EPA People, Prosperity & the Planet grant Final Report
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Project Title: Water Awareness Research & Education
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1. Background and Problem Definition
   - Relationship to people, prosperity and the planet

WARE was designed to promote long term environmental protection of stormwater ponds in East Tampa, an economically disadvantaged urban community. Through WARE's community education and awareness campaign, local pollutant inputs to storm water will be reduced; an activity that not only impacts local pond water quality, but also water quality in the Tampa Bay. The beautification and redevelopment of the three stormwater ponds in East Tampa will provide open spaces for the community and improve quality of life (e.g. availability of exercise paths) and WARE will be instrumental in ensuring the ponds themselves are healthy, a factor that could influence visitors.

WARE established a mechanism through which community awareness and education is tied in with curriculum in a local elementary, middle, high school and local university. USF faculty and students worked with the science teachers at Lockhart and Middleton to create innovative curricula that exposes students to fields of engineering, something that will broaden participation of students in STEMs fields. Following the success of the project at Young Middle School, it became evident that this program needed to be shared with other schools. Based on the anticipated success of the program at Lockhart and Middleton, opportunities were created to ensure the project curriculum and modules created as a part of the project are shared with other schools within East Tampa and beyond. These included exhibits at the USF Engineering Expo, exhibits at the East Tampa community survival day and exhibits and workshops at the annual night of ecology held at Lockhart elementary to which teachers will be invited. The collaborative mechanism developed can serve as a model for other areas within the Tampa city limits. Within the East Tampa community, WARE extended to address a series of environmental issues related to improving the community's quality of life.

   - Relevance and significance to developing or developed world

Urban infrastructure and management of the nitrogen cycle are two of the fourteen grand engineering challenges identified by the American Academy of Engineers. This project addresses both of these topics with an emphasis on education and community based solutions to managing the nitrogen cycle and stormwater. The educational initiatives also

address an even larger and more fundamental problem in the US that deals with Science Technology Engineering and Mathematics education.

Stormwater management and STEM education are also relevant to countries other than the US and WARE not only brings these issues into US classrooms (E.g. through K-12 class presentations by returning peace corps volunteers who are a part of the USF Master's International program in Water and Sanitation), but has also expanded its scope to classrooms and communities outside of the US through education.

- Implementation of the P3 Award project as an educational tool

WARE involved education of USF College of Engineering students, East Tampa community members, and K-12 schools in Hillsborough county. Linkages between People, Prosperity and Planet were weaved into all levels of WARE's educational program.

The PI, Dr. Trotz teaches a Civil and Environmental Engineering Laboratory each semester with an enrollment of between forty and sixty students. This class includes both hydraulics and water quality/treatment components. Students usually learn to conduct water quality tests in the field and laboratory by working in teams of three and make a class presentation on a lab of their choice at the end of the semester. One of the class projects includes a field study that each group conducts individually in a location of their choice. They use a Quanta Hydrolab multimeter probe to collect water quality data and they collect water samples for other parameter testing in the laboratory (alkalinity, hardness, BOD). They also collect sediment samples for particle size distribution. The three East Tampa pond sites identified in this proposal are included in a larger stormwater monitoring program done by the class. The sediment samples collected were analyzed for heavy metals in the PI's lab. In addition to collecting this data, the student groups were asked to use this assignment for their class presentation and emphasize P3 concepts as they apply to the WARE project and their assignment.

P3 concepts are integrated into the curriculum developed as a part of this project for implementation at Lockhart Elementary and at Middleton High School and for the demonstration modules. Educational material developed for WARE demonstrates the linkages between the residents' quality of life and the stormwater ponds and their role in reducing pollution loads and safeguarding pond upkeep. Faculty co-advisor Prof. Trent Green worked with the East Tampa Community Redevelopment Plan from its inception and won the architectural design contract to redevelop the three ponds. He worked with the group to provide design considerations used in the pond's development and educational kiosks.

2. Purpose, Objectives, Scope

P3 concepts were weaved into WARE's educational program for USF College of Engineering students, Young Magnet's middle school students and East Tampa community members the results of which have made a Phase II of the project lucrative. In

the proposed Phase II of the project it is expected that Lockhart Elementary School as well as Middleton High School be brought on board to work with Young Middle Magnet on monitoring the three target ponds as well as making the community more aware of their findings. This is expected to be done through the construction of kiosks at the ponds as well appearances at USF's Engineering Expo and the East Tampa Community Survival Day.

3. Data, Outputs, Outcomes, Findings

Outputs proposed from this project and findings were: a

a) curriculum developed for students at Lockhart Elementary School and Middleton High School;

Jane Kemp, the teacher from Lockhart Elementary moved to Chiles Elementary which was outside of East Tampa. The project expanded as the teacher was critical in developing this curriculum. Graduate student Joniqua Howard worked with her to develop curriculum based on mercury exposure from fish and the curriculum included dissection of a fish whose tissue samples were analyzed at USF. The students were hosted on WMNF, community radio based in East Tampa along with students from King's Kids elementary school in East Tampa.

Figure 1: Elementary students from Kings Kids on air with WMNF 88.9 FM community radio speaking about mercury in fish and stormwater ponds.

