THE EFFECT OF EXPOSURE TO SCIENTIFIC DOCUMENTS ON STEM LITERACY IN HIGH SCHOOL STUDENTS.

A Master’s Research Project Presented to

The Faculty of the College of Education

Ohio University

In Partial Fulfillment

Of the Requirements for the Degree

Master of Education

by

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# Table of Contents

**Chapter I. Introduction**  
Background  
Statement of the Problem  
Research Question  
Methodology  
Definitions  
Limitations  
Overview  

**Chapter II. Literature Review**  
Introduction  
Loss of Interest in STEM-Related Fields  
  Role of Gender in STEM Fields  
  Role of Race in STEM Fields  
  Role of Socioeconomics in STEM Fields  
Importance of STEM Literacy Education  
  STEM Literacy in the Workforce  
  Current Obstacles Facing STEM Literacy in H.S. Education  
  Strategies to Promote STEM Literacy  
Conclusions  

**Chapter III. Methods**  
Introduction  
Setting  
Participants  
Instructor  
Student Surveys  
Phase I Environmental Site Assessment  
Student Interviews  
Data Analysis  

**Chapter IV. Findings of Study**  
Results of Pre-Study Survey  
Results of Post-Study Survey  

**Chapter V. Discussion and Conclusions**  
Discussion  
Limitations and Future Research  
Recommendations  

**References**  

**Appendix A – Phase I Environmental Site Assessment**  
**Appendix B – Pre-Unit Survey**  
**Appendix C – Post-Unit Survey**  
**Appendix D – IRB Proposal and Consent Forms**  
**Appendix E – Plagiarism Check**
CHAPTER I. INTRODUCTION

Background

Interest in promoting science, engineering, math, and technology (STEM)-based learning in high schools and trade schools has been on a rapid increase in the past decade. There has been a call to increase the STEM literacy in students graduating from high school before they enter a secondary education or the workforce. STEM literacy is defined as the mastery of a body of knowledge, rather than the descriptive sense of the term literacy (Asunda, 2012). STEM literate individuals are able to describe, explain, and predict the outcome of natural phenomena, comprehend scientific articles and pieces presented in popular press and media, as well as have the ability to form their own opinion about the validity of scientific claims being made in the press and media. However, STEM literacy first requires an interest and basic understanding of STEM-related fields.

Unfortunately, the majority of today’s students do not have an accurate understanding of science, technology, engineering or mathematics (Skamp & Logan, 2005). Science is something that only ‘scientists’ can do, something that only takes place in a laboratory, and is something that does not pertain to their daily lives. Students do not see a reason to learn or understand science, because they believe they will not be ‘doing’ science in their life or career. Previously, studies have found that despite an interest in science in young children, most students have established, negative attitudes towards science by the age of fourteen (Archer et. al, 2010), before they have even entered high school.
Recently, STEM initiatives have been integrated beyond public high schools to vocational schools, trade schools, and Career and Technical Education (CTE). These schools provide a more hands-on education for students, as well as the ability to directly apply the science, technology, engineering and mathematics they are learning to their future careers. There were an estimated 2.5 million jobs within the United States between 2004 and 2014 available to hire individuals entering STEM-related careers, but many of these job opportunities were outsourced to employees outside the country due to a lack of STEM-literate individuals entering the workforce in the United States (Persaud-Sharma, 2012). It is the goal of STEM integration in high schools, trade schools, and vocational schools to increase awareness and raise interest in these fields in individuals about to enter a secondary education or the workforce.

**Statement of the Problem**

After graduating high school, many students are still unable to apply their knowledge or limited understanding of STEM-related fields, especially the function of mathematics and science outside of the classroom (Cantrell and Ewing-Taylor, 2009). If STEM is not something students grew up with, it is typically not something as they view within their reach. Without a family member who works within a STEM-related field or adequate exposure in high school, students cite they do not understand what a career in a STEM-related field entails, or why such things would apply to them (Hyslop, 2010). Students continue to struggle or fail to employ STEM knowledge and skills outside of the classroom.
**Research Question**

This Master's Research Project investigated the literature available on the current state of STEM literacy in high school students, as well as the efforts to improve STEM education and STEM literacy among these students. This purpose of this study was to answer the following question: What impact does exposure to and replication of research-based writing have on the STEM literacy, interest in STEM-related fields, and attitudes towards STEM-related fields in high school students enrolled at a vocational school?

**Methodology**

The literature selected, reviewed and analyzed for this Master's Research Project was found through various Internet searches. Internet databases and search engines were used in the various searching were as following: EBSCO, JSTOR, Google Scholar and Ohio University's ALICE Online Catalog. Key terms that were searched included 'STEM literacy', 'STEM education', 'Career and Technical Education', 'CTE', 'vocational school', and 'trade school'. These key terms were used to generate literature used in this Master's Research Project.

The methodology used in the classroom varied. Prior to the start of the assignment, students filled out a brief questionnaire about the importance of STEM-related fields and STEM-literacy in their personal live and the role of STEM in their future careers. Next, students were assigned to read a Phase I Environmental Site Assessment (ESA) that I prepared on the job in my previous career. Without explanation, students were then asked to fill out a Likert-type survey about what they have read and how they interpreted it. Students were then guided through the Phase I ESA in their
vocational labs, where they conducted the procedures outlined in the Phase I ESA. Afterwards, students wrote up their findings in groups and reported back to the class what they have discovered about their vocational labs. Then, as a class, the students combined their lab assessments to create a Phase I ESA for the entire school. Finally, after this assignment was completed, students were asked to fill out the same Likert-type survey they had prior to assignment.

**Definition**

A Phase I Environmental Site Assessment (ESA) is a report that’s primary purpose is to identify Recognized Environmental Conditions (RECs) in connection with a property. A Phase I ESA also permits the user of the report (generally landowner, buyer, and/or lender) to satisfy one of the requirements to qualify for landowner liability protections on CERCLA liability and to All Appropriate Inquiry (AAI) into the previous ownership and uses of a property consistent with good commercial or customary practices.

An REC is defined in the American Society for Testing and Materials (ASTM) Standards as “the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, groundwater, or surface of the property.
Limitations

There were limitations on the research proposed. The first limitation was the study school itself. Located in the Appalachian Region of southeastern Ohio, the school is relatively small and is not very diverse. Six individual classes were being observed, and there was a relatively equal distribution of the vocational labs amongst these six classes. However, each period was represented by only a few of the vocational labs, which affected the makeup of the class, including the mix of students’ gender and where the students are from.

As this was a vocational school, the student body was made up of individuals from eight different school districts, as well as individuals who previously attended various home schools. The multi-district source of students also caused a large discrepancy in the base knowledge students have when they arrived at the school and are enrolled in Environmental Science. Students varied greatly in their reading, writing, and mathematical abilities. They also had varying opinions on science and science classes, depending on the instructors and courses they’ve had at their home districts prior to enrolling at the vocational school.

