CAAP Quarterly Report

Date of Report: *July 1, 2016*

Contract Number: *DTPH5615HCAP09*

Prepared for: *U.S. Department of Transportation/Pipeline and Hazardous Materials Safety Administration (USDOT-PHMSA)*

Project Title: *Advancement in the Area of Intrinsically Locatable Plastic Materials*

Prepared by: *West Virginia University, Constructed Facilities Center (WVU-CFC)*

Contact Information: *Dr. Udaya B. Halabe, Professor, CEE Department, WVU*
Email: Udaya.Halabe@mail.wvu.edu
Phone: 304-293-9934

For quarterly period ending: *June 30, 2016*

Business and Activity Section

1. Generated Commitments

1.1 *Agreement Changes*

There has been no change in project participants or other contracts details during the last quarter.

1.2 *Purchases*

Some supplies have been purchased during this reporting period. The purchased supply items are listed in Table 1.

Table 1: Supplies purchased

No.	Item Description	Quantity
1	12” diameter PVC pipes, 14’ long	1
2	6” diameter PVC pipes, 10’ long	1
3	2” diameter PVC pipes, 5’ long	1
4	1” diameter PVC conduits, 10’ long	16
5	12” diameter PVC pipe caps	2
6	12” diameter Fernco caps	6
7	6” diameter PVC pipe caps	6

8	3” diameter Fernco caps	2
9	1” diameter PVC conduit caps	9
10	Soil sensors to measure moisture content, temperature, resistivity and dielectric permittivity	5
11	Miscellaneous items (respirators, spray paint, gloves, plastic buckets, pipe lubricant, 1” diameter PVC junction box, 1” diameter PVC angles, and pipe glue, silicone sealant, silicone gun, spray foam, etc.)	Varies

Note: In addition to the items listed above for this quarter, several PVC pipes, Glass Fiber and Carbon Fiber Reinforced Polymer Composite pipes were already acquired during the first two quarters.

2. Graduate Students Working on the Project

Ph.D. Students – 2

M.S.C.E. Student – 1

B.S.Ch.E. Student – 1

Note: All students have part-time appointments on research project.

3. Status Update of Past Quarter Activities

The following project planning and research activities have been completed during the last quarter (April 1 – June 30, 2016).

3.1 *Procurement of Materials*

In addition to the materials procured in the first two quarters, 12” and 6” diameter plastic (PVC) pipes and caps were acquired. Fabrication of 12” diameter Carbon Fiber Reinforced Polymer (CFRP) composite pipes and 3” diameter Glass Fiber Reinforced Polymer (GFRP) composite pipes was also completed in this quarter. Samples of the GFRP and CFRP pipes are shown in Figure 1.

(a) 12" diameter CFRP pipe *(b) 3" diameter GFRP pipe*

Figure 1: Composite pipes fabricated for use in this research

3.2 *Material Preparation*

Preparatory works (including cutting, surface grinding, and sanding) on additional pipes were completed over the past months. The surfaces of the pipes were sanded to enable adequate bonding with the CFRP fabric during wrapping. CFRP fabric and metallic tapes acquired in the last quarter were used to wrap PVC and GFRP pipes to improve Ground Penetrating Radar (GPR) detectability of these pipes. Some of the PVC and GFRP pipes were not wrapped, and will serve as control specimens during GPR detectability testing of the samples. Some of the wrapped pipes are shown in Figure 2.

(a) *(b)* *(c)* *(d)*

Figure 2: Completed (wrapped) pipes: (a) 6" diameter PVC with carbon fabric rings, (b) 12" diameter PVC with carbon fabric strip, (c) 12" diameter GFRP with metallic rings, and (d) 12" diameter GFRP with metallic strip

Additionally, 48"x24"x51" soil box for leak detection (from burried pipe using Fourier Transform Infrared Spectroscopy (FTIR) testing) has been built and filled with soil. Before the wooden box was filled with soil, a steel pipe with sixteen 1/8" diameter holes drilled into the pipe (4 groups of holes along the length of the pipe and 4 holes per group at each quarter point along the circumference of the pipe as shown in Figure 3) was inserted in the box as shown in Figure 4. The steel pipe will enable other pipes (PVC, GFRP, CFRP) filled with the appropriate liquid or gas to be slid in and out of the soil with ease. The 1/8" diameter hole will enable any escaped gas to move through the soil and be detected using FTIR. One undergraduate student majoring in Chemical Engineering has been working on this aspect of the project. The soil filled box will be used in the coming months to investigate the possibility of buried pipe detection using FTIR by collecting and analyzing air samples. The same soil filled box will be used to investigate the detectability of subsurface pipes carrying hot liquids using Infrared Thermography (IRT) in later quarters.