At Middleton high school, Trina Halfhide developed curriculum and implemented a project based inquiry activity that revolved around algae growth and algal biofuels. The stormwater pond close to Middleton is still fenced and has not been revitalized by the ETCRP due to significant budget reductions following the economic downturn.

At Young Middle Magnet, the teacher and science class associated with the Phase 1 curriculum were changed. We worked closely with the new teacher, Krysta Porteus, in her math resource class. She adopted the stormwater project as their focal project for Spring 2011's 7th grade class and Dr. Trotz along with Mr. Ryan Locicero led those sessions. The curriculum is summarized in Table 1. The school very soon rebranded as

the Young Middle Magnet for Creative Sciences and mainstreamed the stormwater curriculum with actual low impact development structures built on the school compound to deal with stormwater runoff.

Water Awareness Research & Education (WARE)
University of South Florida
Contact Dr. Maya Trotz (matrotz@usf.edu)
Young Middle Magnet - Creative Science Theme

7th Grade: Sustainability
First Quarter- Scientific Inquiry/Pond
Second Quarter- Calculating Carbon Footprint
Third Quarter-
Fourth Quarter-

8th Grade: Creative Global Engineering
First Quarter- Global Water Crisis
Second Quarter-Global Warming
Third Quarter- Effects of Weather on Structures
Fourth Quarter- Infrastructure

7th Grade (Semester 1)	8th Grade (Semester 2)
1- Introduction to Project 2- Visit Ponds for Initial Observations 3- Hydrologic cycle and Stormwater ponds (detention/retention/dry pond) 4- Mapping and Survey at the pond 5- Vegetation Index Introduction 6- Vegetation Index Pond Survey 7-Build Secchi disc 8- Secchi disc Pond Testing/ Bottled Water observation 9-Florida Friendly Landscaping (FFL) 10- Observe FFL at school- compare to home and pond 11- Low Impact Development (LID) Introduction 12- Water Percolation Experiment 13- Basin Mapping (Pervious vs. Impervious) 14- Calculate Impervious structure at pond 15- Calculate flow 16- Calculate outflow and weir model experiment 17- Making LID change to pond/effect on flow 18- Closing discussion/ surveys	1- Introduction to Project 2- Visit ponds for Initial Observations 3- What pollutants are in stormwater ponds? • Urban vs Rural impacts • Point and Non-Point sources 4- Bottled Water Observation/Secchi disc building 5- Intro to Pond test kit & testing Turbidity • Identify what each things is and how to use • explain and use turbidity tests 6-Field testing (water monitoring kits and secchi discs) 7-Hydrologic Cycle/ Intro to Rain Gauge 8- Take Rain Gauge measurements/Graphing trends 9- How pollutants effect environment? • phosphates, nitrates, dissolved oxygen, eutrophication, heavy metals 10- Video field trip- Clips and Questions 11- Pond Sampling (add data to previous sampling graph) 12- Design for Water Quality 13- Bio-Retention 14- Biofield visit and sampling 15- Rain Gauge Sampling 16- Pond Sampling 17- Pond Sampling 18- Closing discussion and surveys

Figure 2: Lesson plan for middles school students that revolve around stormwater management.

Figure 3: Rain garden with weather station constructed on the property at Young Middle Magnet for stormwater management.

Dr. Trotz received a $500 K National Science Foundation Research Experience for Teachers grant entitled RET: WARE in 2012 to train teachers and pre-service teachers in Hillsborough county at the University of South Florida. One of the teachers developed curriculum which can be found here: http://zunal.com/webquest.php?w=159425. The curriculum developed for WARE is being improved and will eventually be placed on teachengineering.org as a requirement for the RET program.

b) stormwater retention pond demonstration modules and tour that can be used to share information with other school teachers, students and community members;

Figure 4 shows the various types of pond demonstration models that were used at Lockhart Elementary and Young Middle Magnet as well as at public events like the EPA EXPO, the USF Engineering EXPO, Lockhart's Night of Ecology, and the EPA Community Survival Day. Figure 5 shows pictures of the educational kiosk installed at Young Middle Magnet which was designed by students at Lockhart Elementary, Young Middle Magnet along with USF students and teachers at both schools. A bus tour of East Tampa that places the stormwater ponds in a cultural context has been developed by community member Mrs. Evangeline Best. This tour has been given to any USF student groups doing work in East Tampa on stormwater (e.g. classes) and teachers who participate in the NSF RET program (http://www.ware-ret.net). A snippet of the tour can be seen on this video which shows how the project started: https://vimeo.com/68137826.


Figure 4: Various stormwater pond models used for WARE.

