Hualapai Waste Lagoons

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Project location and purpose

- Peach Springs , AZ Northwest of the state of Arizona
- Hualapai Nation
- Population of 1009(2010)
- The purpose of this project is to decide if the amount of algae in wastewater is feasible to be harvested for biofuels.

Figure 1: Shows the location of Peach Spring, AZ in the map [1] http://www.thedirectory.org/cities/AZ/az-peachsprings.htm.

Project location and purpose

- 5 lagoons, connected sequentially

Table 1: Shows the Surface Area for Each pond in different units.

Pond	Length ft	Width ft	Area ha	Volume L
1	317.40	278.25	0.8204	12504230
2	202.29	248.94	0.4678	7129910
3	353.29	211.81	0.6951	10594798
4	563.08	217.22	1.1363	17317484
5	522.93	220.90	1.0732	16355136

- AVG Depth 5 Ft.

Figure 2: Show a Top view for the 5 Lagoons of Peach Spring, AZ [2]

https://www.google.com/maps/place/Peach+Springs,+AZ+86434/@35.525346 7,-

Project Tasks

- Sampling
- Analysis
  - Identify Algae Species Present.
  - Compute Biomass.
- Recommendations
  - Sampling Plan.
  - Method to Increase Algae Production of Ponds.

Sampling

Figure 3: Shows an outflow into pond #2

- February 2015: General site visit, samples used for practice analysis
- September 2015: Samples analyzed for algae species and total suspended solids (TSS).

Sampling

- Two samples per pond:
  - Top
  - Bottom
- Sampling bottles attached to a rod

Figure 4: Shows the sample bottles used to collect samples.

Laboratory Analysis - Microscopy

Figure 5: Shows the Euglena Under the Microscope

Photo credit: Dr. Terry Baxter.

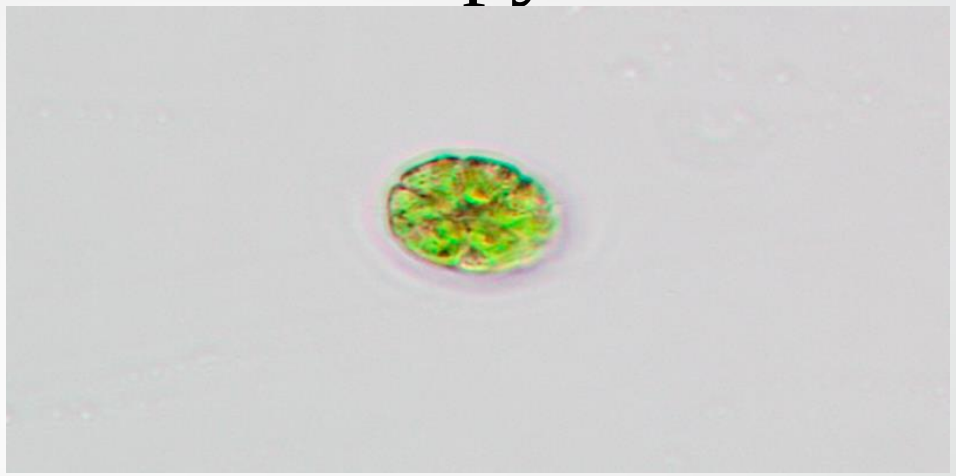

Figure 6: Shows the Coelastrum under the Microscope

Photo credit: Dr. Terry Baxter

- Algae species identified:
  - Coelastrum: ~5%
  - Sphaerocystis: ~5%
  - Chlorella: ~50%
  - Euglena: ~40%

Laboratory Analysis - Microscopy

- **Algae Concentration Data**

  Algae Concentration in units of:

$$\frac{\#\ of\ Cells}{ml} = \frac{(\#\ Cells\ Counted)(Total\ \#\ Grids)}{(Total\ Vol.\ H_2O\ Sample)(\#\ Grids\ Observed)}$$

