

A horizontal splash of clear blue water with bubbles, set against a light blue gradient background.

# American Society of Civil Engineers (ASCE) Environmental Design Competition



CENE 476

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# Project Understanding

- 1.7 million deaths per year can be attributed to the unsafe water supply and unsanitary treatment methods within developing countries [1].
- 29% of the human population does not have access to a protected water source [2].

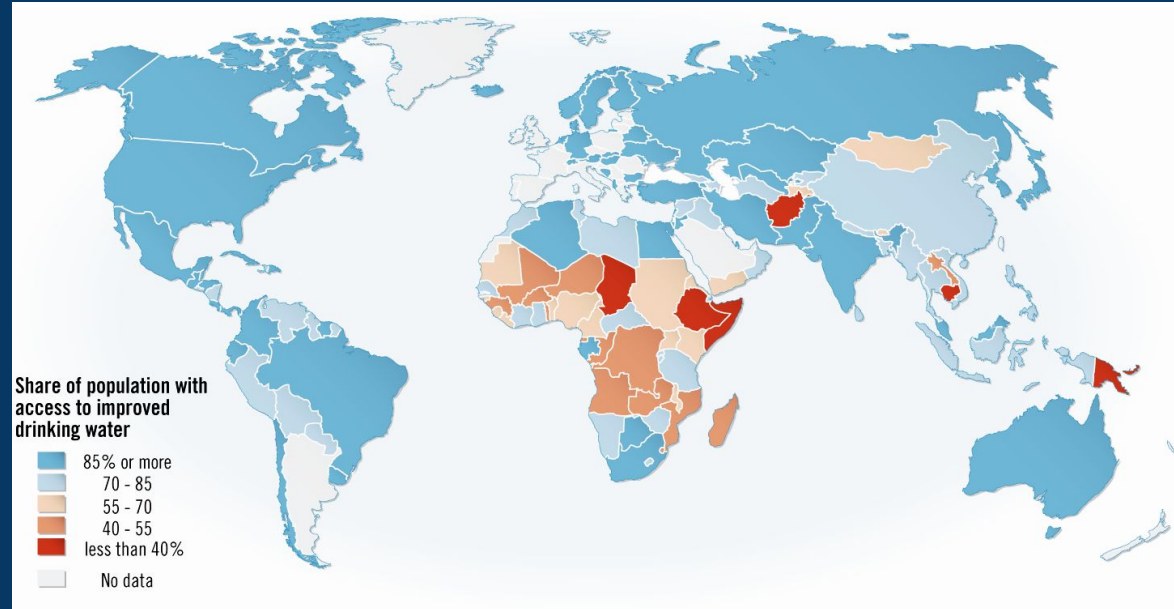


Figure 1: Access to Improved Drinking Water Sources Around the World [3]

# Project Understanding

- Pacific Southwest Conference (PSWC) 2018 located in Tempe, Arizona [4]
- Design and construct a reusable, low-cost household water treatment system that is low maintenance and simple to construct [4].
- The outflow will produce potable water intended for the households of developing countries. The system will also be scalable to accommodate the needs of communities.



*Figure 1: PSWC 2017 Environmental Competition in Irvine, CA*

*Photo courtesy of Celine Bannourah* Reilly 3



# Project Understanding

Drinking water standards for the outflow of the designed water treatment system will be compliant with World Health Organization's drinking water standards [1].

Table 1: Contaminant Quantities Per Nine Gallon Sample [4]

Contaminant	Quantity Per Nine Gallon Sample
Miracle Gro All Purpose Plant Food	1000 g
Bulk Apothecary Kaolin Clay	1000 g
Star Kay White Pure Lavender Extract	30 mL
Wastewater Treatment Plant (WWTP) Effluent	20 mL

Table 2: Testing Parameters and Water Quality Goals [4]

Parameters	Goal
Total P- $PO_4^{3-}$	$\leq 1$ mg/L
Total N- $NO_3^-$	$\leq 10$ mg/L
Turbidity	$\leq 1$ NTU
Chlorine	$4 \pm 1$ ppm
Total coliforms	$\leq 5\%$
Odor	PASS

# Project Understanding

- Stakeholders:
  - Populations of developing regions
  - Northern Arizona University (NAU)
  - NAU ASCE student chapter
  - The client, Mark Lamer
- Potential challenges include:
  - The difference in climate between Flagstaff and the competition location, Tempe [4].