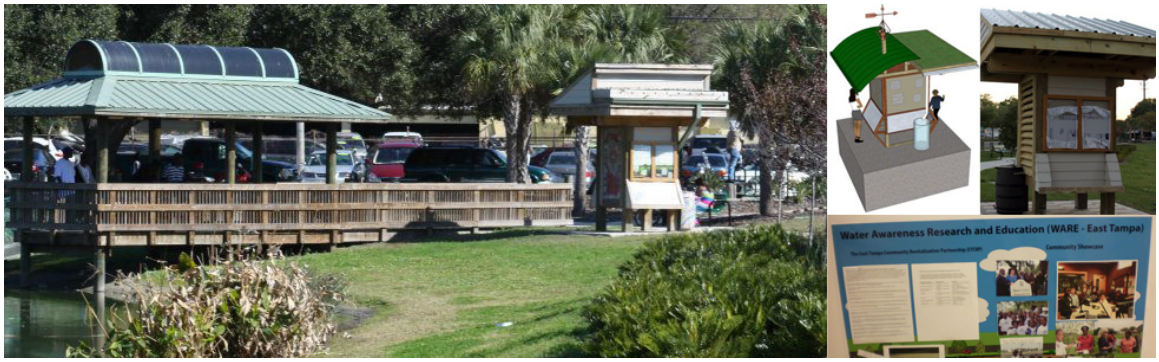
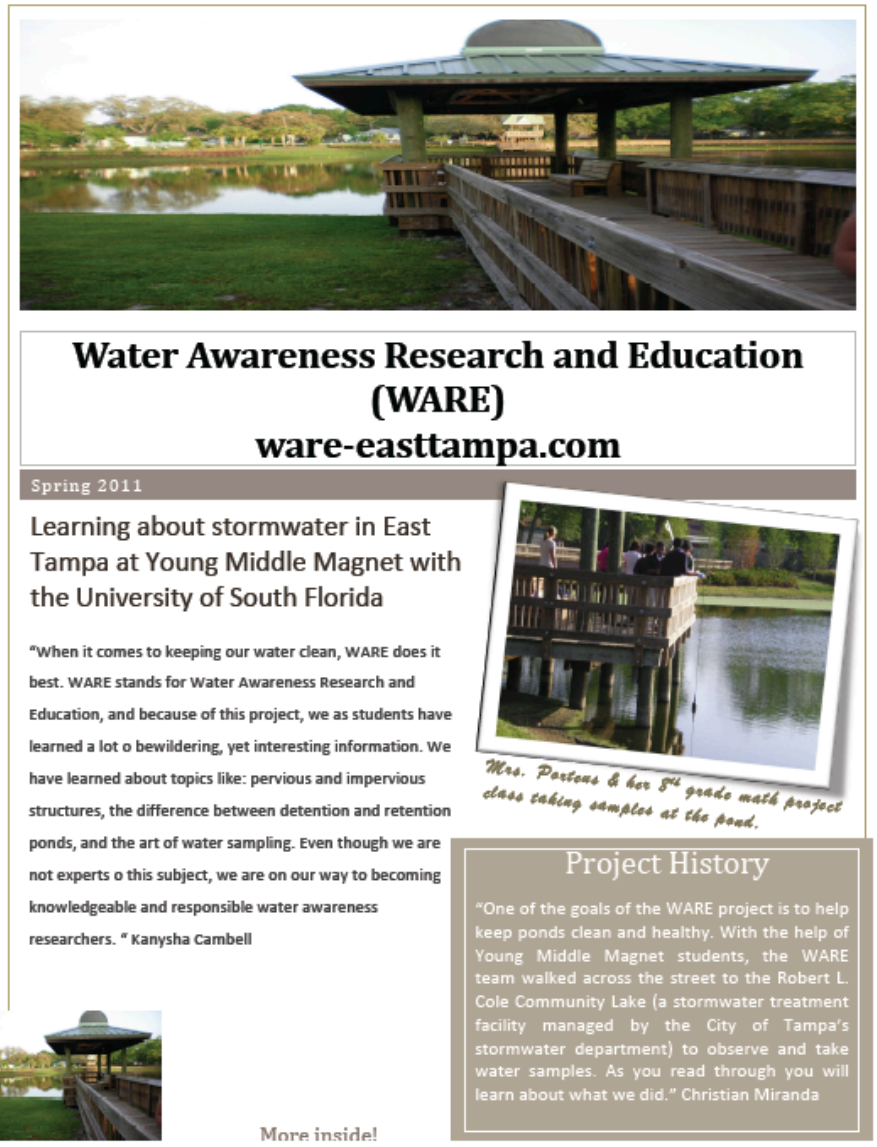


Figure 5: Educational kiosk installed at the Robert Cole Community Lake in East Tampa, a stormwater pond opposite Young Middle Magnet.

c) water quality data collection for three retention ponds in East Tampa and establishment of a sustainable water monitoring program;


Figure 6: Students from Young Middle Magnet sampling water at the Robert Cole Community Lake.

Water quality data is now being collected as a part of a USF undergraduate environmental engineering laboratory class (Fall and Spring) and by various classes at Young Middle Magnet in East Tampa. Research students also include water quality data collection for various East Tampa ponds shown in Figure 9 (e.g. Tables 1-3). The Young students collect data from the ponds across from their school while the USF students collect from at least 3 ponds in East Tampa. Summer undergraduate researchers have also worked with the PI to collect data on a larger number of ponds in the East Tampa area. These ponds have been added to the Hillsborough County's Water Atlas which now enables the water quality data and other information to be shared online.



