs require a bit of math if their total volume isn't stamped on them by the manufacturer. Larger reservoirs are often uniformly shaped, either square or round, and their volumes can be calculated using simple formulas most remember from middle school geometry. The conversion factor of 7.5 gallons in a cubic foot useful. Depending on accessibility of large reservoirs a dip stick may or may not be practical.

Once the reservoir capacity is known another useful volume to know is how much solution is "out" in the system during normal circulation. This includes the number of gallons in the delivery/supply line, gallons in the channels themselves, and gallons riding back to the reservoir in the return line.

The total volume of water "out" in the crop production area and not in the reservoir can be determined as follows. With the system running dip the reservoir to determine how many gallons are present. Turn off the pump shutting the system down, allow it to drain, and read the reservoir level a second time. The difference after subtracting the before and after volumes is the number of gallons circulating in the system. Be sure to have the system operating at a level that avoids overflow of the reservoir when the system is drained.

Using the sanitation isolation reservoir

System Pulse

Here's one example of how an in-crop sanitizer pulse could be delivered. My research with UpTake PRO[®] has identified a pulse of 2 ppm for a duration of ten minutes and frequency of 2 pulses per six week lettuce crop cycle as safe for lettuce plants. This treatment is delivered as follows;

1. With the nutrient film system in daily nutrient circulation mode turn the system off and allow it to drain.
2. Switch valves to choose the sanitation reservoir pump, supply and return lines, and begin timing the ten minute pulse when the furthest channels are receiving solution to deliver the pulse treatment (the supply line may contain a minimal volume of undrained nutrient solution).
3. At ten minutes shut off the sanitation reservoir pump and allow the system to drain back to the reservoir.
4. Once the pulse treatment has been delivered and drained resume daily nutrient solution circulation.

System Shock

Between crops

Between crop system treatment is significantly easier to manage due to the absence of plants. Without plants the concentration of any sanitizer can be higher and, therefore, more effective. Follow product labels for basic concentration vs exposure recommendations. System sanitation procedures often include removing nutrient film channels for cleaning before sanitizing. If supply and return lines are to be shocked doing so with channels in place after they've been cleaned is considerably easier.

In crop

The idea of installing a new line to deliver sanitizing solution directly to the return leg of the system at its furthest point offers the option of isolating the return line for treatment during a crop cycle. We've all seen some pretty nasty looking return lines in our travels contaminated with visible algae and biofilms and invisible microbes assumed to include plant pathogens. Having this option available offers another line of defense. Delivering a nighttime return leg shock treatment would include;

1. Shut the system down and allow it to drain
2. Select the sanitation reservoir 'return line' valve
3. Shock the return line for the desired time at the desired concentration and allow to drain
4. Return the system to regular operation

In-crop reservoir flip

Having the second reservoir allows for in-crop flipping of the two to keep each clean. A flipping procedure could include the following steps;

1. Allow the daily nutrient solution reservoir level to drop in advance to as low a level as is comfortable
2. Turn the system off and allow it to drain
3. Select the sanitizing reservoir pump to transfer its solution to the depleted reservoir
4. Once transferred fill the old sanitizing reservoir with fresh nutrient solution
5. Select the new nutrient reservoir and resume daily operation
6. Add sanitizer to the desired concentration to the new sanitizer reservoir

Conclusion

For growers who want to tweak their hydroponic system sanitation procedures to minimize phytotoxicity while optimizing sanitation treatment efficacy adding a sanitation isolation reservoir offers potential. I've used the adjective 'intriguing' repeatedly in this two part article intentionally to emphasize how research is advancing our knowledge base.

Are there a lot of valves in Figure 5? Yes, yes there are. Perhaps too many for some growers to feel comfortable managing. However, I am confident research will uncover yet to be identified benefits offered by a second reservoir that will make extra valves a small price to pay compared to the dividends returned.

Even better, let's take another step up the tech ladder from the rung offering normally open-normally closed electrical switches to control the pumps. How about stepping up to a higher rung that leverages two-way valve technology to reduce the valve count in Figure 5 from six to three.