*Figure 2: PSWC 2017 Environmental Competition in Irvine, CA  
Photo courtesy of Celine Bannourah*

# Scope of Services

1. Literature Review
  - 1.1 Developing Country Resources
  - 1.2 Treatment Methods
    - Sari cloth, sand filtration, and zeolite filtration
    - High-capacity anion-exchange resin, biological processes
2. Unit Design Selection
  - 2.1 Component Prototyping
  - 2.2 Software Schematic
3. Acquisition of Materials
  - Unclean Water Constituents
  - Treatment System



*Figure 3: Ganges River in India [5]*

# Scope of Services

4. Fabrication
  - Device units, components including filters, pipes, a holding tank, and supporting structure
5. Proposal 50%
6. Prototype Testing
  - Use WHO treatment methods
7. Compile Results and Construct Final Design
8. Perform at PSWC Competition
9. Final Presentation
10. Final Paper



*Figure 4: Water collection in developing countries [6]*

# Schedule

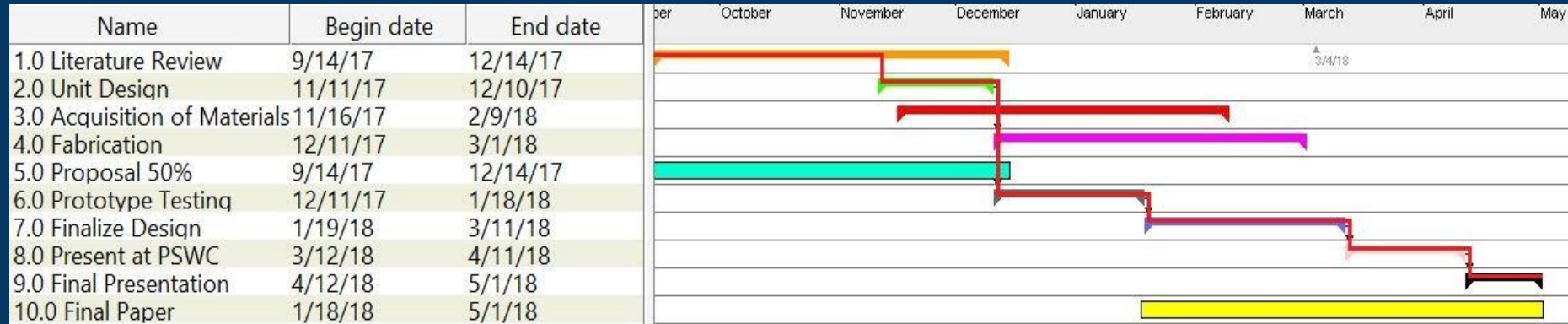


Figure 4: Gantt Chart Schedule

- Critical Path defined by designing tasks and presentation deadlines  
(Sept. 14, 2017 - May 1, 2018)





# Staffing

Table 1: Total Staffing Hours

Task	Subtask	STAFF (hrs)				Task Total
		PE	Manager	EIT	Lab Tech	
1) Literature Review	Developing Country Resources	5	5	20	0	30
	Treatment Methods	5	5	20	0	30
2) Design Selection	Component Prototyping	25	20	40	20	105
	Software Schematic	5	5	10	10	30
3) Acquisition of Materials		0	2	10	5	17
4) Prototyping		10	10	45	40	105
5) Water Quality Parameter Testing		0	5	20	80	105
6) Compile Results/Finalize Design		45	20	45	30	140
7) Present at PSWC	Construction and Demonstration	10	20	20	10	60
	Poster Presentation	2	2	10	0	14
	Technical Presentation	2	2	10	0	14
<b>Staff Total</b>		<b>96</b>	<b>109</b>	<b>250</b>	<b>195</b>	<b>650</b>