Water Awareness Research and Education (WARE)
ware-easttampa.com

Spring 2011

Learning about stormwater in East Tampa at Young Middle Magnet with the University of South Florida

"When it comes to keeping our water clean, WARE does it best. WARE stands for Water Awareness Research and Education, and because of this project, we as students have learned a lot o bewildering, yet interesting information. We have learned about topics like: pervious and impervious structures, the difference between detention and retention ponds, and the art of water sampling. Even though we are not experts o this subject, we are on our way to becoming knowledgeable and responsible water awareness researchers. " Kanysha Cambell

Mrs. Porteus & her 5th grade math project class taking samples at the pond.

Project History

"One of the goals of the WARE project is to help keep ponds clean and healthy. With the help of Young Middle Magnet students, the WARE team walked across the street to the Robert L. Cole Community Lake (a stormwater treatment facility managed by the City of Tampa's stormwater department) to observe and take water samples. As you read through you will learn about what we did." Christian Miranda

More inside!

For the Young Middle Magnet students, the sampling results were reported in newsletters issued during Spring 2011 and 2012. The educational kiosk was built with a secure door for storing sampling equipment and with an empty display panel for updated information pertaining to the P3 project. These newsletters were distributed to students and to incoming teachers to East Tampa in August 2011 and 2012.

Figure 7: WARE newsletter distributed to students at Young Middle Magnet and new teachers to East Tampa.

cont.

Water Sampling tells us about the water quality. We can also sample to determine the water's biodiversity. Our experience gave us the test results below.

Samples Taken on March 24th, 2011 using a Quanta Hydrolab

	Site 1	Site 2
Temperature (oC)	24.6	24.8
pH	7.3	7.8
Dissolved Oxygen (mg/L)	6.8	6.3
Conductivity (µmhos/s)	0.302	0.273
Turbidity (NTU)	19.8	16.8

Turbidity: how clear is the water?

We measured turbidity using the Quanta probe and we also used the World Water Day Monitoring Kit. For that test, we placed a colored disc at the bottom of the sample container. Then we filled the container with our sample. We then compared what we saw with the chart.

Figure 8: Water quality data included in the newsletter.

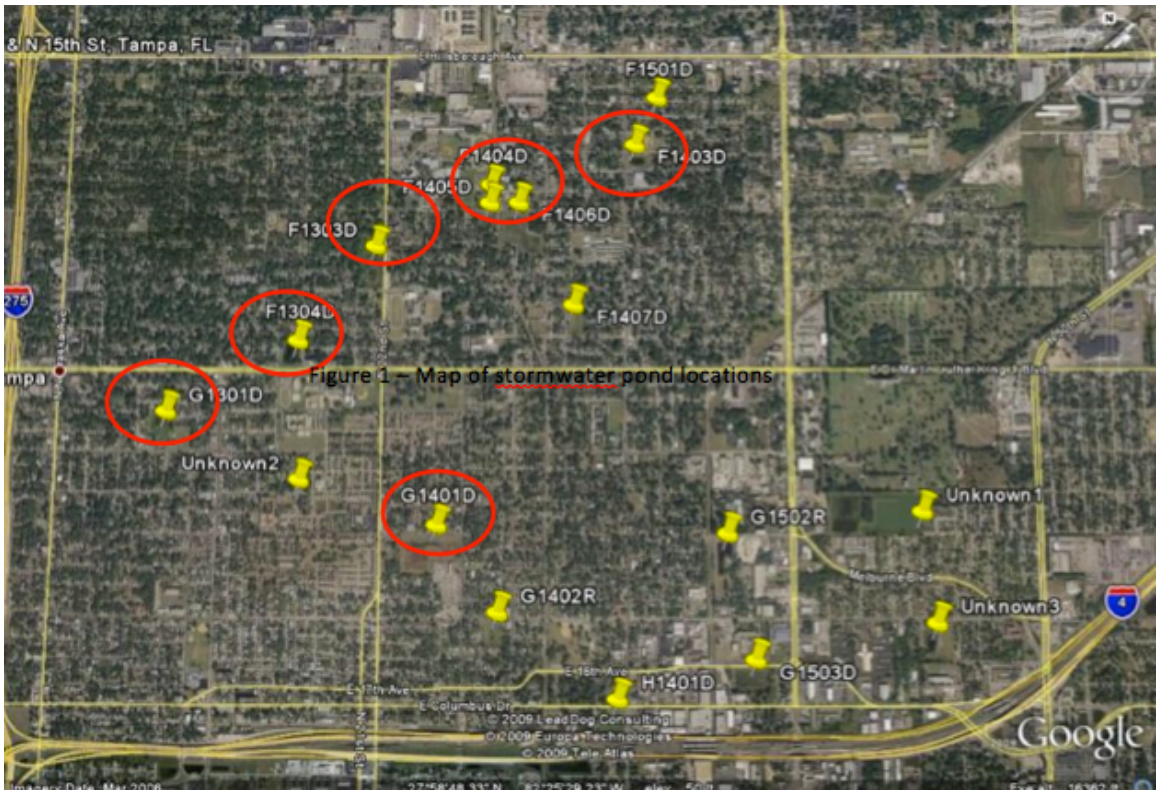


Figure 1 – Map of stormwater pond locations

Figure 9: Stormwater ponds in East Tampa sampled by research students.

