Improving Water Quality and Reducing Water Discharge in RAS using AquaPonic and Membrane Technology

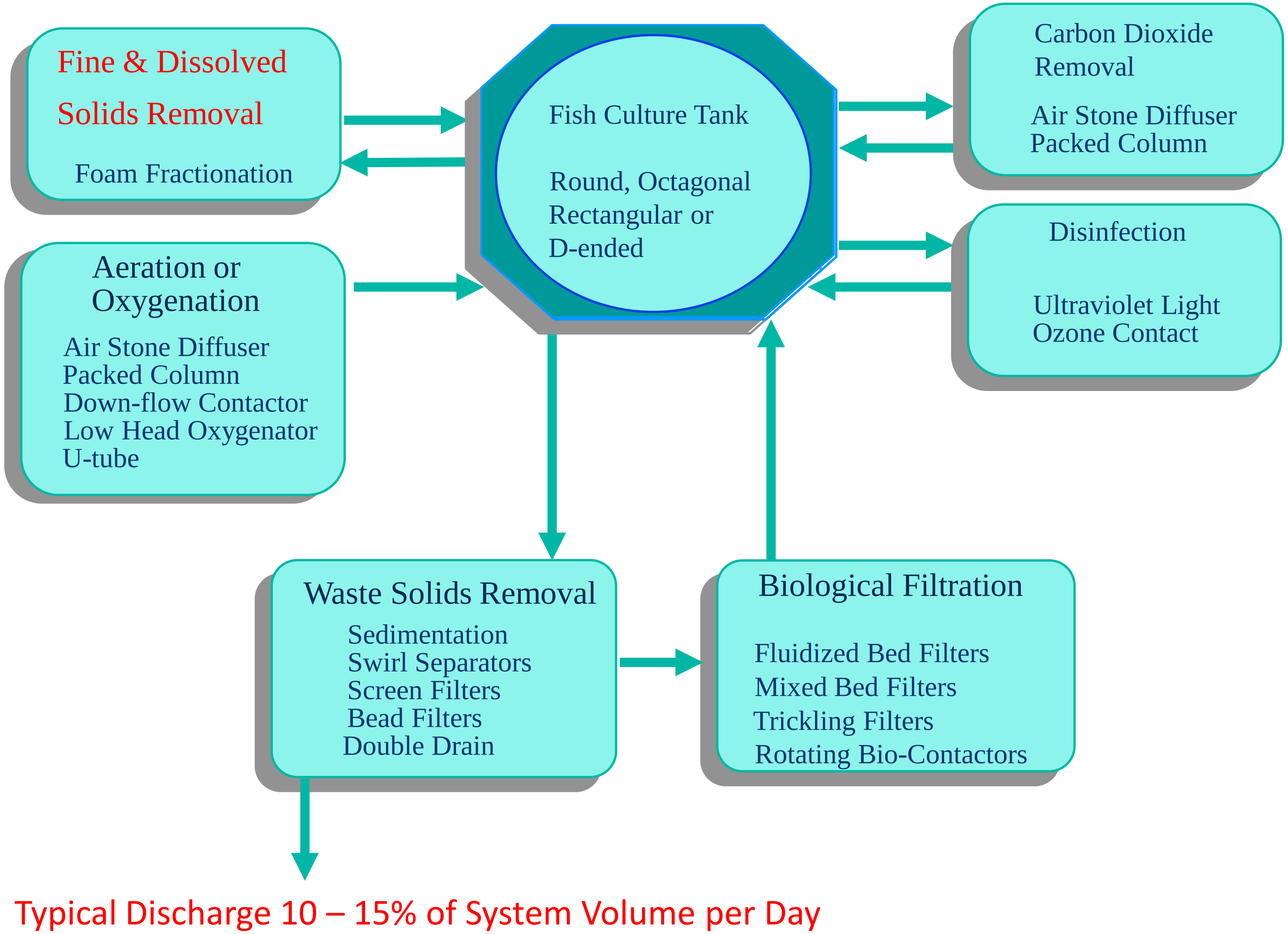
Thomas M. Losordo, PhD
Principal Scientist & Chief Engineer
Pentair Aquatic Eco-Systems