Overview

The intent of this Master's Research Program was to find answers to the following problem: the decline of STEM-literacy in high school students entering secondary education or the workforce. This was attempted through both an analysis of existing literature resources, as well as the analysis implementation of research-based writing in an environmental science class. Based on the analysis of the collected data,
recommendations have been made with regard to the effectiveness of employing research-based writing in the science and trade classrooms. In order to better understand the rationale and proposed research, Chapter II presents a review of current literature on the subject.
CHAPTER II. LITERATURE REVIEW

Introduction

Beginning in the 1990s, the National Science Foundation (NSF) began to encourage new integrative approaches to science, technology, engineering and mathematics (STEM) education. STEM can be described as an "initiative for securing America's leadership in science, technology, engineering and mathematics fields and identifying promising strategies for strengthening the educational pipeline that leads to STEM careers" (Hyslop, 2010). When compared to other nations in the 2003 Program for International Student Assessment (PISA), the United States ranked 28th in math literacy and 24th in science literacy, as well as 20th among nations with 24-year-olds who earn degrees in science or engineering (Kuenzi, 2008), which prompted the American Competitive Initiative and the signing of STEM education plans into law. However, even in the early 2000s, the meaning of the acronym was still relatively unknown and not well understood, and suffers still from ambiguity, even for those who participate or actively study the fields. However, there are still several challenges to be addressed, and while some positive impacts have been made, the infrastructure and pedagogy of STEM education itself remains a point with room for improvement.

Loss of Interest in STEM-Related Fields

A widely publicized problem is the amount of students who lose interest in (or are never exposed to) the STEM fields. In particular, the underrepresentation of minorities is largely examined (Riegle-Crumb & King, 2010), as well as the absence of women (Hyslop, 2010) in these fields. African-Americans, Latinos and Native Americans are
not well represented in these fields when compared with their Caucasian or Asian American counterparts (Hurtado et. al, 2010). In America, socioeconomic status is more tightly correlated with test scores than in other countries (Hyslop, 2010). It has also been found that male students respond more economic changes than females, and students in STEM fields are more motivated by job opportunities than students in other fields (Langen & Dekkers, 2005). When asked, students have indicated they are discouraged from pursuing careers in STEM-related fields because they do not know anyone who works in these fields, or they do not understand what the people who work in those fields actually do (Hyslop, 2010).

**Role of Gender in STEM Fields**

Despite the progress being made in the inclusion of women in STEM fields, these fields are still dominated by males. While women hold almost half of all jobs in the United States, they hold less than a quarter of the available STEM positions (Beede et. al, 2011). However, gender equality is not possible in these fields without an increase of the presence of women in these STEM-related fields. Attitudes towards these subjects in school differ between the sexes, and are usually more positive in males. Even when female students enter the sciences, they tend to stick to the life and biological sciences, viewing the more physical sciences as “too masculine” (Archer et. al, 2010). This excludes women from technology, engineering, and mathematical fields (Dawson, 2000), on top of physics and chemistry.

The lack of women present in STEM-related fields may not be simply an education problem. Studies have found a higher turnover rate among female faculty than male faculty in STEM fields, with reasons cited as the work environment and institutional
culture (Xu, 2008). Even with a STEM-related degree, women are still less likely to obtain a job in a STEM field than men with the same degree (Beede et al., 2011). The exclusion of women in these fields may be due to a hostile work environment, gender stereotyping, and a lack of a female role model during education, which makes STEM seem less attainable to this group.

Role of Race in STEM Fields

Women are not the only group who suffer from a lack of role models during high school and college education. Many minorities, such as African-Americans, Native Americans, and Latinos are underrepresented in STEM-related fields as well (Hurtado et al., 2010). Research has shown that the general climate of the school towards the STEM topics will directly influence both how underrepresented students perceive these topics and envision their own future. If a student cannot envision themselves fulfilling a role in one of these fields—for example, most students describe a middle-aged, white male when asked to describe a scientist—they are much less likely to pursue a future in those fields (Painter et al., 2006).

More diversity among students is usually found at more urban schools. However, there cross-cultural barriers between schools, due to the types of science instruction at these urban schools, where more minority students attend class. Both elementary and middle school students show less scientific academic achievement in inner-city schools in the U.S. National Assessment of Educational Progress (1996-2000) results (Ruby, 2006). These are the same students that will enter high school, with a lower understanding of science and STEM topics than their peers of the same age, who have attended school at a more rural setting, putting them at a disadvantage. Students who enter high school
underprepared in the areas of science, technology, engineering, and mathematics are more likely to form a negative attitude of STEM-related, and are ultimately less likely to pursue STEM-related activities in their career or life after high school.

**Role of Socioeconomic Status in STEM Fields**

Both ethnicity and socioeconomic status play key factors in how students relate to the STEM fields in their daily lives (Kanter & Konstantopoulos, 2010). It has been argued that it is not race that acts as a barrier to STEM education and thus, careers in STEM fields, but access to better education standards (LaPoint & Jackson, 2004). Middle- and lower-class families and students do not have the same education opportunities as their peers in a higher socioeconomic class. Furthermore, the socioeconomic level of the school has just as much impact on students' education as individual levels of socioeconomic class (Rumberger & Palardy, 2005). If a student's only exposure to science, technology, engineering, and mathematics is at school, then an underprivileged school further compromises their understanding and access to STEM-related fields.

Nationally, there is a strong relationship between race and socioeconomic status that cannot be ignored. Latinos, Native Americans and African-Americans represent a disproportionate amount of students in schools with 50-100% students from a low-income household (Orfield & Lee, 2005). This relationship cannot be ignored, if both socioeconomic groups and racial groups are at a disadvantage, than the majority of students are being excluded and underexposed to STEM-related fields and topics.
**Importance of STEM Literacy in Education**

One of the central themes of STEM education reform is the idea of increasing STEM literacy (Sanders, 2009). STEM literacy is defined as the mastery of the body of knowledge, rather than the traditional sense of the term literacy, which is the ability to read and write at a level that allows communication with others. STEM literate individuals are capable of understanding and assessing scientific reports presented to them in media and press; they are also capable of assessing science- and technology-related problems, predicting the outcome, and carrying out the engineered solution (Asunda, 2012). Each one of the four fields represented by STEM also has their own definition of literacy within their field (Zollman, 2012).

**STEM Literacy and the Workforce**

There is an increasing demand for STEM literacy in the workforce for day-to-day tasks, critical thinking, and problem-solving. It is not just a social or political argument, but an economic argument as well (Williams, 2011). A STEM literate individual is able to adapt and accept changes driven by the constant evolution of knowledge within the STEM fields. It has been suggested that individuals are evaluated by their ability to operate at minimum standards and optimal conditions (Erdmann, 2010). As of 2009, standards for STEM literacy are closely aligned with the Standards for Technological Literacy (STL). Low STEM literacy in students translates to the low math and science scores from 2003 seen in 4th, 8th and 12th grade students, which were not as competitive as students of the same grade class in other nations (Kuenzi, 2008). Students have difficulty grasping these mathematical and scientific concepts when they are presented as
abstract ideas, rather than as examples or as knowledge students can employ in their daily lives.