Table 1: Results for Total Nitrogen in water samples taken from ponds in East Tampa; July 22, 2011

	Unfiltered Samples		Filtered Samples	
Sample	Absorbance (nm)	Concentration (mg/L)	Absorbance (nm)	Concentration (mg/L)
Blank	0.000	0.181	0.000	0.181
G1401D	0.023	1.128	0.010	0.593
F1404D	0.038	1.745	0.014	0.757
G1301D	0.032	1.498	0.036	1.663
F1405D	0.024	1.169	0.053	2.362
F1304D	0.033	1.539	0.006	0.428
F1403D	0.025	1.210	0.055	2.444

Table 2: Quanta probe results for water quality of ponds in East Tampa; July 28/2011

TPond	pH	Specific Conductivity (mS/cm)	Turbidity (NTU)	DO	DO%	Temperature (˚C)	ORP
F1304D	7.25	0.214	15.7	6.53	86.8	31.56	368
F1401D	6.81	0.394	28.9	3.08	46.9	31.76	317
G1301D	8.13	0.251	28.9	8.75	121.6	32.35	336
F1403D	7.08	0.465	5.4	4.16	63	27.83	375

Table 3: East Tampa surface water stormwater Pond sample results using HACH Test Kits.

Sample	TP (mg/L)	Iron (mg/L)	Aluminum (mg/L)	Chromium (mg/L)	Nickel (mg/L)
1403-1	0.966	0.049	0.01	0.011	0.042
1403-2	0.937	0.048	0.017	0.017	0.06
1304-1	0.94	0.024	0.014	0.01	0.053
1304-2	0.91	0.019	0.003	0.013	0.054
1401-1	1.04	0.156	0.006	0.012	0.055
1401-2	1.01	0.159	0.017	0.013	0.061
1301-1	0.971	0.026	0.04	0.013	0.042
1301-2	0.909	0.023	0.039	0.011	0.054
Field Blank-1	0.076	-0.016	0.006	0.01	0.026
Field Blank-2	0.115	-0.015	0	0.013	0.02

d) assessment of heavy metal sediment loads in the storm water ponds in East Tampa;

e) reports of proposed activities needed to continue this project that are shared with the public through exhibits and on the web.

Multiple presentations have been made on this project, including the USF Engineering EXPO, ETCRP monthly meetings, and the East Tampa Community Survival Day. The WARE-EASTTAMPA.com website archived all of the project reports until February 2013. A more economical site to host this information is under consideration, however, a FB page has been established to continue updating the public on this project.

Figure 10: EPA P3 EXPO in April, 2011 and USF Engineering EXPO in February, 2011.


Figure 11: East Tampa Community Survival Day, August 2010.

The outcomes from this project were an increased understanding of stormwater ponds and their importance to communities in Florida and the creation of a mechanism to raise the level of environmental awareness amongst East Tampa residents.

Classroom and activity surveys showed knowledge of stormwater ponds through pre and post surveys with an increase in knowledge after a given activity. Multiple interdisciplinary proposals that build on WARE have been written with support from the East Tampa Community. Three that have been successful to date are:

- Tampa Bay Environmental Fund ($105,000; PI: Sarina Ergas and co-PI Dr. Maya Trotz and Dr. James Mihelcic; June 2013 – June 2015; 4 bioretention cells to be built in East Tampa and community members trained in their construction and maintenance) Reducing N Loads to Tampa Bay Using Bioretention Systems.
- National Science Foundation Research Experiences for Undergraduates (REU) ($392,816; Co-PI: Sarina Ergas; August 2012 – July 2015; 12 undergraduate researchers supported each year) Tampa Interdisciplinary Environmental Research (TIER).

- National Science Foundation Research Experiences for Teachers (RET) ($500,000; Co-PI: Tina Hohlfeld; June 2012 – May 2015; 16 pre and in service teachers supported each year) Water Awareness Research and Education (WARE).
- National Science Foundation

Other USF classes have used the WARE project to contribute to stormwater management in East Tampa (Figure 12). In spring 2012, two of Dr. Ergas' capstone design teams carried out stormwater design projects to alleviate flooding and water quality problems and improve community access to green space in East Tampa that integrated LID features such as bioretention systems and floating wetlands. One stormwater team won a national design competition sponsored by the Water Environment Federation (www.wef.org/PublicInformation/). Presentations to the East Tampa community were made in April 2012.

Figure 12: USF faculty and students in Capstone Engineering and Cultural Anthropology visit East Tampa with community member Mrs. Evangeline Best, January 2012.

The main teacher from Young Middle Magnet who worked on the project from Spring 2011 was a finalist for the 2013 Teacher of the Year award (http://www.educationfoundation.com/excellenceeducation/teacheroftheyear):
"Krysta Porteus graduated magna cum laude from the University of Tampa with a degree in Elementary Education in May 2009. She was hired at Young Middle Magnet where she has worked for four years teaching sixth, seventh, and eighth grade math. Porteus has earned certifications for Gifted Education and Middle Grades Math. In her first four years of teaching she has been awarded the PRISM Teacher of Promise for Hillsborough County in both Math and Science, presented at two national conferences, and partnered with the USF WARE project to bring a rain garden to Young's campus. Porteus is currently working on her master's degree in Educational Leadership."