Huy Tran
Manager
Aquaponics Sales
Pentair Aquatic Eco-Systems

Phil Rolchigo, PhD
Vice President
Water Filtration
Pentair

Dave Haider
Managing Partner
Urban Organics

Recirculating Aquaculture Systems (RAS)



- Intensive Fish Culture Tanks
- Solids Removal Components
- Biofiltration (Nitrification)
- Carbon Dioxide Removal
- UV Filters
- Oxygenation Components
- Denitrification Loop

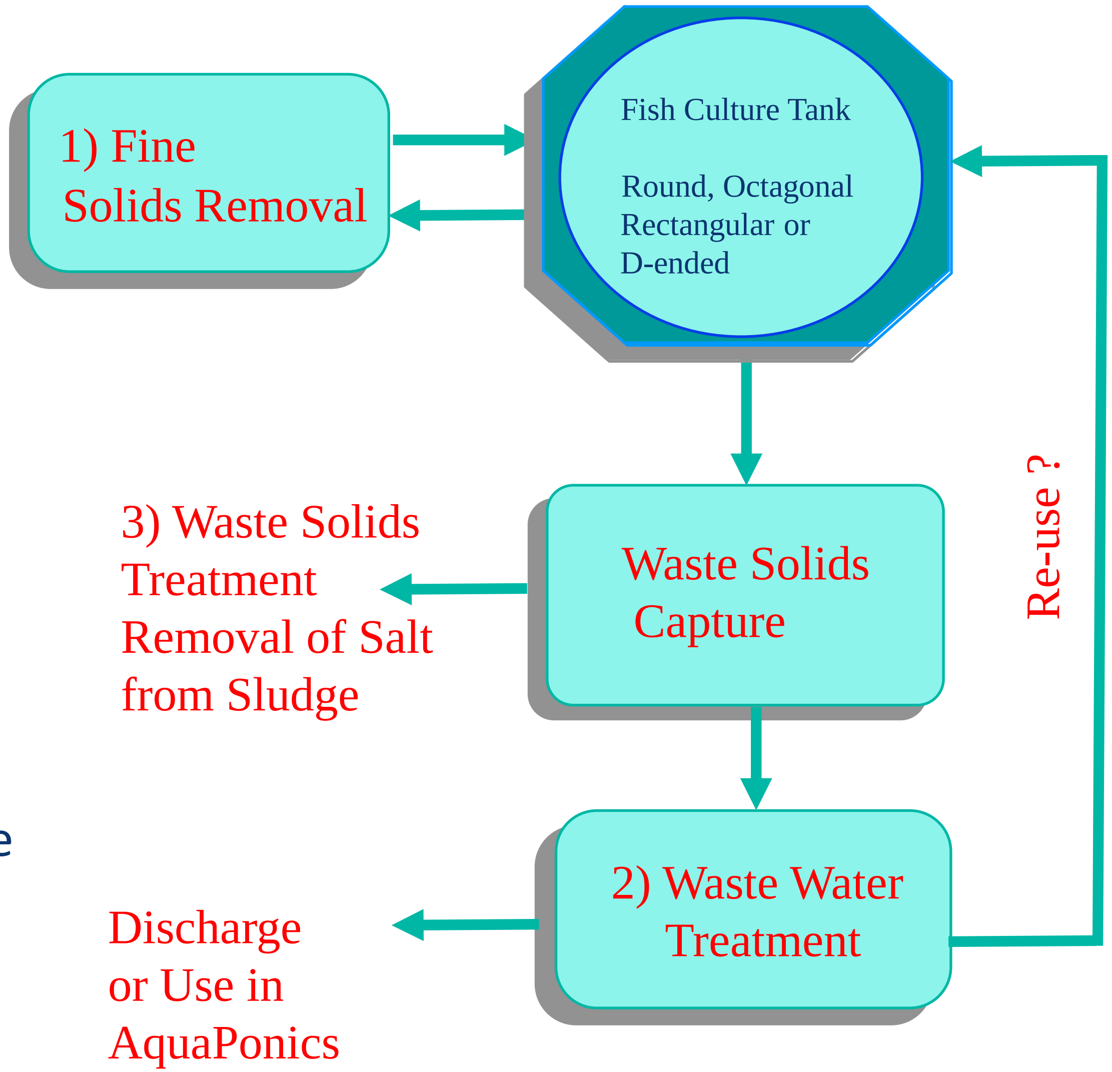
The Basics of RAS Technology has been developing for over 40 years