Current Obstacles Facing STEM Literacy in High School Education

There are three major problems facing educators in STEM-related fields. The first major obstacle is the lack of cohesive definition of 'STEM-literacy' as defined by a ruling organization or government. While the government supports and funds STEM programs, it has no coordination in its approach, and instead employs multiple foundations, companies and organizations to rally the STEM cause in the United States (Williams, 2011). As it currently stands, only these individuals or programs offer any definitions, and educators are forced to take what is available to them or create their own definition based on the four definitions provided for each one of the individual fields. This can cause confusion among both educators and students, and result in students underprepared for future education or the workforce.

The second major obstacle is the seeming inability to merge all four fields instead of treating them as individual entities (Zollman, 2012). Technology and engineering are often seen as 'additional layers' to science and mathematics, something that can be added on as additional coursework as opposed to something that can be integrated fully into science and mathematics lessons (Morrison, 2006). It is also believed that science and math teachers are incapable of included technology and engineering into their lessons, and vice versa. Perceptions among educators also create a bias. Unsure what 'technology literacy' actually is, some instructors fear it is being devalued and less emphasized than the other fields in STEM (Williams, 2011).
The third major obstacle is the STEM pipeline itself, which currently focuses on the national deficit in science, technology, engineering, and mathematics education, rather than individuals’ needs (Zollman, 2012). As stated above, there is no overarching plan or guidelines. Different organizations, programs, and foundations set their own standards, which can lead to a biased curriculum. These groups can fail to recognize interests and cultures of individuals, and thus, fail to make the STEM fields accessible to individual students, thus excluding them from pursuing further education or careers in these areas.

There are other issues STEM education and STEM literacy faces outside these issues. On top of the struggle to combine the four fields, it is proving difficult to adapt current curriculums found in schools to provide an integrative approach to all the fields instead of teach each subject consecutively (Williams, 2011). Classrooms may not be appropriately outfitted with current technology to promote the learning of engineering and technology at school. Another issue is the struggle to actually measure the success of STEM programs and STEM literacy in students (Subotnik et. al, 2010). These issues, however, are addressed below.

**Strategies to Promote STEM Literacy**

To increase STEM literacy in educational environments, it has been suggested that STEM education incorporates the pedagogy referred to as “purposeful design and inquiry” (PD&I) to combine the different STEM fields, specifically science and technology, to engage students in to engage in teamwork and problem-solving activities (Sanders, 2009). A good design, problem or project intended to help students learn or apply knowledge should be: pragmatic, grounded, flexible, interactive, integrative and
contextual (Wang & Hannafin, 2005). Students who are exposed to a problem and constraints in a story-like or lecture format prior to designing their own solution to a similar problem where found to score higher than students who were not exposed to a problem or constraints prior to being asked to solve the same problem (Milles and Treagust, 2003; Barron et. al, 1998). Problem-solving allows students to take responsibility for their own designs and solutions, and in turn, responsibility of their own learning. Giving students this sort of responsibility increases their motivation because it gives them ownership of the problems and solutions, as opposed to being spoon-fed information they otherwise are uninterested in (Savey, 2006). It is important to include hands-on learning, as well as lectures, in the classroom. Students exposed to project-based learning often had higher standardized test scores compared to both their previous scores (prior to project-based learning techniques), as well as students who were not exposed to project-based learning (Bell, 2010). Both techniques allow students to practice collaborating with their colleagues, exercise time management and organizing their resources; all of these skills will be useful should the students chose to pursue a career or a college education after graduating from high school.

It has also been suggested that, on top of altering curriculum to include more integrative activities, educators also make STEM literacy culturally relevant to their individual students (Morrison, 2006). Involving cultural, social, or vocational interests can increase the students' impression of the importance of STEM-related fields in their lives outside of the classroom, and improve their desire to become more STEM literate.

Finally, it is important to increase the presence of engineering and technology in mathematics and science courses. It would be pertinent to deign a ruling body over
STEM education, such as NSF or some other national foundation heavily invested in all STEM-related fields.

**Conclusion**

Currently, STEM-literacy is not well measured in high school settings (Subotnik et. al, 2010). A seminar series in 2009 found that several students commented on their surveys that it was the first time the relevance of high school math and science was impressed upon them – they previously saw no value in the topics (Cantrell & Ewing-Taylor, 2009). In order to increase STEM literacy in the classroom, it is important to also increase the value of STEM topics in the students' minds. Increasing the importance of these topics will increase the value of being STEM literate, something students will need to pursue further education or a career in STEM-related fields. Increased exposure to STEM writing, involving students in more STEM-related projects and creating a more integrative classroom will hopefully start to improve the deficit the United States sees in both science and mathematical test scores, as well as job occupancy in STEM-related fields.
CHAPTER III. METHODS

Currently, there are not many studies that assess STEM literacy, or the different
effects methods of teaching have on students' STEM literacy. These methods have been
adapted from studies that focus on inquiry-based learning in science classrooms. In order
to measure STEM literacy in students, it is also important to assess students' interest and
understanding of the topic. To do so, students' thoughts and impressions of science,
STEM fields, and STEM literacy should also be measured and included. The following
section explains the methods of surveys, student assessment, and statistical analysis used
to analyze STEM literacy in students.

Setting

I conducted my research at a trade school in the Appalachian Region of
Southeastern Ohio. At this high school, students spent half the school day in their
vocational labs and half the day attending academic classes. The school is made up of
11th and 12th graders from eight different school districts in a three county area. The
school is located within town, near the regional commuter college. The school is made of
several buildings, which house both the traditional classrooms, and the trade and
vocational labs.

The majority of students (>99%) enrolled at the high school are Caucasian, with
six African-Americans, and one Latino students. The majority of the students are in
middle- to middle-lower socioeconomic classes. Of the total student population,
approximately 36% students are diagnosed with IEPs.
Participants

Six periods were observed, which made up a total of 73 students observed. The participants are in the junior class and are of the ages 16-18. 71 students are Caucasian and 2 students are of African-American decent. All students are of the middle- to lower socioeconomic classes. All students in this study are enrolled in Environmental Science, which is not a requirement for 11th grade students, but one required science options for this grade. The other options include chemistry and physics.

The students participated in this study during their Environmental Science class period. Class periods were fifty minutes in length, and students had Environmental Science daily, five days a week. Periods were usually grouped by the students' vocational labs; each period has representatives of only a few labs. The students represent a range of school districts, prior science knowledge, and all academic levels. All XX students in these periods were asked to participate in this study.