Currently, graduate student Ryan Locicero is completing a dissertation that builds on the WARE project for urban stormwater management. In addition to developing curriculum for Young Middle Magnet has worked with the students and teachers to design and build a rain garden at Young and now manages a rain garden website: http://raingardens.us/?author=1.

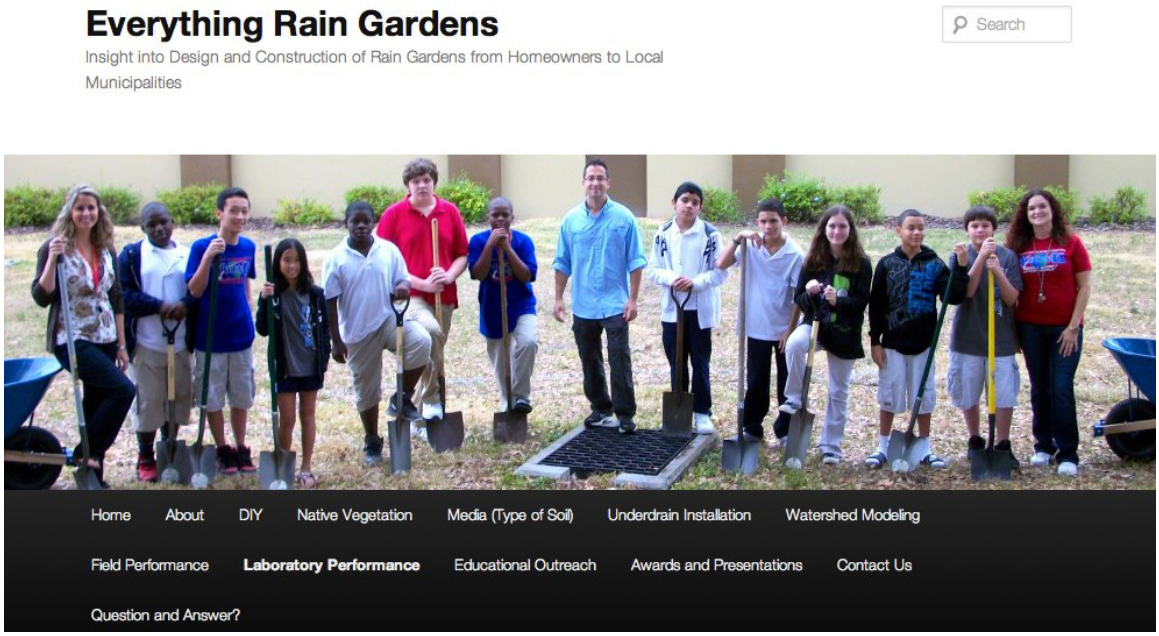


Figure 13: Image of website developed by USF graduate student and USF ESW president Ryan Locicero based on his work at Young Middle Magnet.

The WARE work has also been studied by colleagues in education and some of that is discussed in the following publication: Allan Feldman, Angela Chapman, Vanessa Vernaza-Hernández, Dilek Ozalp, Fayez Alshehri (2012). Inquiry-based science education as multiple outcome interdisciplinary research and learning (MOIRL). Science Education International Vol.23, No.4, December 2012, 328-337. http://www.icaseonline.net/sei/december2012/p2.pdf

Many of the outreach activities initiated under WARE will continue as they have become integrated into middle school curriculum and other projects with various outputs for the web and other avenues of communication with a broader public.

Figure 14: Various activities linked with the WARE P3 project, including an online learning tool created by students in the Spring 2011 USF College of Engineering Technology Development course.

4. Discussion, Conclusions, Recommendations
   - Benefits to people, prosperity, and the planet (estimated or actual)

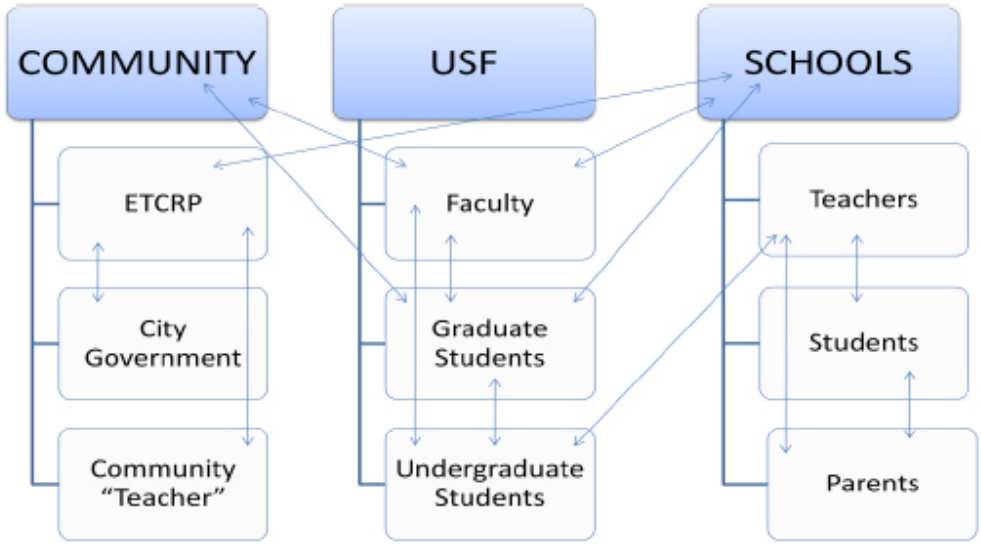


Figure 15 Organizational Chart for WARE, Indicating Areas of Interaction of The Members of Each of The Three Participatory Groups (Community, USF, Schools). Arrows Indicate Mutually Beneficial Interactions Between Various Members. **Taken from http://scholarcommons.usf.edu/etd/3465**