Recirculating Aquaculture Systems Future Challenges

1) Fine solids accumulation increases both capital and operating costs in RAS.

2) Treatment of Waste Water from RAS does not always get the attention it deserves.

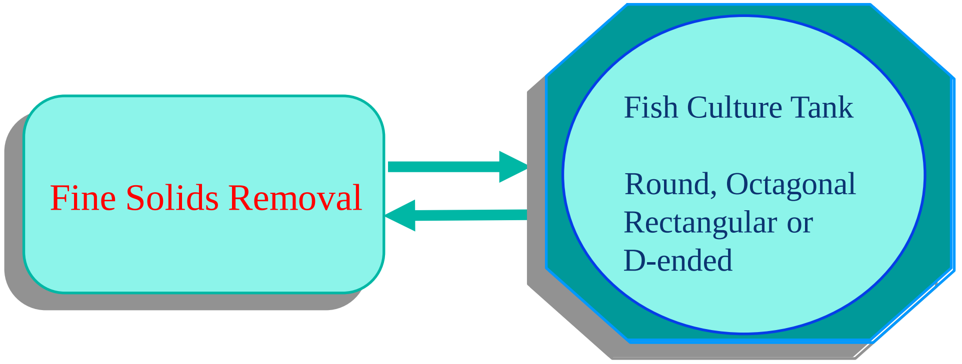
3) Treatment and disposal of salty sludge is and will be a big problem in Marine RAS.



Today we will discuss advances required in both of these areas

Fine Solids Capture in RAS

- Fine Organic Solids:
  - Produce more ammonia nitrogen requiring a larger biofilter.
  - Feed heterotrophic bacteria on a biofilter; reducing nitrification.
  - Additional nitrate production within the system requires more water exchange or a larger denitrification system.
  - Adds to the Biochemical Oxygen Demand requiring a larger oxygenation system.
  - Increases the use of oxygen; more $$
  - Irritate the gills of some cultured species