The Instructor

The researcher co-taught these students and participants throughout the entire school year. In the second half of the year, the researcher was the main instructor in the Environmental Science course. He was well acquainted with the students, their backgrounds, and their learning styles. As the primary instructor for the spring semester, he had been responsible for lesson creation and instruction, and was able to monitor student interest and understanding of the lessons. Due to the relationship of the research and the students, it was made clear to the participants that their responses to the survey would not affect or standing their grade in any way, shape, or form.
Prior to classroom experience, the instructor preformed numerous Phase I ESAs as a professional environmental geologist.

**Student Surveys**

Students were given a Phase I Environmental Site Assessment ESA (see Appendix A) to read without any prior knowledge outside of what they have covered in their current curriculum. They were then given a survey (see Appendix B) asking them to describe the assessment, the site that has been assessed, and rate their understanding of the Phase I ESA. Surveys are often used for assessment and can be analyzed using qualitative methods (Cantrell & Ewing-Taylor, 2009). Care was taken not to bias the students in any way, and students were informed that their responses will remain anonymous and did not affect their grade or standing in the class. A second survey was given to the students to complete after they completed a Phase I ESA of the school and their vocational labs (see Appendix C). Surveys were coded with a number for identification to ensure pre- and post-assignment surveys matched up. The code identification sheet was destroyed promptly after post-assignment surveys were coded to ensure anonymity.

The survey is a collection of statements. Students were asked to response with: Strongly Agree, Agree, Slightly Agree, Slightly Disagree, Disagree, or Strongly Disagree. These responses were assigned numerical values to preform statistical analyses (described below). The four questions were opened ended, to assess the students’ understanding of a Phase I ESA. All surveys contained identical questions. Answers were analyzed from pre- and post-assignment survey to monitor for a change in student
understanding and interest in the topic. Students (ID numbers) that did not have both pre- and post-study surveys were dropped from the analysis due to the restrictions of the chosen statistical analysis. A total of 73 individuals were used for the statistical analysis.

**Phase I Environmental Site Assessment**

For the assignment, students were walked through the Phase I ESA, a scientific document students are likely to see in their lives or careers after high school. After the initial introduction, each class period spent two weeks conducting their own Phase I ESA. They were able to review historic aerials and environmental databases, have contact with various government officials and experts on site at the school, and they also conducted site reconnaissance of their individual trade labs and the school. After the students assessed their labs, they presented their findings to the class and collaborated to complete a Phase I ESA for the entire school.

Once students completed their own Phase I ESA for the school, they were given a survey to evaluate if they were better able to understand the original Phase I ESA (see Appendix C).

**Procedure**

Students were first provided with a Phase I ESA to read (see Appendix A). They were then given a survey (see Appendix B) prior to the assignment. This survey was used to analyze students' understanding of the topic, their current state of STEM literacy, and their current feelings towards STEM-related topics. The survey was administered after students had the chance to read through the Phase I ESA. All students were asked to
participate, but were given the ability to opt out without penalty. All participants completed the survey willingly.

After the first survey, the Phase I ESA and assignment were explained. Students conducted a Phase I ESA of their individual vocational labs and the school for the following week and a half. Following completion of analysis of aerial photos, interviews with experts, and searching historical databases, students completed the assessment with their group. Students then presented their findings to the class and compiled a complete assessment for the entire class period.

After students completed the Phase I ESA for the school, they were given the original Phase I ESA (Appendix A) and a post-assignment survey (see Appendix C). The survey contained the same questions as the pre-assignment survey, plus one additional question. Students were given the same instruction and the same amount of time to complete the survey. The information provided by the survey was used to analyze students' STEM literacy, impressions, and feelings towards the STEM fields.

A table describing the described research design and timetable is included below:

<table>
<thead>
<tr>
<th>Research Instrument</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students read the Phase I ESA (Appendix A) and complete the pre-assignment surveys (Appendix B)</td>
<td>First day of two week period in beginning of May</td>
</tr>
<tr>
<td>Student environmental site assessment</td>
<td>Ten day period in middle of May</td>
</tr>
<tr>
<td>Students re-read the Phase I ESA (Appendix A) and complete the post-assignment surveys (Appendix C)</td>
<td>Final three days in two week period in middle of May</td>
</tr>
<tr>
<td>Statistical analysis</td>
<td>Third week of May</td>
</tr>
</tbody>
</table>
Data Analysis

Surveys were given to analyze comprehension before and after the students completed their Phase I Environmental Site Assessment projects. At least half the questions on the survey were ranked numerically (rate 1-6). This allowed a Student’s paired t-test analysis of the scores to determine if there was a significant difference in students' self-assessment of their understanding and STEM literacy.

Questionnaires were used to assess students’ thoughts on STEM-related fields and STEM literacy. They were also used to monitor students’ reactions to the project, identify what students liked, what students did not like, and what students did not understand. The answers to these questionnaires were used to suggest future improvements with this teaching style.

The findings of this research project are presented in Chapter Four.
CHAPTER IV. FINDINGS OF STUDY

Results of Pre-Study Survey

The pre-survey (see Appendix B) was distributed to students after reading the Environmental Site Assessment (see Appendix A) for the first time, before they received any instruction, explanation, or began their own assessments. All students were asked to participate in the survey. There were 117 students in the Environmental Science class, but the data only reflects 73 student responses. Some of these missing surveys are due to student absences. Other surveys had to be removed from the study if students did not complete both pre- and post-study surveys or if students did not write their assigned numbers on the surveys. In questions 1 – 9, students were asked to circle the statement that most accurately described their feelings on the question. Answers were then ranked based on the Likert scale: Strongly Disagree = 1, Disagree = 2, Slightly Disagree = 3, Slightly Agree = 4, Agree = 5, and Strongly Agree = 6. Student answers were input into Microsoft Excel. Unanswered questions were left blank when calculating means (see Table 1). Excel sheets were then transformed into text files and input into RStudio. Unanswered questions were recorded as a 0 when doing the Student’s Paired T-Test to satisfy test’s assumptions. Data analysis for the written response of questions 9b, 10b, and 12 follows the statistical analysis of questions 1 – 11.
Table 1. Mean student pre-study survey responses.