This project has impacted numerous people from the community, university and K-12 schools in Hillsborough county. At the community level East Tampa residents have learned about and from the project through presentations at their monthly meetings, through two radio broadcasts, through community events, and through newsletters distributed to students and new teachers. Mrs. Evangeline Best has become the community teacher who leads stormwater bus tours in East Tampa and who brought numerous other projects to her community through WARE. At USF faculty from engineering, architecture, anthropology and education have benefitted from WARE through research and education initiatives. Graduate students have published on WARE and integrated various aspects of the project into their research and professional development. Undergraduate students in multiple classes have participated in WARE though research and coursework. Schools throughout Hillsborough county have benefited from WARE with new curriculum and approaches to project based inquiry to improve water awareness. The project has contributed to the professional development of many teachers like Mrs. Krysta Porteus who has become a leading teacher in the district. Through projects like the RET WARE project, even more teachers are being trained with long term influence through the teachengineering website. Students from many classes and schools at the K-12 level have participated in this project with positive feedback after the various activities. Their parents have also been involved at our outreach activities and through our newsletters.

Benefits to prosperity include the continued beautification projects in East Tampa and beyond, especially as they relate to stormwater management. Also, as more students at K-12 engage with the project and as teachers present materials in more exciting way, there

should be positive influences on getting students into STEM fields. The planet benefits from this project as people will better manage stormwater and ensure it is not polluted (e.g. with fertilizers). They will also see themselves as being integral to solutions that can be implemented at the community and household levels.

- Other pertinent information, including, if appropriate, analysis and explanation of cost overruns or high unit costs.

The project did not spend all of the funding. This resulted from the turnover in students at USF and principals and teachers in East Tampa. A large part of the success of this project depends on interpersonal relationships and connections. After the original ESW students graduated, a new doctoral student took over responsibility. There were initial challenges as engineers struggle to see educational initiatives as anything other than outreach. That student has now completely integrated engineering education as a part of his dissertation and transformed the WARE project into one upon which actual new interventions are being made to deal with community stormwater. Young Middle Magnet where he works has adopted themes of global citizenship and sustainability and has mainstreamed the WARE project into various grades. Much of the spending to complete the demonstration project occurred in Fall 2012 and Spring 2013 after the grant ended.

Figure 16: New projects at Young Middle Magnet

5. Summary of Educational Accomplishments Resulting from P3 Project
   - Itemization of the number of undergraduate and graduate students involved since inception as a P3 project

Undergraduates:

1. Anton Dapcic, USF
2. Kori Higgs (North Carolina Agricultural and Technical University student in the REU-TIER program, 6- 8/2011)
3. Jefrey Kwang (Johns Hopkins University student in the REU-TIER program, 6-8/2011)
4. Barbara Araneda (University of Florida student in the REU-TIER program, 6-8/2010):
5. Chiu Hong, USF
6. Daniela Soledade, USF
7. Brittany Carl (University of Florida student in the REU-TIER program, 6-8/2009):
8. Tuliagenda Beresford, USF

+ undergraduate classes at USF: 1) Environmental Engineering Laboratory (~50 students/semester and done both semesters in 2010, 2011 and Spring 2012); 2) College of Education Technology Development course (~9 students in Spring 2011); 3) Cultural Anthropology (~40 students in Spring 2011); 4) College of Education Capstone course (~10 students in Spring 2011).

Graduate Students:

1. Erlande Omisca
2. Joniqua Howard
3. Ken Thomas
4. Tommy Lynn
5. Ryan Locicero
6. Angela Chapman
7. Alden Earle
8. Suzanne Boxman
9. Trina Halfhide
10. Danielle DeVuyst
11. Arlin Briley
12. Angela Chapman

+ graduate students who presented in classes and volunteered with ESW USF.