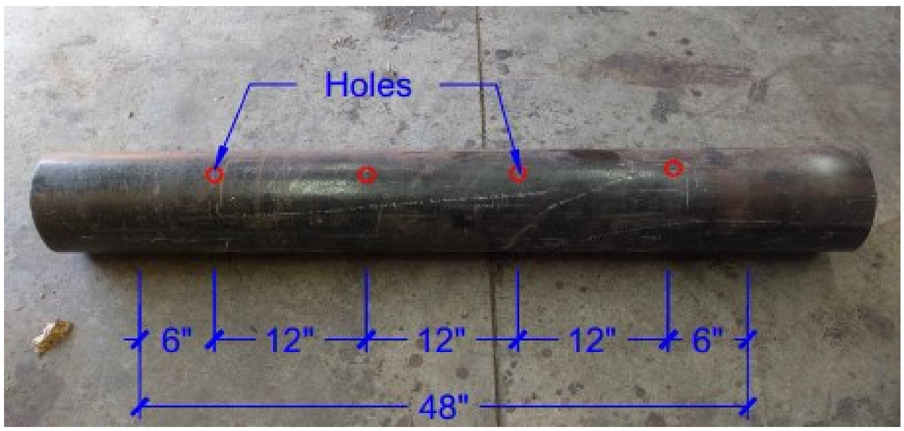


Figure 3: Steel pipe with sixteen 1/8" holes drilled

Figure 4: Soil box for leak detection using FTIR

3.3 *Pipe Layout*

Over the past two quarters, the site for burying the pipes was assessed and the best layout of different pipeline segments was determined. This site assessment and pipe layout configuration were done to ensure that all the different pipeline segments fit within the allocated site, and also to ensure that there is no interference coming from nearby objects/utilities (including adjacent pipelines) in the GPR signal during testing. Total of 33 pipes were buried in 3 trenches with 12ft. spacing between the trenches.

3.4 *Pipe Burying*

Pipe specimens prepared for GPR testing (including PVC and GFRP pipes with carbon fabric rings or strips, PVC and GFRP pipes with metallic rings or strips, unwrapped PVC and GFRP pies, and CFRP pipes) were buried at the site located on WVU campus. Utility lines close to the allocated site were first marked to prevent excavation damage of the lines at the time of pipe burying. The site and the marked utility lines are shown in Figure 5.