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean Response</th>
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</thead>
<tbody>
<tr>
<td>1) I enjoy science class.</td>
<td>3.79</td>
</tr>
<tr>
<td>2) I think my science textbook is difficult to understand.</td>
<td>2.97</td>
</tr>
<tr>
<td>3) I learn best when listening to my teacher explain a topic.</td>
<td>3.81</td>
</tr>
<tr>
<td>4) I learn best when doing a hands-on project.</td>
<td>5.26</td>
</tr>
<tr>
<td>5) I think science is useful to me.</td>
<td>4.07</td>
</tr>
<tr>
<td>6) I think I will use what I have learned in science class in my adult life or career.</td>
<td>3.79</td>
</tr>
<tr>
<td>7) I think science applies to my trade or vocational lab.</td>
<td>4.15</td>
</tr>
<tr>
<td>8) I think the Phase I ESA was difficult to understand.</td>
<td>4.54</td>
</tr>
<tr>
<td>9) I understood the information from the Phase I section titled &quot;Records Review&quot;.</td>
<td>2.97</td>
</tr>
<tr>
<td>10) I understood the information from the Phase I section titled &quot;Site Reconnaissance.&quot;</td>
<td>3.06</td>
</tr>
<tr>
<td>11) I understood the information from the Phase I section titled &quot;Historical Use Information&quot;.</td>
<td>3.13</td>
</tr>
</tbody>
</table>

When looking at the pre-study survey, the highest scoring response is Question 4: “I learn best when doing a hands-on project.” It would have been interesting to be able to do this survey at the beginning and end of a school year, before students were exposed to any projects or learning activities in their environmental science class, but that was not possible given the structure of student teaching. It is considerably higher than Question 3: “I learn best when listening to my teacher explain a topic.” and probably indicates a preference for more hands on learning.
The questions that scored the lowest are Question 2: “I think my science textbook is difficult to understand.” and Question 9: “I understood the information from the Phase I section titled “Records Review”, both with a score of 2.97. These responses are very interesting – the average student disagreed that their assigned class textbook was difficult to understand, implying they do have some basic experience reading and understanding literature describing scientific topics. Therefore, it makes Q9 more powerful; also a scientific text, on average, students did not understand the Records Review section in the Phase I ESA.

It should also be noticed that the second-highest scoring question was Question 8: “I think the Phase I ESA was difficult to understand.” At a score of 4.54, most students agreed with this statement. Question 10: "I understood the information from the Phase I section titled 'Site Reconnaissance.'" Question 11: "I understood the information from the Phase I section titled "Historical Use Information." both had very low scores (3.06 and 3.15 respectively), indicated students also "Slightly Disagreed" with the statement that they understood these sections of the Phase I ESA. While the general response was that students understood their textbook and seemed to prefer hands-on projects, the majority of students did not understand the Phase I ESA, and its Records Review section in particular.
Table 2. Student response to being asked to provide a written description of the records review section in pre-study survey.

<table>
<thead>
<tr>
<th>Answer</th>
<th>Response (n=73)</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I don't know.</td>
<td>42</td>
<td>57.5</td>
</tr>
<tr>
<td>General/vague description of section.</td>
<td>16</td>
<td>22.0</td>
</tr>
<tr>
<td>Identified 1+ points made in section.</td>
<td>15</td>
<td>20.5</td>
</tr>
</tbody>
</table>

Only students who responded to both surveys were used in this analysis. More than half the students (57.5%) responded that they did not know, or were unable to describe the details they had read in the records review section in the Phase I ESA (Table 2). Only 20.5% of the students were able to correctly identify one or more of the topics covered in the Phase I ESA, which was the lowest of the three categories the answered were filed into (Table 2).

**Results of Post-Study Observation**

The post-survey (see Appendix C) was distributed to students after reading the Environmental Site Assessment (see Appendix A) for the second time, after they discussed the original ESA, received instruction, and preformed an ESA of their laboratory and the school, which they then presented to their peers. All students were asked to participate in the survey. There were 117 students in the Environmental Science class, but the data only reflects 73 student responses. Some of these missing surveys are due to student absences. Other surveys had to be removed from the study if students did
not complete both pre- and post-study surveys or if students did not write their assigned numbers on the surveys. In questions 1 – 9, students were asked to circle the statement that most accurately described their feelings on the question. Answers were then ranked based on the Likert scale: Strongly Disagree = 1, Disagree = 2, Slightly Disagree = 3, Slightly Agree = 4, Agree = 5, and Strongly Agree = 6. Student answers were input into Microsoft Excel. Unanswered questions were left blank when calculating means (see Table 1). Excel sheets were then transformed into text files and input into RStudio. Unanswered questions were recorded as a 0 when doing the Student’s Paired T-Test to satisfy test’s assumptions. Data analysis for the written response of questions 9b, 10, and 12 – 13 follows the statistical analysis of questions 1 – 11.
Table 3. Mean student post-survey responses.

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean Response (n=73)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) I enjoy science class.</td>
<td>3.81</td>
</tr>
<tr>
<td>2) I think my science textbook is difficult to understand.</td>
<td>2.92</td>
</tr>
<tr>
<td>3) I learn best when listening to my teacher explain a topic.</td>
<td>3.87</td>
</tr>
<tr>
<td>4) I learn best when doing a hands-on project.</td>
<td>5.00</td>
</tr>
<tr>
<td>5) I think science is useful to me.</td>
<td>4.15</td>
</tr>
<tr>
<td>6) I think I will use what I have learned in science class in my adult life or career.</td>
<td>3.75</td>
</tr>
<tr>
<td>7) I think science applies to my trade or vocational lab.</td>
<td>4.13</td>
</tr>
<tr>
<td>8) I think the Phase I ESA was difficult to understand.</td>
<td>4.11</td>
</tr>
<tr>
<td>9) I understood the information from the Phase I section titled &quot;Records Review&quot;.</td>
<td>3.85</td>
</tr>
<tr>
<td>10) I understood the information from the Phase I section titled &quot;Site Reconnaissance.&quot;</td>
<td>3.94</td>
</tr>
<tr>
<td>11) I understood the information from the Phase I section titled &quot;Historical Use Information&quot;</td>
<td>3.83</td>
</tr>
</tbody>
</table>
Table 4. Changes in response from pre- to post-study survey.

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean Response Difference</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) I enjoy science class.</td>
<td>0.02</td>
<td>0.917</td>
</tr>
<tr>
<td>2) I think my science textbook is difficult to understand.</td>
<td>-0.05</td>
<td>0.701</td>
</tr>
<tr>
<td>3) I learn best when listening to my teacher explain a topic.</td>
<td>0.06</td>
<td>0.827</td>
</tr>
<tr>
<td>4) I learn best when doing a hands-on project.</td>
<td>-0.26</td>
<td>0.036</td>
</tr>
<tr>
<td>5) I think science is useful to me.</td>
<td>0.08</td>
<td>0.876</td>
</tr>
<tr>
<td>6) I think I will use what I have learned in science class in my adult life or career.</td>
<td>-0.04</td>
<td>0.801</td>
</tr>
<tr>
<td>7) I think science applies to my trade or vocational lab.</td>
<td>-0.02</td>
<td>0.842</td>
</tr>
<tr>
<td>8) I think the Phase I ESA was difficult to understand.</td>
<td>-0.43</td>
<td>0.032</td>
</tr>
<tr>
<td>9) I understood the information from the Phase I section titled &quot;Records Review&quot;.</td>
<td>0.88</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>10) I understood the information from the Phase I section titled &quot;Site Reconnaissance.&quot;</td>
<td>0.88</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>11) I understood the information from the Phase I section titled &quot;Historical Use Information&quot;.</td>
<td>0.7</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Changes were seen both positively and negatively between the pre- and post-study surveys, but only three questions saw a significant change in response (Table 4). Curiously, there was a significant decrease (p = 0.036) in Question 4: “I learn best when doing a hands-on project.” The mean post-study score was 5.00 (Table 3), as opposed to the score of 5.26 (Table 1) in the pre-study survey. However, that does not change the result, and ultimately, students still agreed, on average, that they learn best doing hands-on projects.
Question 8: “I think the Phase I ESA was difficult to understand.” saw a significant decrease of 0.43 points (p = 0.032), to a score of 4.11 (Table 3). While students still agreed the Phase I ESA was difficult to understand, there was a detectable increase in understanding among all eight periods. It is possible that given more time on the topic, the actual number score may have decreased enough to fall into a new category.