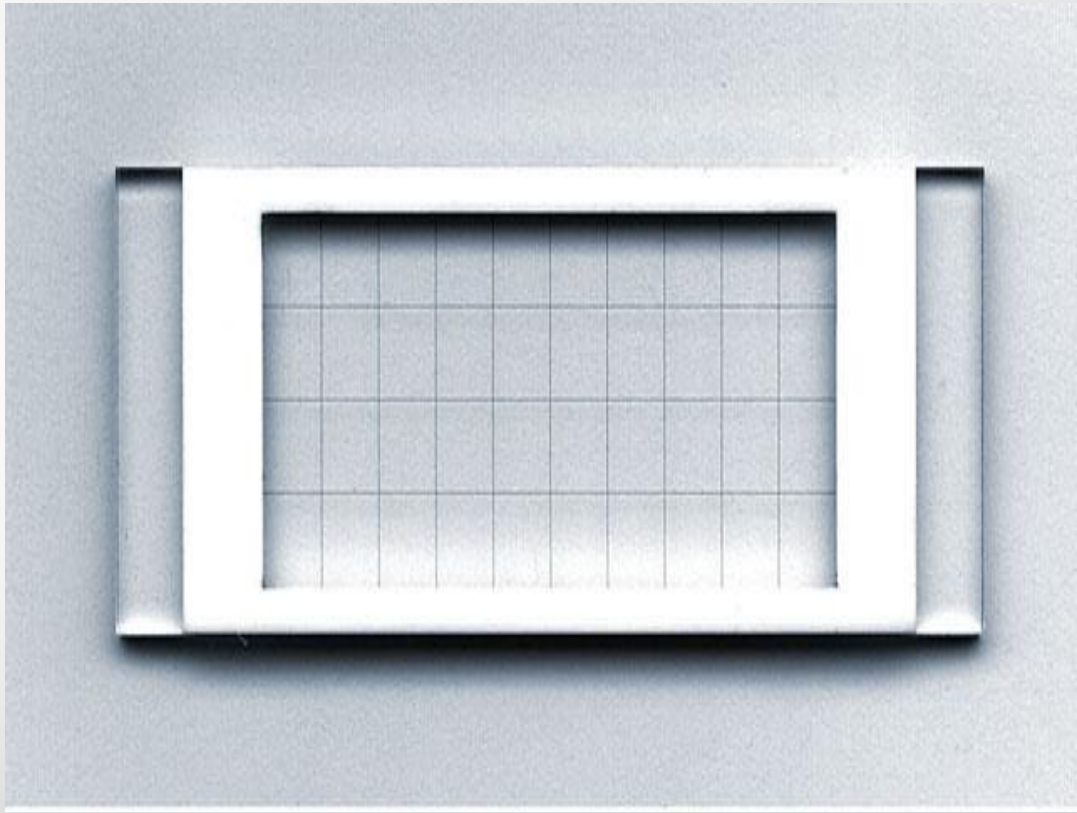

Figure 7: Sedgewick rafter.

http://www.phycotech.com/products.html

Laboratory Analysis - Algae Concentrations

Table 2: Algae count.

Pond ID	Cell Count (cells/ml)		Average (cells/ml)
Pond 1	Top	146.6	206.6
	Bottom	266.6	
Pond 2	Top	133.3	183.30
	Bottom	233.3	
Pond 3	Top	113.3	156.65
	Bottom	200.0	
Pond 4	Top	86.6	126.60
	Bottom	166.6	
Pond 5	Top	80.0	123.30
	Bottom	166.6	

