MAINTENANCE AND OPERATION GUIDE FOR RESEARCH (MOR)

1. INTRODUCTION TO THE COLLEGE 8 GREENHOUSE

- ☐ The College 8 Greenhouse was a project by The Student Environmental Centers Green Building Campaign (2013-2014).
- ☐ The project is based around three main components that are sustainable and environmentally-friendly as well as provides students with a carbon sequestration demonstration.
- ☐ Closed loop systems – a water tank is used as a reservoir to cycle sediment-free water through two growing beds, a sump and then is returned to the tank. The system absorbs carbon from the atmosphere, and converts it to plant matter acting as a carbon sink.
- ☐ Rainwater Catchment – water is collected off-grid from a shed that was built by Green Building Campaign (2012-2013). Carbon emissions are reduced by the absence of water treatment energy and transportation costs.
- ☐ Photovoltaics – off grid energy, reduces energy used from grid that was produced from burning coal. The stored energy acts as a charging station that can power any components necessary to provide optimal growing conditions in the greenhouse.
- ☐ Aquaponics – the combination of aquaculture and hydroponics that offers organic sustainable food production. Fish are reared, grown, and harvested in tanks where the "poop water" is collected then transported to biological filter tanks. Bacteria are responsible for converting the ammonia from fish excretion into nitrite, then into nitrate. Nitrate is an essential nutrient for optimal plant growth and is non-toxic. The filtered water is pumped into growing beds that may support many types of crops and finally returned to the fish tank(s).
- ☐ Data logs and/or Research spreadsheets – used to record the following in order to monitor and maintain ideal growing conditions in the greenhouse and aquatic system. (Temperature, Energy usage, Water levels, pH, KH, Nitrogen levels, Oxygen Levels, Total dissolved solids, Electrical Conductivity, etc.)
- ☐ This greenhouse also serves as a learning opportunity where students enrolled in the College 8 garden class can gain a hands-on field research experience based around rainwater catchment, solar energy, and organic food production systems.

2. MAITENENCE FOR CARBON LAB

- ☐ As much as possible:

- Check water level and adjust as needed using hose from water catchment, **be sure** to only fill water when pumps are off to not overflow main tank. If tank is beyond capacity, use spout located behind the greenhouse to drain excess water. Reuse water, please.
- Water any plants, starts or vertical walls that are dry or look sad. A soil moisture meter may be available in the shed or for purchase.
- Check greenhouse cover for any tears in plastic, use a clear tape on both sides to patch, or replace by undoing wiggle wire at the edges and cut out new plastic. Use 6m or thicker plastic from hardware store. May be able to contact facilities on campus that can source another material that is suitable for the greenhouse cover. (e.g. black shade cloth)

☐ Weekly:

- Check water level of the main tank and adjust if necessary, remove solids from tank using the spout outside the greenhouse on the SW corner if needed. Use water in the grow beds, garden, for plant starts, worm bin or compost. Do not over soak any of the following, please.
- Remove azolla plant (mosquito fern) from the surface of the main tank. Dry the azolla in a netted bag and accumulate for another use. The dried azolla can be used for bio-tea, worm food, or can be composted. Be sure to leave at least a quarter of the tank full of azolla at all times to allow shading and the reduction of algae build-up.
- Clean any trash or plant materials that are located around the greenhouse and college 8 garden. Place in the appropriate area: compost, trash, recycle, or reuse.

☐ Monthly:

- Check grow beds and rinse using "clean" water if there is any solids build up. Divert water into a watering can to be used in the college 8 garden, vertical garden, or any seedlings. If all is watered, add to compost or worm bin. Do not over water please.
- Print data sheets if necessary, file existing data sheets into folder located in the College 8 shed or the greenhouse garden box.
- If any problems, please contact the College 8 maintenance shop for help.

☐ Yearly:

- Replace greenhouse cover. Carefully, remove all wiggle wire from brackets located on the outside of the greenhouse frame. Please recycle or reuse the plastic, and replace with either 6m plastic from hardware store or alternative cover.
- Decide to maintain or disassemble components within the College 8 Greenhouse. If project is to be dismantled, please contact SEC to reach Kevin Green or Kristian Flores for assistance.

☐ Other Maintenance Tasks:

- Check rain barrels, check sump tank for solids, water any seedlings, water vertical succulent wall, weed the greenhouse perimeter, mulch the landscape, develop ideas or projects for the college 8 greenhouse, update data log and/or research spreadsheets.

3. OPERATION OF COLLEGE 8 GREENHOUSE

☐ Information on appropriate levels for aquatic system.