Question 9: “I understood the information from the Phase I titled ‘Records Review.’” saw one of the most significant change in response (p = <0.001). The score increased to 3.85 (Table 3), changing the response from ‘Disagree’ to ‘Slightly Disagree’.

Question 10: "I understood the information from the Phase I section titled 'Site Reconnaissance.'" also experienced a very significant change in response (p = <0.001), which increased to 3.94, almost moving it from the 'Slightly Disagree' to the 'Slightly Agree' block. Question 11: "I understood the information from the Phase I section titled "Historical Use Information." also saw a significant increase (p=0.002) in score, though it stayed within the 'Slightly Disagree' block.

The rest of the questions did not experience a significant change in mean response (Table 4). However, these responses were not necessarily neutral, indicating a consistent feeling towards the topic throughout the different students (Table 1 and 3).
Table 5. Student response to being asked to provide a written description of the records review section in post-study survey.

<table>
<thead>
<tr>
<th>Answer</th>
<th>Response (n=73)</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I don't know.</td>
<td>4</td>
<td>5.5</td>
</tr>
<tr>
<td>General/vague description of section.</td>
<td>18</td>
<td>24.7</td>
</tr>
<tr>
<td>Identified 1+ points made in section.</td>
<td>51</td>
<td>69.8</td>
</tr>
</tbody>
</table>

In the post-study survey, the majority of students (69.8%) were able to correctly identify one or more points made in the Phase I ESA’s records review (Table 5). The smallest category, students responded to the request for a verbal description of the results they discussed in the Phase I ESA, only contained 5.5% of the students (Table 5).
CHAPTER V. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Data were collected towards the end of the spring semester when students preformed their own Phase I Environmental Site Assessment on the school as a culmination of skills and knowledge they had acquired after a year of Environmental Science. Students were first asked to read a Phase I ESA and answer a survey on it before they discussed the paper in class. After discussion and lecture, students conducted their own Phase I ESA during class time in small groups on their individual trade labs, before reporting their findings back to their classmates. A common strategy to make learning in science classrooms more effective is to make the topic value the students’ interests and life experiences, which was why this project was partially done in the students’ trade lab, something students themselves chose when entering the school (Beeman-Cadwallader, 2008). After completion of the project, students were asked to re-read the Phase I ESA and complete the survey for a second time.

This study was meant to investigate the following question: What impact does exposure to and replication of research-based writing have on the STEM literacy, interest in STEM-related fields, and attitudes towards STEM-related fields in high school students enrolled at a vocational school? The Phase I ESA is a fairly common piece of scientific writing a layperson may encounter in careers and lifestyles outside of traditional STEM fields. For example, business owners may conduct Phase I ESA’s in compliance with federal rules and regulations, or a Phase I ESA may be conducted before the sale or purchase of a piece of property. If a layperson is STEM illiterate, that is, they are unable to read, digest, and apply the scientific, technologic, engineering, or
mathematical knowledge presented to them, they are at a disadvantage in today’s economy. More and more, employers are looking for STEM literate employees (Williams, 2011). Students today are exiting high school with low scores in math and sciences, indicating they are less STEM literate than students graduate in foreign countries with much higher national averages in those areas (Kuenzi, 2008).

By exposing students to scientific literature in high school, it can be applied to individuals’ interests and strengths. Allowing students to perform a Phase I ESA on their trade labs made the topic more relevant to them, as opposed to instructing students to read a scientific paper and review the manuscript. One of the major obstacles in STEM education today is the focus on education itself, rather than students’ individual needs (Zollman, 2012). There are no overarching plans or guidelines from governing bodies or national societies, leaving students in the lurch and without much access to STEM activities or education before entering a college education, if they pursue one at all.

The majority of the questions on the survey provided to students before they were instructed and able to investigate a Phase I ESA by preforming one on their lab classes indicated fairly neutral feelings about science, science class, and how students felt science played a role in their lives outside the classroom (Table 1). These results did not change significantly after students conducted their Phase I ESA project, which lasted about three weeks at the end of their spring semester (Table 3 and 4).

Five questions exhibited significant changes in the student response between pre- and post-survey (Table 4). The response towards hands-on projects dropped slightly, but still remained within the ‘Agree’ bracket, indicating the majority of students still agree they learn well when they are given a hands-on project to illustrate a lesson or a topic
(Table 3), which has been known to influence students’ attitudes towards science (Ornstein, 2006). Not only do hands-on projects allow students to investigate and experience the lesson material, as opposed to simply sitting and listening, it also allows them to work on small groups. Working with their peers encourages students to discuss and debate their knowledge with their peers. Being able to receive, process, and communicate scientific information to others is a very important part of STEM literacy (Asunda, 2012). While they may not realize it, students are improving their STEM literacy just through communication.

There were also significant changes seen in questions 8 through 11. Question 8, which asked students if the Phase I ESA was difficult to understand, shifted within its bracket. While the overall grouping of ‘Slightly Agree’, the number dropped, indicated that more students had chosen ‘Slightly Disagree’, ‘Disagree’, or ‘Strongly Disagree’. While the change was not large, it still reveals a change in student understanding of a complex scientific report through a hands-on project. They increased their understanding of the document through repeating the processes and writing that were described.

Question 9 saw a significant increase. When asked if they understood the records review section, the mean answer was initially 'Disagree' (Table 1). After instruction and going through the projects, the answer had changed to slightly disagree (Table 3 and 4). Furthermore, 69.8% of students were able to describe at least one factor discussed in the records review section after their projects, a huge leap from the 20.5% of students able to do the same task after reading the records review for the first time (Table 2 and 5).