The buildup of fine solids is limiting production in RAS

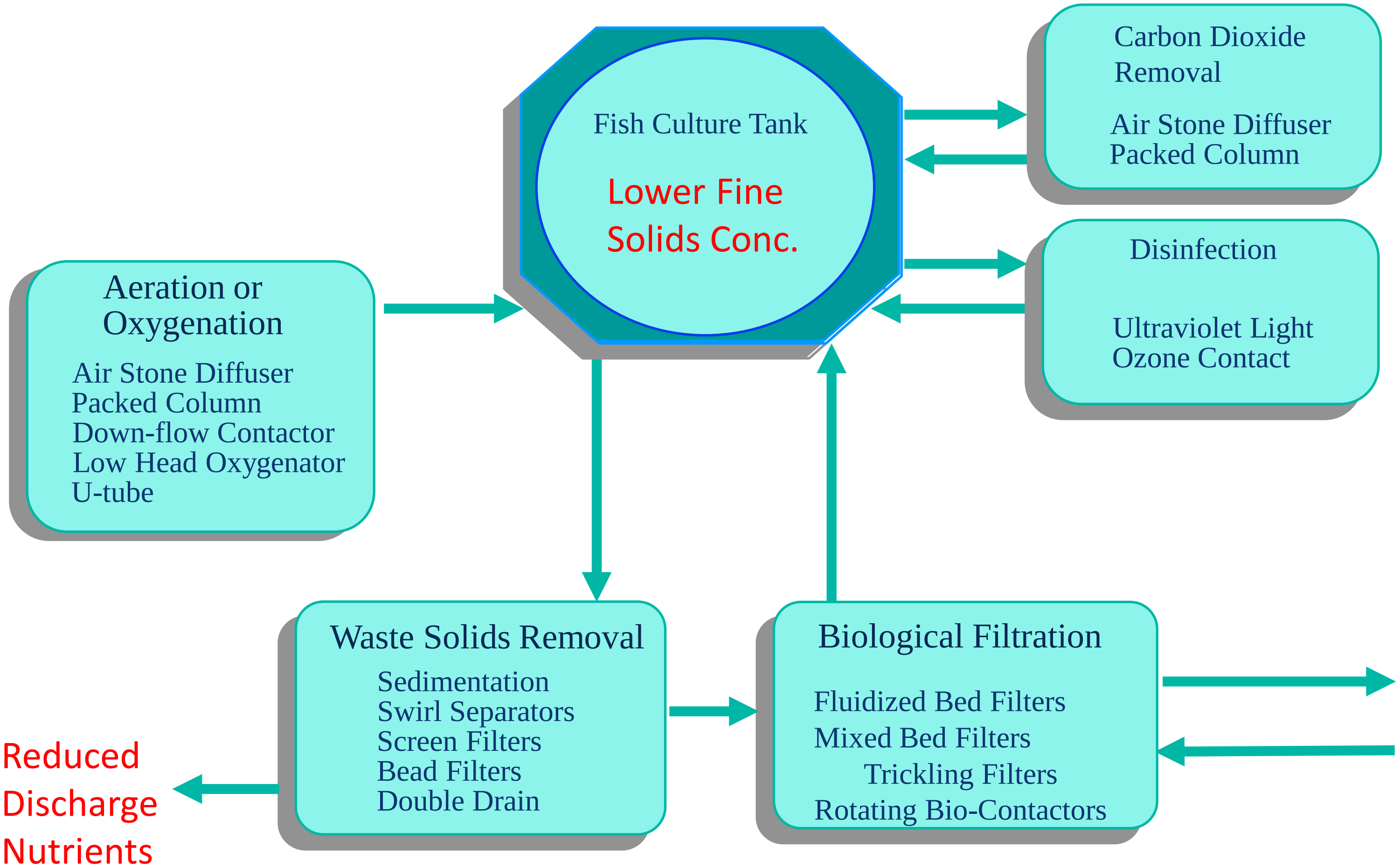
Traditional AquaPonics Systems: UVI Design

- Fish Culture Tanks
- Solids Removal; Often Settling Technology
- Fine Solids Removal within Floating Plant Roots
- Nutrient Removal with the Plant Culture
- Aeration Provide at Fish Culture Tanks
- Typical 7 : 1 Plant Area to Fish Area Ratio

University of the Virgin Islands System
Annual Output
5,000 kg of fish
1,400 Cases of Lettuce
5,000 kg of Basel
2,900 kg of Okra