Laboratory Analysis - TSS
ASTM Standard Method #2540 D

Figure 8: Lab work

Laboratory Analysis - TSS

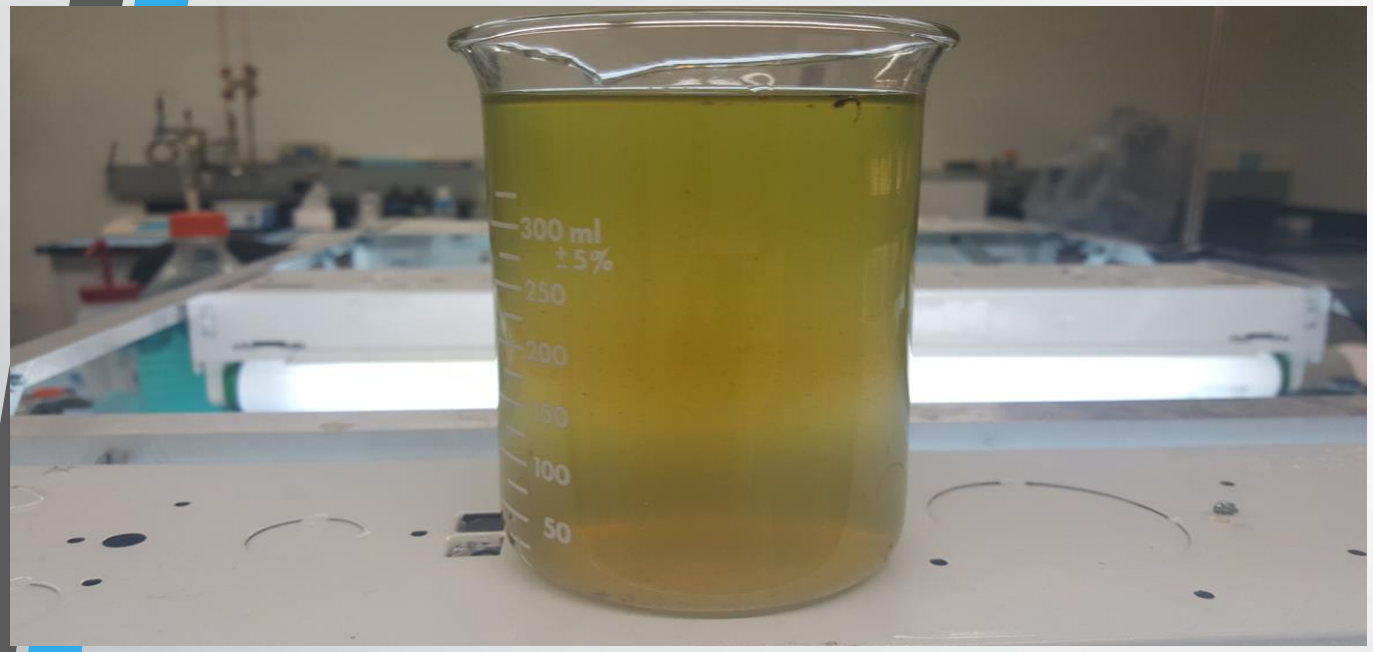

Figure 9: Wastewater lagoon sample

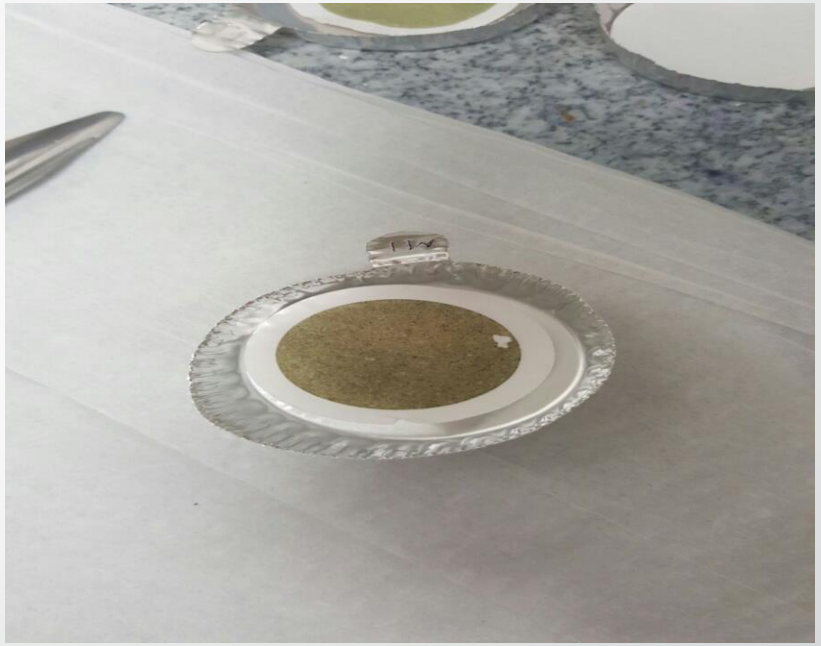

Figure 10: Filter with solids

- Pour measured volume pond water through filter
- Collect solids on filter, dry and weigh
- TSS = mg weight on filter / L pond water