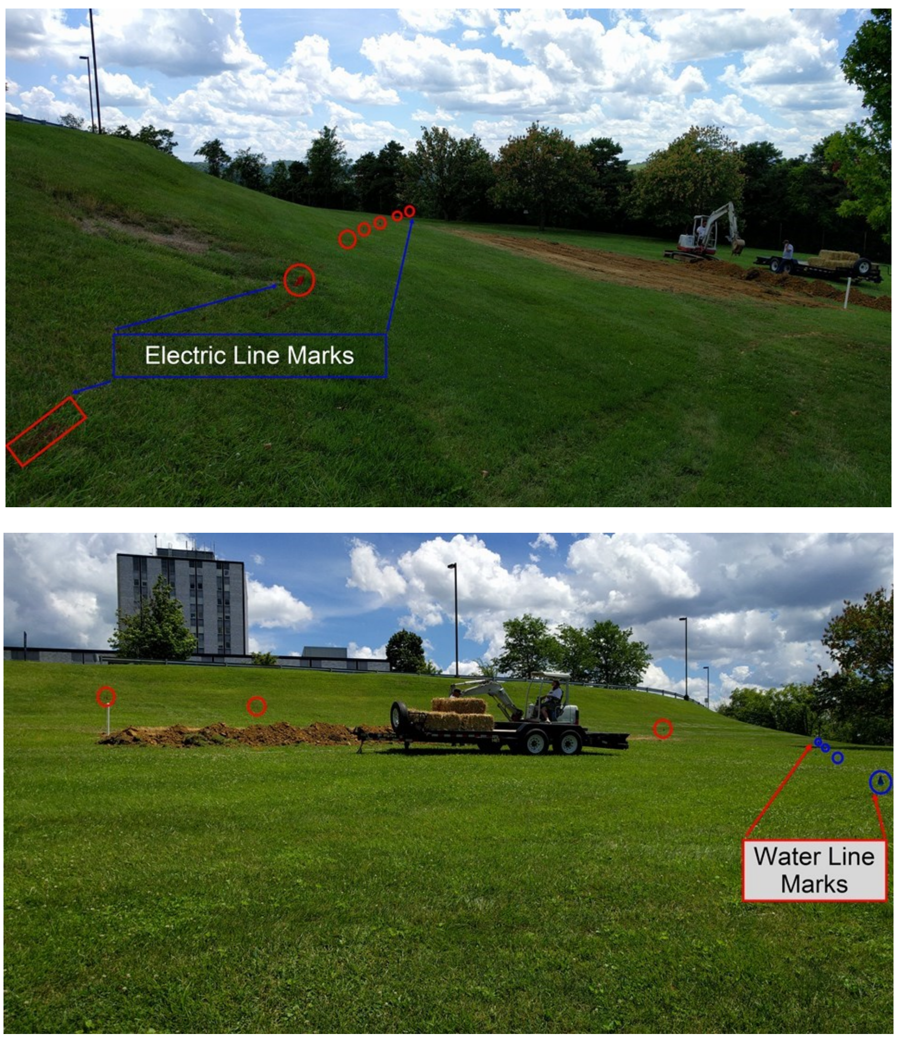
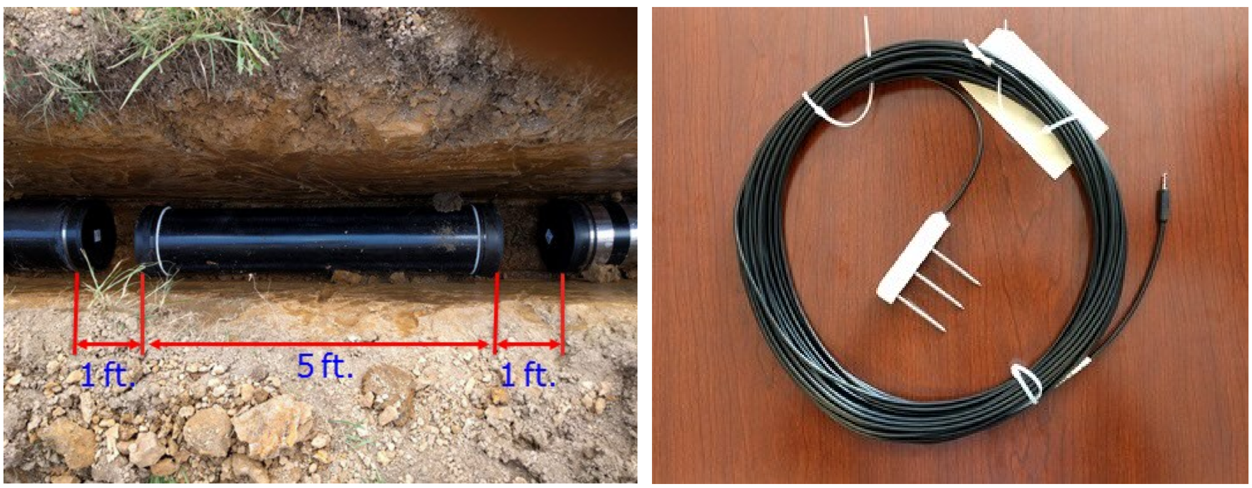


Figure 5: Utility lines marked at the excavation site

The pipe samples were buried in 3 separate 65ft. long trenches, spaced at 12 ft. apart. 12" diameter and 5 ft. long PVC, CFRP, and GFRP pipes were buried at a depth of 4 ft. in one of the trenches (total trench depth of 5ft.). The second trench had 3" diameter pipes (each 5ft. in length) buried at a depth of 2ft. (total trench depth of 27"). Two different diameter pipes, 12" and 6" (each 5ft. in length), were buried in the third trench, both diameters buried at a depth of 3ft. to the top of the pipe. Eleven pipes were buried in each trench, with 1ft. spacing between each subsequent pipe as shown in Figure 6(a). Additionally, 5 soil sensors (Figure 6(b)) were buried along the trenches at different depths to measure soil properties throughout the testing period. Two of the sensors were buried at 4ft. depth along the 12" diameter pipes, two were buried at 2ft. depth along the 3" diameter pipes and one will be used to measure soil properties at various locations on the ground surface. These sensors will enable quantitative determination of volumetric water content, electrical conductivity, temperature, and dielectric permittivity of the soil during the testing period.