Questions 10 and 11 also saw significant increases in score when asked if students understood respective sections of the Phase I ESA (Table 4). However, despite these
increases, the mean response still remained within the 'Slightly Disagree' bracket. These questions were also coupled with written responses. These written responses showed a significant increase in knowledge of what was read – it is very likely that students did not give themselves enough credit and scored their understanding lower than it actually was. In the future, it may be beneficial to include a scored assignment within the project to demonstrate the change in knowledge to the students themselves during the actual project.
Limitations and Future Research

This study was limited by the time constraints of student teaching. The study was conducted over a four week period. In the future, it would be more appropriate to administer a similar survey at the beginning of the year before students engage in any Environmental Science classes, to better evaluate the students’ previous knowledge and feelings on the topic coming into the class for the first time. It would be interesting to see if a larger time period would influence the results of the project and students’ impressions of the topic.

A second limitation to this research was the demographics of the students. The population of the school was not very economically or ethnically diverse, and results may be different at schools with a different student population.

In the future, it would be beneficial to have a larger sample size, which would be achieved by collecting more surveys from students within the classes.

The results of this study were also analyzed from students’ self-surveys. While this is a good measure of the thoughts and impressions of the topic, students may not be rating their knowledge or understanding of the topic appropriately. For future studies, it may be more appropriate also include a graded assignment before and after the project. While it does not necessarily have to be calculated into their grade for the class, it would give more concrete evidence that students’ understanding of the topic and ability to communicate their knowledge was improving (or not).
Recommendations

The study worked well at the study school, and would be worth repeating on a yearly basis. It exposed students to scientific writing, and was a specific example of what they might encounter in their adult lives or careers after leaving the vocational school. It would also work well at schools that are not trade schools by definition, but offer several vocational labs for students to participate in. Finally, I suggest this project would work well at schools in urban environments, where there would be a higher density of environmentally related listings on surrounding properties for students to look at and evaluate.

For more rural schools, and schools without vocational labs, we do not recommend this project, simply because there would not be as many environmental concerns on school grounds. Without items for students to evaluate and report findings on, I do not believe the project will have as big an impact. Instead, I suggest a slight variation. A project could be arranged to visit a well-known property within the community, and students could take a field trip to evaluate said property. They would still be able to report findings and present said findings to their class afterwards.

I also recommend extending the time the unit is conducted, and breaking it into multiple smaller sections. By doing this, each section could end with a small survey or quiz. I recommend the addition of quizzes (or another method of grading) because we found that students’ self-evaluation on their surveys did not match up with what they were reporting in class and on the written parts of their surveys. Most students had actually done much better than they had reported, and we believe giving students an
assignment with a grade or a number attached to it might help students see the increase in their knowledge and understanding of the topic.
References


American Society for Engineering Education.


Appendix A

Phase I Environmental Site Assessment
Phase I
Environmental Site Assessment
of
1234 & 1235 Wooster Road,
Wooster, Ohio
# TABLE OF CONTENTS

I. EXECUTIVE SUMMARY 5

II. INTRODUCTION AND QUALIFYING CONDITIONS 8
   2.1 Purpose 8
   2.2 Terms and Conditions 8
   2.3 Limitations and Exceptions 8
   2.4 Scope of Services 9
   2.5 Limiting Conditions, Deviations from ASTM Practice E 1527-05, and Data Gaps 9

III. SITE DESCRIPTION 10
   3.1 Location and Legal Description 10
   3.2 Site and Vicinity Characteristics and Environmental Setting 10
   3.3 Description of Structures, Roads, and Other Improvements on the Site 10
   3.4 Current Use of the Property 11
   3.5 Current Uses of the Adjoining Properties 11

IV. RECORDS REVIEW 12
   4.1 Federal and State Regulatory Records 12
   4.2 Local Records 14
   4.3 Records Review Summary 14

V. HISTORICAL USE INFORMATION 16
   5.1 City Directories 16
   5.2 Aerial Photographs 16
   5.3 Historical Maps 17
   5.4 Historical Use Summary 18

VI. SITE RECONNAISSANCE 19
   6.1 Methodology and Limiting Conditions 19
   6.2 General Site Setting 19
   6.3 Pits, Ponds, Lagoons, and Wetlands 19
   6.4 Hazardous Substances, Petroleum Products, and Other Materials 19
   6.5 Storage Tanks 19
   6.6 Indications of PCBs 19
   6.7 Building Systems 20
   6.8 Indications of a Release 20
   6.9 Drains and Sumps 20
   6.10 Disposal Methods 20
   6.11 Wells 20
   6.12 Fill Material 20
   6.13 Asbestos-Containing Materials 20
   6.14 Site Reconnaissance Summary 21
TABLE OF CONTENTS-continued…

VII. USER PROVIDED INFORMATION 22
   7.1 Title Records 22
   7.2 Environmental Liens or Activity and Use Limitations 22
   7.3 Specialized Knowledge of Experience 22
   7.4 Evaluation of Purchase Price 22
   7.5 Commonly Known or Reasonably Ascertainable Information 22
   7.6 Reason for Performing the Phase I 22

VIII. INTERVIEWS 23
   8.1 Owner Interview 23
   8.2 Key Site Manager Interview 23
   8.3 Occupant Interview 23
   8.4 Other Interviews 23

IX. FINDINGS 24

X. CONCLUSIONS 26
LIST OF FIGURES

Figure 1 1994 United States Geological Survey (USGS) Topological Map of the Wooster, Ohio Quadrangle
Figure 2 Wayne County Tax Map
Figure 3 2010 Aerial Photograph

APPENDICES

Appendix A Environmental Records Documentation
Appendix B Historical Research Documentation
Appendix C Property Photograph
Appendix D Records of Communication and Miscellaneous Documentation
Appendix E Qualifications
I. EXECUTIVE SUMMARY

Sutter Environmental, Inc., was retained by Mr. Andy Dodd with Tri-County Bank and Trust to conduct a Phase I Environmental Site Assessment of 1234 and 1235 Wooster Road, Wooster, Ohio (herein referred to as the Property). Five buildings are located on the 1.6351-acre Property. The Property inspected on November 30, 2010, by Mr. James Sutter, Environmental Geologist.

The purpose of this Phase I Environmental Site Assessment is to identify, to the extent feasible pursuant to the processes described herein, recognized environmental conditions (RECs) and historical recognized environmental conditions (HRECs) in connection with the Property, as well as other potential environmental concerns.

Sutter Environmental derived the data in this report primarily from examining records in the public domain, visually inspecting the Property, and conducting interviews with persons familiar with the Property. No Data Gaps or other significant limiting conditions were encountered, except the interior of the residence was not accessed.

Record Review Summary – The Property is listed on the UST and LUST databases. The Listings refer to three gasoline UST systems (two 6,000-gallon USTs and one 8,000-gallon UST), including associated piping and dispensers were installed in 1968-1969 and removed in 1993. A closure report documenting the removal of the USTs was prepared by Petroleum Industry Consultants, Inc. The report indicates the tanks showed no visible holes upon removal and inspection. The tank cavity was over excavated and contaminated soils were removed and disposed of at a landfill. Soil samples were then collected from the sides and bottom of the excavation and analyzed for gasoline parameters (TPH and BTEX). Sample analysis showed only low concentrations of TPH and BTEX, which were below Action Levels.