Traditional AquaPonics systems capture fine solids within root systems

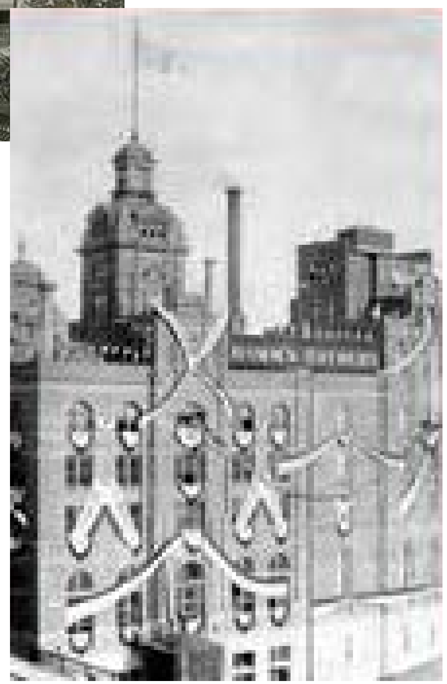
Linking RAS with AquaPonics



Fine Solids capture, breakdown and treatment

Fine Solids removal with nitrogen and phosphorus control

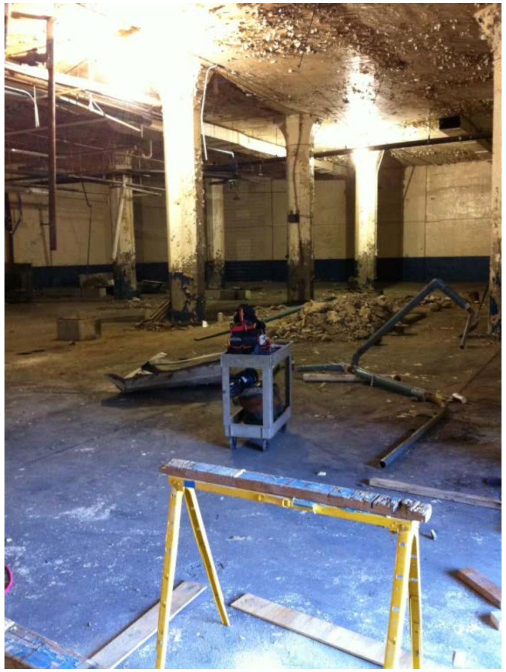
Urban Organics Links RAS with AquaPonics



A Historic Business had fallen into Disrepair: The site for Urban Aquaculture

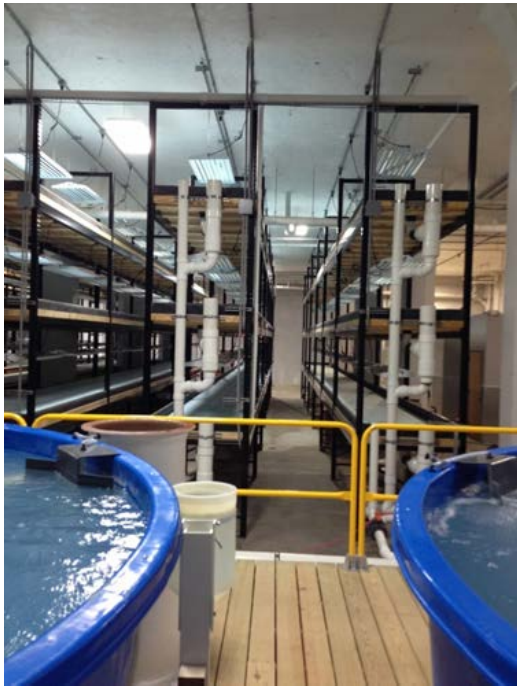
Goals for the Urban Organics Project

- Create a Fish and Plant Production Systems within the City
- Existing Building Provides Advantages of Lower Capital Costs & Subsidies for Redevelopment
- Create a System that Produces Fish and Plants at Rates to meet our Market Demand