- Number of theses to which the P3 project contributed

2 PhD dissertations had educational components that were built around the WARE model.

- Listing of courses or classwork to which P3 project has contributed

1. ENV4004L Environmental Engineering Laboratory, Department of Civil and Environmental Engineering

2. CWR 4812 Capstone Water Resources/Environmental Design, Department of Civil and Environmental Engineering

3. ANT 2410 Cultural Anthropology, Department of Anthropology

4. EME 6613 - Development of Technology-based Instruction, College of Education

6. Publications, Presentations, Video Links, Relevant Web Sites

Publications:

Howard, Joniqua A'ja. (2010) "Mercury in the Environment: Field Studies from Tampa, Bolivia, And Guyana". Graduate School Theses and Dissertations. http://scholarcommons.usf.edu/etd/3465

Thomas, Ken Darrie (2010) "Ecotourism and Water Quality: Linking Management, Activities and Sustainability Indicators in the Caribbean". Graduate School Theses and Dissertations. http://scholarcommons.usf.edu/etd/3464

Mihelcic, J.R.; Trotz, M. A. (2010) Sustainability and the Environmental Engineer: Implications for Education, Research, and Practice. Environmental Engineer: Applied Research and Practice, Vol. 10, Winter, 2010, in Environmental Engineer, the Magazine of the American Academy of Environmental Engineers, 10:27-34.

Trotz, M. A.; Muga, H. E.; Phillips, L.D.; Yeh, D.; Stuart, A.; Mihelcic, J. R. (2009) Non-traditional University research partners that facilitate service learning and graduate research for sustainable development. AC 2009-1393, Proceedings of the ASEE Annual Conference & Exposition, Austin, TX , June 14-17, 2009.

Trotz, M. A.; Thomas, K. D. (2009) Sustainability concepts through an applied environmental engineering laboratory: Studying stormwater ponds at the university and local communities. AC 2009-820, Proceedings of the ASEE Annual Conference & Exposition, Austin, TX, June14-17, 2009, 9 pages.

Trotz, M.A.; Muga, H.E.; Phillips, L.D.; Yeh, D.; Stuart, A.; Mihelcic, J.R. (2009) Non-traditional university research partners that facilitate service learning and graduate research for sustainable development. Proceedings of the 2009 World Environmental & Water Resources Congress," Kansas City, MO, May 17-21, 2009, 11 pages.

Thomas, K. D.; Howard, J. A.#; Omisca, E.; Green, T.; Trotz, M. A. (2009) Stormwater pond beautification in East Tampa: The basis for University, K-12, and community partnerships that broaden participation in environmental engineering. Proceedings of the Southeastern Section Meeting of ASEE, Memphis, TN, Marietta, GA, April 5-7, 2009, 12 pages.

Thomas, K, D.; Howard, J. A.; Omisca, E.; Green, T.; Trotz, M. A. Using Stormwater Ponds in East Tampa to Promote Sustainable, Healthy Communities: A Community Partnership Approach. 2010 National Water Quality Monitoring Council Conference (Monitoring from the Summit to the Sea), Denver, CO, 6/25/10.

Presentations:

Trotz, M. A. (invited talk) Caribbean Sustainability and Education. Inter American Development Bank (IADB) Regional Climate Change Dialogue, Punta Cana, Dominican Republic, 9/20/12.

Trotz, M. A. (invited talk) Water Awareness Research and Education - transdisciplinary approach to urban stormwater management in East Tampa". Center for Urban Environmental Research and Education 2011-2012 Seminar Series, University of Maryland Baltimore County, 4/27/2012.

Trotz, M. A. (invited talk) Climate Change Education -unique linkages and opportunities between the Caribbean and CACCE. CACCE Workshop on Impacts of Climate Change over the Caribbean Countries, Mayaguez, Puerto Rico, 2/3/12. http://cohemis.uprm.edu/cacce/pdfs/16Trotz.pdf

Trotz, M. A. (invited talk) Opportunities for Integrated Approaches to Water Systems. United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Caribbean Community Climate Change Centre (CCCCC) Management of Coastal Aquifers and Adaptation Measures to Climate Change Workshop, Port of Spain, Trinidad and Tobago, 12/16/11.

Trotz, M. A. (invited talk) Sustainable Stormwater Management: A Case Study from Tampa with University, K–12, and Community Partnerships. Nova Southeastern University's Climate-Sustainability Lecture Series, Fort Lauderdale, Florida, 11/3/11.

Trotz, M. A. (invited talk) Research, Education and Knowledge Transfer Experiences in Adaptation to Climate Change in the Water Sector. University of Guyana Special Lecture, Georgetown, Guyana, 10/6/11.

Trotz, M. A. (invited talk) Overview of options and actions for mainstreaming adaptation. IADB Capacity-Building Workshop: Water Resources and Adaptation to Climate Change, Georgetown, Guyana, 10/4/11.

Trotz, M. A. (invited talk) Climate change impacts to the Caribbean region and adaptation in the water sector. IADB Capacity-Building Workshop: Water Resources and Adaptation to Climate Change, Georgetown, Guyana, 10/3/11.

Trotz, M. A.Considering Humans: Case Study on Stormwater Management in Urban Communities. UNEXE-USF Green Water Infrastructure Workshop 2011, Exeter, London, 9/1/11.

Trotz, M. A. (invited talk) Focus Latin America and the Caribbean: Americas' Regional Panel on Water and Climate Change, IADB panel at World Water Week, Stockholm, Sweden, 8/24/11.

Trotz, M. A. (invited talk) Climate Change & Water in the Caribbean. Climate change and disaster risk management network, 2nd Meeting on Climate Change, Antigua, Guatemala, 7/19/11.

Websites:
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7. Supplemental key words

ecosystem protection, environmental analysis, monitoring, sustainable environment, community based, surface water.