- pH: 6.8 -7.2 is optimal; Use electronic pH testing probe, and liquid tests to correctly gage the pH. The tank will generally tend to be more acidic and lower in pH, so a carbonate buffer will need to be sustained. Refer to KH testing for more information.
- TDS (total dissolved solids): 600 ~ 1200 ppm; Use electronic probe to read the total dissolved solids in the main tank and sump. To increase TDS readings, add nutrients to system or

increase density of living organisms in the tank and feed. (e.g. Worm casting tea, bio-thrive micronutrients, fish and organic fish food, any organic nutrient solution)

- Nitrogen ppm: NH4 (ammonia) 0.0~6.0ppm; NH2 (nitrite) ~ 0.0 ppm; NO3 (nitrate) ~ 0 – 200 ppm. Take water samples in measuring cups and record results from API Freshwater Master test kit. If kit is running low, request purchase of a new kit from Amazon.
- Dissolved Oxygen: > 4 ppm, if lower than 3 ppm, add more oxygen through system with either solar air pumps or electric pumps to be connected to solar battery. Use meter if available or check bubbles using guide from Chemistry of Aquaponics resource.
- Tank Temperature: ~ 60-75 degrees Fahrenheit. Use Electric Temperature Probe to test
- Greenhouse Temperature: ~ 70-85 degrees Fahrenheit. Utilize fan by programming timer to provide air flow during hot days. If necessary, add climate controls to maintain a stable temperature.
- KH (calcium carbonate) - 80ppm or greater reading is needed to maintain a carbonate buffer. Test with KH test kit. A carbonate buffer is necessary to counteract harsh drops in pH due to nitrification and other aquatic cycles. If reading below 80 ppm, add calcium bicarbonate located in shed at appropriate levels by adding to 5 gallon bucket and dissolving before adding to sump tank over the period of an hour. Measure kH once the system has cycled for 45 minutes.
- Record all tests on data sheets include date and signature

☐ Information on crops that can be grown and how they should be growing

- Basil, Cilantro, Lettuce, Spinach, Tomatoes, Peppers, Cucumbers, and you may choose to experiment with other varieties of crops. Start all seeds in propagation trays.
- Once your seedling has fairly strong root growth, transplant the start by uncovering a space in the growing bed to plant into. Using a net pot and coir fiber can provide a stable way to plant into the grow beds. Plants can also be planted directly into the system if the root structure is fairly dense.
- Micro-nutrient foliar spray may be used throughout the growing cycle to promote plant health. Use a sprayer located in the shed and fill with either worm casting tea, compost tea and/ or bio-thrive. Apply at dawn or dusk to avoid scorching foliage!

☐ General Tasks:

- Check ph, Total Dissolved Solids (TDS), temperature, and other levels using appropriate meters and record on data sheet and compare to above. Adjust as necessary.
- Maintain timer, reset and program if necessary. Pumps should be set to go off at least twice a day for an hour to cycle water. Pumps should be checked and cleaned if necessary. Tubing may also need to be washed or replaced.
- Make responsible decisions and be safe when working at the College 8 Greenhouse and Garden. Please ask for assistance if you need help, feel free to contact the creators of the MOR.

4. RESEARCH ASPECTS

☐ Projects/ class discussions/ student word of mouth

☐ Growing rates of various crops that are grown in conventional aquaponics systems and compare.

- ☐ Yields produced in relation to square meter growing space and density comparisons. How much you can grow with the space you have.
- ☐ Amount of compost/ vermicompost used to produce various levels of TDS and response from the system.
- ☐ How different varieties of the same crop develop and produce in system.
- ☐ Gallons water reserved (rainwater catchment- evapotranspiration= Gallons). Off grid Energy generated- (track KWH generated with solar panel).

5. RESOURCES:

- Ten Guidelines for Aquaponics: http://aquaponics.com/media/docs/articles/Ten-Guidelines-for-Aquaponics.pdf
- Aquaponics Stocking Density: http://verticalfoodblog.com/aquaponics-stocking-density/
- Polyculture of Fishes in Aquaponics: http://aquaponics.com/media/docs/articles/Polyculture-of-Fishes-in-Aquaponics.pdf
- The Chemistry of Aquaponics: http://cleanfoodsolutions.org/uploads/The_Chemistry_of_Aquaonics.pdf
- Links on Bacteria and BSA:
  - http://en.wikipedia.org/wiki/Nitrobacter
  - http://microbewiki.kenyon.edu/index.php/Nitrosomonas
  - http://microbewiki.kenyon.edu/index.php/Nitrospira
  - http://microbewiki.kenyon.edu/index.php?title=Special%3ASearch&profile=default&search=nitrobacter&fulltext=Search
  - http://youtu.be/EKGiXoJMLbo - BSA + other helpful videos
  - http://www.swisstropicals.com/wp_site/wp-content/uploads/EMW-Fishkeeping-Aquafarm-Filters.pdf - Polyether foam info

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