# Cost of Engineering Services

*Table 2: Total Staffing Cost*

<b>Position Title</b>	<b>Base Pay Rate/Hour</b>	<b>Benefits % of Base Pay</b>	<b>Actual Pay/Hour</b>	<b>Total Hours Work</b>	<b>Total Cost</b>
PE	\$90.00	40.00%	\$126.00	96	\$12,096.00
Project Manager	\$70.00	40.00%	\$98.00	109	\$10,682.00
EIT	\$50.00	30.00%	\$65.00	250	\$16,250.00
Lab Tech	\$40.00	30.00%	\$52.00	195	\$10,140.00
<b>Total</b>					<b>\$49,168.00</b>



# Cost of Engineering Services

*Table 3: Total Materials and Equipment Cost*

<b>Materials and Equipment</b>	<b>Units</b>	<b>Number of Units</b>	<b>Unit Cost</b>	<b>Total Cost</b>
Miracle Gro All Purpose Plant Food	1000 grams	1	\$10.00	\$10.00
Bulk Apothecary Kaolin Clay	1000 grams	2	\$5.00	\$10.00
Star Kay White Pure Lavender Extract	30 mL	1	\$15.00	\$15.00
Wastewater Treatment Plant (WWTP) Effluent	30 mL	1	\$0.00	\$0.00
PTFE Membrane Filters, 0.10 um, 25mm, Nonsterile	200 pack	2	\$105.00	\$210.00
Homer Bucket	5 gal	2	\$10.00	\$20.00
Wood Stir Stick	1 stick	2	\$5.00	\$10.00
Presentation Board	1 board	1	\$5.00	\$5.00
Filter media: Pool Filter Sand #20 Grade Silica Sand	50 lbs	1	\$30.00	\$30.00
Filter media: Vivadoria Activated Charcoal	34 grams	5	\$10.00	\$50.00
			<b>Total</b>	<b>\$360.00</b>



# Cost of Engineering Services

*Table 4: Total Travel Cost*

<b>Travel Costs</b>	<b>Units</b>	<b>Number of Units</b>	<b>Average Cost Per Unit</b>	<b>Total Cost</b>
Rental Car	Days	4	\$55.00	\$220.00
Gasoline	Gallons	40	\$5.00	\$200.00
Hotel Rooms	2 Rooms Per Night	8	\$200.00	\$1,600.00
Meals	3 Meals Per Day	12	\$10.00	\$120.00
<b><i>Total Travel Cost</i></b>				<b><i>\$2,140.00</i></b>

Staffing Subtotal	\$49,168.00
Materials and Equipment Subtotal	\$360.00
Travel Subtotal	\$2,140.00
<b><i>Total Cost of Project</i></b>	<b><i>\$51,668.00</i></b>



# References

- [1] "WHO | Environment and health in developing countries", Who.int, 2017. [Online]. Available: <http://www.who.int/heli/risks/ehindevcoun/en/>. [Accessed: 17- Oct- 2017].
- [2] "Water and Development — Global Issues", Globalissues.org, 2017. [Online]. Available: <http://www.globalissues.org/article/601/water-and-development>. [Accessed: 17- Oct- 2017]
- [3] Earth Habitat. (2017). Fresh Water Scarcity and Pollution. [online] Available at: <https://earthhabitat.wordpress.com/2010/02/23/fresh-water-scarcity-and-pollution/> [Accessed 30 Nov. 2017].
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- [5] A. Dakkak, "Water Pollution Worries in Developing World", *EcoMENA*, 2017. [Online]. Available: <https://www.ecomena.org/water-pollution/>. [Accessed: 30- Nov- 2017].
- [6] "Papplewick pumping station: Demand for water", *Papplewickpumpingstation.org.uk*, 2017. [Online]. Available: [http://www.papplewickpumpingstation.org.uk/water\\_supply\\_in\\_developing\\_countries.html](http://www.papplewickpumpingstation.org.uk/water_supply_in_developing_countries.html). [Accessed: 30- Nov- 2017].
- [7] PSWC American Society of Civil Engineers Environmental Competition. Irvine, 2017, pp. 1-9.