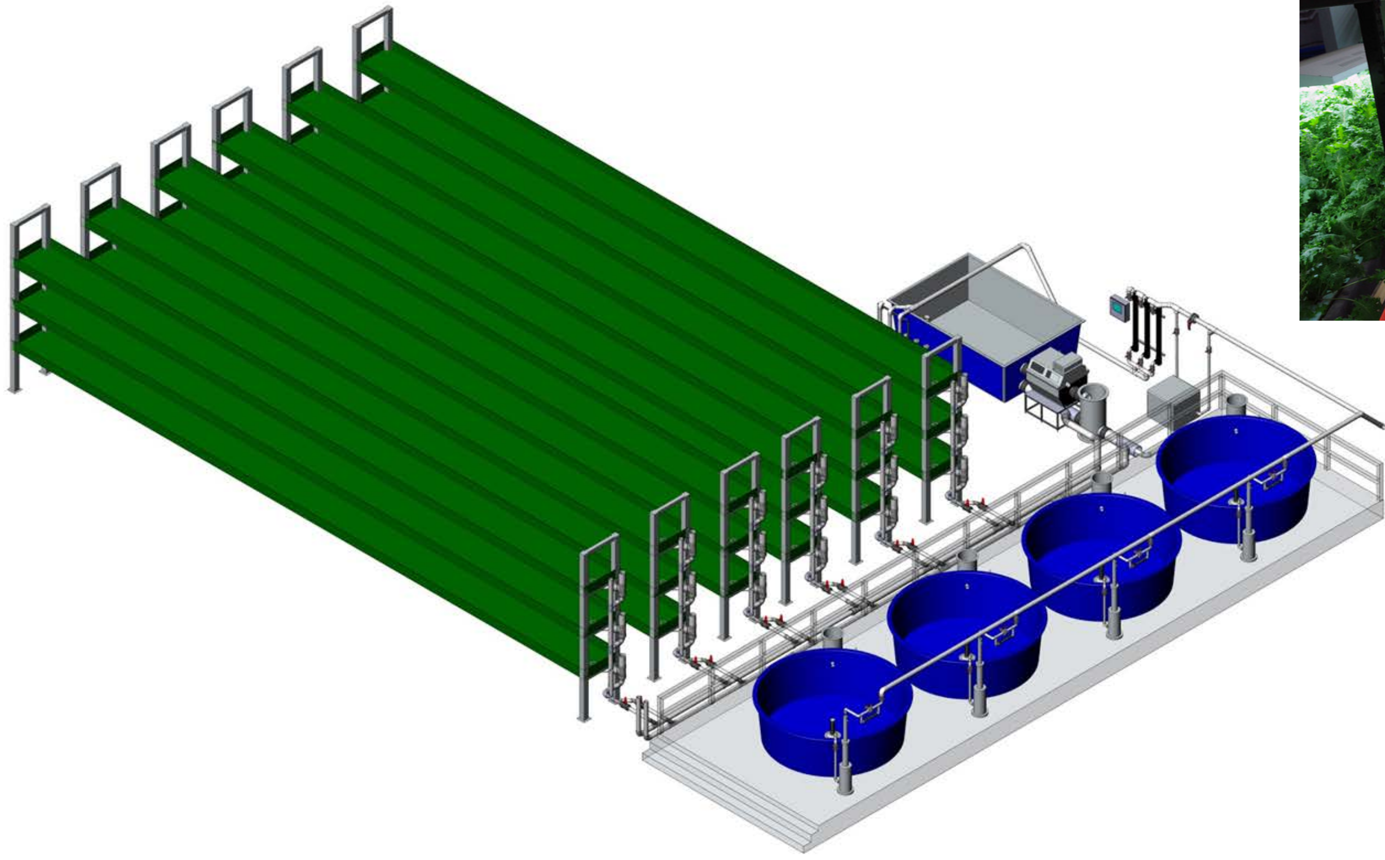
Making Abandoned This

Into Productive This



Take unproductive urban structures and make it productive again

Urban Organics Linked RAS and AquaPonics

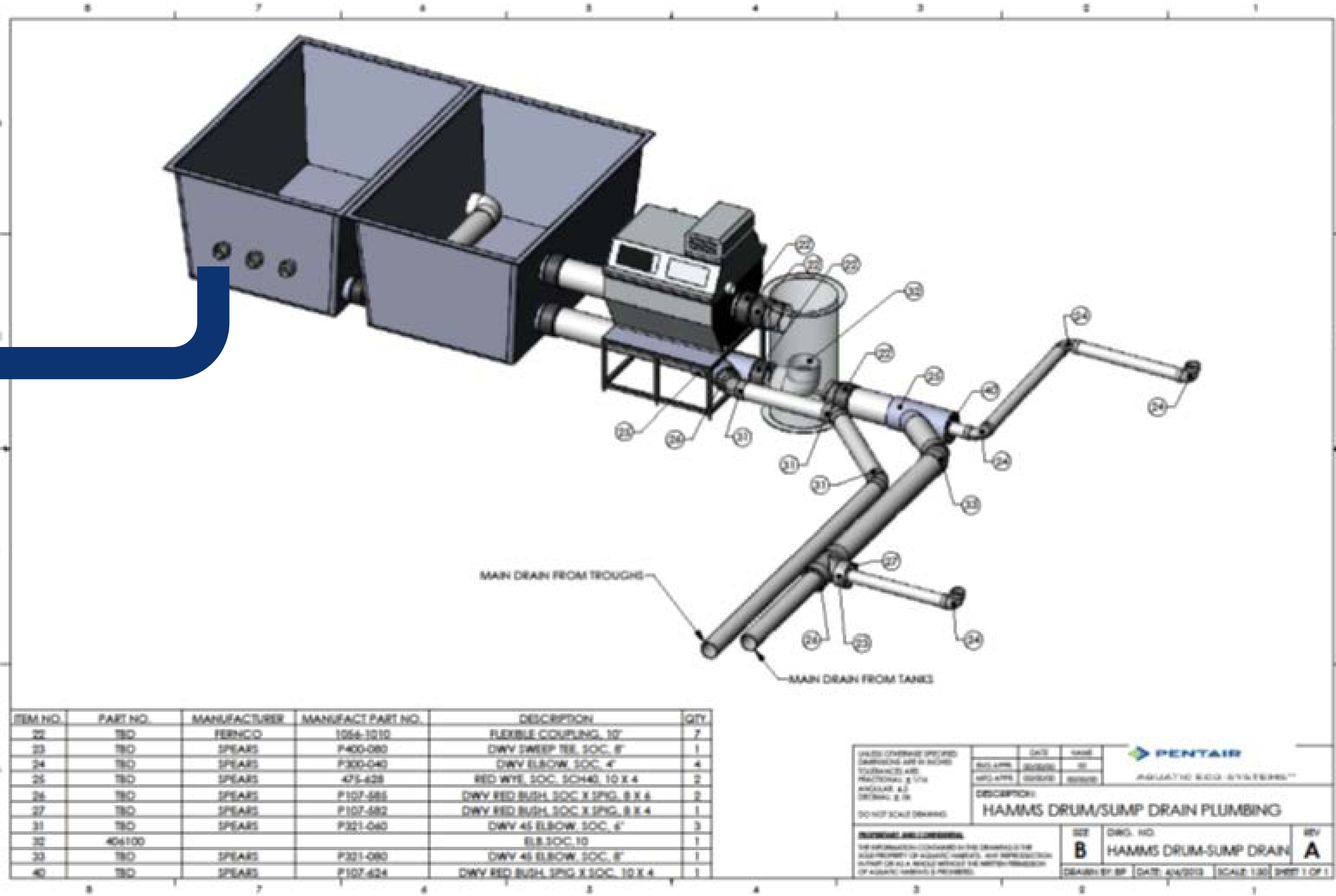


Urban Organics utilizes multi-level plant trays with artificial light

Linkage with AquaPonics at the Moving Bed Biofilter

Two Variable Speed, Constant Flow Pumps move water to the Fish Culture Tanks,

One Variable Speed, Constant Flow Pump moves water to the AquaPonics Trays



ITEM NO.	PART NO.	MANUFACTURER	MANUFACT PART NO.	DESCRIPTION	QTY.
22	TBD	FERNCO	1056-1010	FLEXIBLE COUPLING, 10"	7
23	TBD	SPEARS	P400-080	DWV SWEEP TEE, SOC, 8"	1
24	TBD	SPEARS	P300-040	DWV ELBOW, SOC, 4"	4
25	TBD	SPEARS	475-628	RED WYE, SOC, SCH40, 10 X 4	2
26	TBD	SPEARS	P107-585	DWV RED BUSH, SOC X SPIG, 8 X 6	2
27	TBD	SPEARS	P107-582	DWV RED BUSH, SOC X SPIG, 8 X 4	1
31	TBD	SPEARS	P321-060	DWV 45 ELBOW, SOC, 6"	3
32	406100			ELB,SOC,10	1
33	TBD	SPEARS	P321-080	DWV 45 ELBOW, SOC, 8"	1
40	TBD	SPEARS	P107-624	DWV RED BUSH, SPIG X SOC, 10 X 4	1

One Variable Speed pump moves water from the biofilter to AquaPonics Trays

Urban Organics Linked RAS and AquaPonics