Laboratory Analysis - TSS Results

Table 3: TSS Results

Sample	TSS(mg/L)	Algae count (cells/mL)
Pond 1	86.6	206.6
Pond 2	96.6	183.30
Pond 3	21.48	156.65
Pond 4	18.32	126.60
Pond 5	50.37	123.30

- Top of pond sample tested
- TSS are assumed to be all algae.

Annual Biomass Productivity – estimated from literature

- Assumption: Open pond produces 16.6 – 33.1 tonnes algae/hectare/year (*"Algae for Biofuel Production - EXtension." Algae for Biofuel Production - EXtension. Web*)
- Use 22.4 tonnes/hectare/year for estimate.
- 22.4 tonnes algae/hectare/yr * 4.195 hectares = 93.97 tonnes algae/yr
- Lipid production @ 38% lipid (based on Chlorella):
  - 93.97 tonnes algae/yr * 0.38 tons lipid/ton algae * 0.9 L lipid/kg lipid *kg/2.2 lb * 2000 lb/ton = 29,215 L lipid/yr

Annual Biomass Productivity – Estimate by TSS Results

- Compute tonnes algae/hectare/yr

$$Volume\ of\ Pond\ (L) * TSS\ of\ pond\ \left(\frac{mg}{L}\right) = Mass\ of\ algae\ in\ pond\ (mg)$$

- Assumptions:
  - ~70% TSS is algae.
  - September sampling not peak season – TSS likely higher during peak (June) – as much as 10x higher.
  - Could harvest algae twice/month during peak season.

Annual Biomass Productivity – Estimate by TSS Results

Table 4: Pond-production R\rate

Pond	TSS(mg/L)	Volume of pond(L)	pond-prod(Tonnes/ha/yr)
1	86.6	12504230	15.84
2	96.6	7129910	17.67
3	21.48	10594798	3.93
4	18.32	17317484	3.35
5	50.37	16355136	9.21

- Assumes 12 harvests/year

Recommendations

- Additional sampling required to get peak season data.
- Must increase algae production given limited growing season.
  - Recommend adding nutrients and improving mixing.
  - Economic analysis of dosing.

Figure 10: Lab work.

Sampling Plan

- Sample once during the months of (October-January).
- Sample twice during the months of (February-September).
  - Algae lives near the surface of the ponds but samples should be taken from the top and bottom of each pond to identify algae density in water column.
  - Samples must be preserved (not exposed to bright light).
  - Sampling bottles must be left slightly open to allow air to enter.
- Identify algae species
- Determine TSS concentrations

Adding Nutrients + Mixing

- Nutrients: provides additional food for algae
- Nutrients options:
  - Ethanolamine: 1000$/kg
  - Propyl gallate: 367$/kg
  - Gibberellic Acid: 3330$/kg
  - Dosing rate cannot be determined.
- Mixing: provides increased contact between algae and nutrients
  - Turbine powered paddlewheel.
  - Mobile paddlewheel.
  - Cost: 200-600 $/ paddlewheel

Figure 11: Mobile Paddlewheel

http://www.aquaculture-product.com/english/equipment/aerator-e1.htm

Cost of Project

Table 5: Cost of Project

Item	Classification	Hours	Rate $/hr	Cost
1.0 Personnel	SENG	110	130	$14,300
	ENG	280	71	$19,880
	LAB	71	50	$3550
	Total Personnel	461		$37,730
2.0 Analytical supplies	Glassware, PPE, filters and microscope			$1,000
3.0 Travel	2 trips,226 miles/trip	$0.4/mile		$181
	2 days vehicle rental $55/day			$110
	Total Travel			$495
Project Total				$39,552

The total cost of the project is **$39,552** compared to predicted cost which was **$35,395**.

Questions?

20