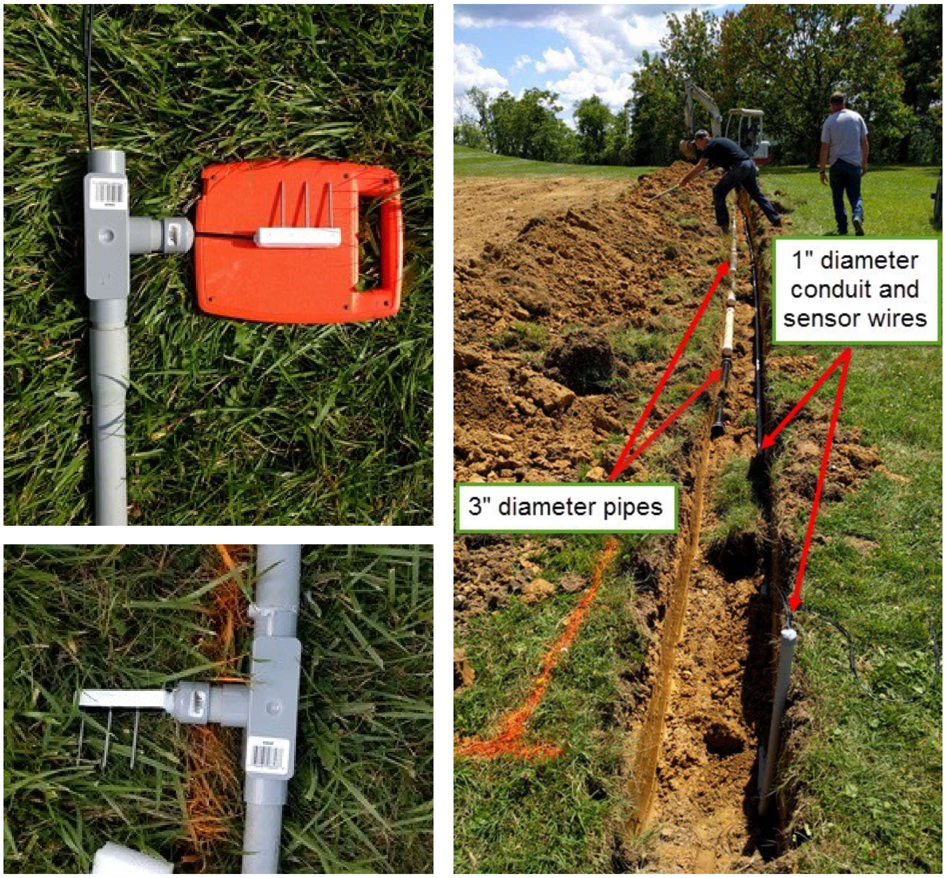


(a) *(b)*

Figure 6: (a) Arrangement of pipes in the trench, (b) soil moisture and resistivity sensor

Wire connecting the soil sensors to a dataloger were run through 1" diameter PVC conduits before burrying to prevent the wires from getting damaged during compaction of backfill (Figure 7). Figure 8 (a and b) show the 12" and 6" diameter pipes placed at 3ft. depth (to the top of the pipe) in the trench and the pipes being covered with backfill. Figure 8(c) shows some of the 12" diameter pipes placed in the trench at 4ft. depth (to the top of the pipe). Two steel plates were buried at 3” depth (one at each end of the trench) to mark the beginning and end of each trench for GPR testing.

Finally, the ground surface was levelled and seeded with grass after backfilling the trenches (Figure 9) to restore the initial field condion. GPR testing will commence after the straw ascimilates into the soil and grass starts growing.



(a) *(b)*

Figure 7: (a) Soil sensors with data wires running through conduits to protect the wires, (b) 3" diameter pipes and sensors in the 27" deep trench

(a) (b) (c)

Figure 8: 12" and 6" diameter pipes being buried

Figure 9: Grass seeding of the ground after burying pipes

4. Description of any Problems/Challenges

No challenges were encountered in the past quarter.

5. Planned Activities for the Next Quarter

The following activities are planned for the next quarter:

1. The detectability of the buried PVC, GFRP, and CFRP pipes will be evaluated using GPR over the next several quarters under various soil moisture conditions.
2. Also, leak detection from a pipe buried in a box filled with soil and carrying compressed gas will be conducted using FTIR equipment.