Urban Organics utilizes multi-level plant trays with artificial light

The “Farm” has Operated for 14 Months on One Floor

- Feed Rates average 36 – 45 kg / day
- New Water used 1.5 m^3 daily (62.5 m^3 system) or 2.5%* exch daily from drumscreen & 1.62 m3 / day wasted 2.3% / day for total 5.8% daily
- Energy use is approximately 1030 kWh / day

Oxygen provided by an onsite oxygen generator; no ozone used, iron added

Farm Operation: 18 Trays Provide 225 m^2 Planted Area

- 4000 fish stocked at 1 gram. One year later average weight 680 g
- 2885 kg of Feed used (FCR 1.1 : 1)*
- Fish harvest Sept 1 – Oct 25, 2014 = 376 kg. Fish have been a nutrient source for plants

Fish Results within the First year; Sept – Oct Feed = 904 kg in addition

Farm Operation: Produce Harvests to Date

- Plant Harvests began 2-25-14
- Up to 8-20-14 the following quantities harvested
- 1373 kg Kale & Swiss Chard ($13.23 / kg farm-gate)
- 60 kg of Cilantro and Parsley ($13.23 / kg farm-gate)
- 103 kg of Basil ($17.64 / kg farm-gate)
- 755 kg of Basil and Mint from Sept 1 – Oct 25, 2014

As typical in AquaPonics, organic produce dominate the income

Production System Effluent Water Quality

		6/30/2014	7/7/2014	7/14/2014	7/21/2014	7/28/2014	8/4/2014	8/25/2014	9/1/2014
Temperature	ºC	26.9	26.7	27.1	28.1	26.9	27.6	29.5	28.4
Dissolved Oxygen	mg/L	7.84	8.27	8.46	6.35	6.79	6.80	6.85	5.63
pH		6.86	6.18	6.53	6.76	6.60	6.71	5.83	6.27
Ammonium-N	mg/L	0.45	0.45	0.51	0.60	0.53	0.52	0.23	1.17
Nitrite-N	mg/L	0.19	0.17	0.18	0.25	0.16	0.27	0.16	0.27
Nitrate-N	mg / L	50.71	54.53	51.62	50.05	56.99	60.43	69.3	66.6
Orthophosphate-P	mg/L	0.15	0.13	0.13	0.11	0.24	0.36	1.74	2.23
Alkalinity	mg $CaCO_3$ / L	31	17	17	34	11.50	146	9	8
Solids: total suspended	mg/L	7	7	11	1		6	32	18

Stable effluent water quality parameters with very low water exchange

Turning Aquaculture Waste into a Valuable Commodity

The valuable produce grown on what RAS typically wastes is impressive

Production limited by decision to scale up elsewhere....a significant scale up

Acknowledgements

Fred Haberman

Robert Davis

David Haider

Kristen Koontz Haider

Anthony Johannes

The Urban Organic Team

Urban Organics, 700 Minnehaha Ave E., Saint Paul, MN 55130

Acknowledgements

Ed Aneshansley
Engineering Manager

Bill Peacock
Senior Designer

Rick Jones
Field Services Engineer

Pentair Aquatic Eco-Systems
Beverly MA

www.aquaticeco.com