A “No Further Action” (NFA) letter was issued for the Property by BUSTR in 1997; however, it is not known if the NFA letter was issued for the above incident or for a separate incident as the release incident on the NFA letter lists an initial date of 1991, which does not coincide with the removal of the USTs in 1993.

The southwest adjoining property is reported to the UST and LUST databases with No Further Action status and 2 UST were reportedly removed in 1993. Based on the status of the LUST incident and removal of the UST, the listings do not pose a significant concern to the Property. Two other nearby properties appear on the UST and LUST databases are reported, both with NFA status.

Two spills are recorded in the area, neither of which is likely to significantly impact the property.

A local fire department had records of 3 UST systems having been removed from the Property in 1993. Other local officials reported no concerns regarding the Property or the surrounding area.

Historical Use Summary – The Property has been used for numerous commercial operations (furniture sales and storage, antique sales and auctioneers, carpet sales, and a barber shop) since at least 1965, between the early 1968 and 1993. The southern portion of the property was used.
as an auto filling and service station between at least the 1960s to 1993. Additionally, the Property has had a residence since at least 1925. Prior to 1925, the use(s) of the Property are not known, but based on the surrounding area in the 1951 aerial photograph and 1903 topographical map it was likely farm of vacant land.

The north adjoining property has been used for a restaurant/snack shop since the 1960s. The east and south adjoining areas has been mainly residential since the at least 1950s. The southwest adjoining property has had a commercial building with various commercial businesses since the mid 1960s. The west adjoining property has been a nursery since the 1970s.

The surrounding area has had various commercial operations, some of which included the long term use of USTs since at least the mid 1950s.

Site Reconnaissance Summary – No hazardous substances or petroleum products are currently used or stored on the Property. Floor drains and the remnants of 2 in-ground hydraulic lifts are located inside of the garage/warehouse building. Floor drain systems and in-ground lifts have a propensity to leak and contaminate the subsurface. Oily staining was present on the floor of the garage, mainly by the in-ground hydraulic lifts and hydraulic lines. Some minor staining was present outside of the buildings on the asphalt and concrete areas in the parking lot. Three UST systems were reportedly removed from the property in 1993. Additionally, the possibility for additional UST systems (ex: waste oil) and additional in-ground lifts remains. The Property is currently connected to the sanitary sewer system, but a former on-site septic systems may be present. All drains on the Property reportedly discharge into the sanitary sewer. Two water wells service the residence and south warehouse building; no ODNR well logs are available for these wells. A large propane tank that was used for auxiliary heating is present in the center of the Property; this tank is currently not in use.

Sutter Environmental has performed the Phase I Environmental Site Assessment of 1234 and 1235 Wooster, Wooster, Ohio, in conformance with the scope and limitations of ASTM Practice E 1527-05. This assessment has revealed 2 recognized environmental conditions in connection with the Property: REC 1. Three gasoline underground storage tank (UST) systems were removed from the Property in 1993; REC 2. Former use of the Property for auto filling and service station operations

REC 1. Three gasoline underground storage tank (UST) systems were removed from the Property in 1993.

Three gasoline UST systems (two 6,000-gallon USTs and one 8,000-gallon UST), including associated piping and dispensers were removed in April 1993. A closure report prepared by Petroleum Industry Consultants, Inc., documenting the removal of the USTs was provided by the Property owner. The report indicates the tanks, which had been installed in 1968-1969, showed no visible holes upon removal and inspection. The tank cavity was over excavated and approximately 925 tons of contaminated soils were removed and disposed of at a landfill. Soil samples were then collected from the sides and bottom of the excavation and analyzed for gasoline parameters (TPH and BTEX) no groundwater was reportedly encountered. Sample analysis showed only low concentrations of TPH and BTEX, which were below Action Levels.
The report does not include any sampling and analysis from beneath the piping and dispenser areas, as required by the Bureau of Underground Storage Tank Regulations (BUSTR) standards for closure reports. Dispensers and piping were reportedly removed at the same time of the tank removal.

A “No Further Action” (NFA) letter was issued by BUSTR in 1997; however, it is not known if the NFA letter was issued for the above incident or for a separate incident as the release incident on the NFA letter lists an initial date of 1991, which does not coincide with the removal of the USTs in 1993.

**REC 2. Former use of the Property for auto filling and service station operations.**

The Property has been used for auto filling and service station operations since at least the 1960s. Three steel UST systems installed in 1968-1969 were removed from the Property in 1993. Floor drains and the remnants of 2 in-ground hydraulic lifts are located inside of the garage/warehouse building. Floor drain systems and in-ground lifts have a propensity to leak and contaminate the subsurface. Oily staining was present on the floor of the garage, mainly by the in-ground hydraulic lifts and hydraulic lines. Some minor staining was present outside of the buildings on the asphalt and concrete areas in the parking lot. Because the building was formerly used as an auto filling and service station, the possibility for additional UST systems (ex: waste oil) and additional in-ground lifts remains.

*The following issues pose some potential environmental concerns to the Property, but do not meet the definition of an REC because it is possible, but not likely, that a release has occurred and significantly impacted the Property.*

The presence of some commercial uses in the area, including a nursery, repair garages, a gas station, etc. Some of the adjoining and nearby commercial properties utilized UST systems and are recorded on the LUST and UST databases; all listings have NFA status.

*The nonscope (ASTM) issues of wetlands and asbestos were included as part of the Phase I. No obvious wetland areas were observed on the Property.*

Based on the age of the house and south warehouse, many of the building materials must be assumed or presumed to be asbestos-containing materials (ACMs). All viable materials were in relatively good condition, but the interior of the residence was not accessed. Roofing materials are suspect ACMs. It is likely that few, if any, asbestos-containing materials exist in the newer retail store/warehouse or child's play house.

*Based on the findings of this report, it is the opinion of Sutter Environmental that a Phase II Site Investigation including soil and groundwater sampling should be conducted to determine if any areas of contamination exist from the RECs. Additionally, a ground penetrating radar (GPR) survey should be conducted to help determine if any abandoned USTs remain on the Property.*
II. INTRODUCTION AND QUALIFYING CONDITIONS

2.1 Purpose

The primary purpose of this Phase I Environmental Site Assessment (Phase I ESA) is to identify, to the extent feasible pursuant to the processes described herein, recognized environmental conditions (RECs) in connection with the Property; to permit the User of this report to satisfy one of the requirements to qualify for the landowner liability protections on CERCLA liability; and to constitute "All Appropriate Inquiry" (AAI) into the previous ownership and uses of the Property consistent with good commercial or customary practice.

An REC is defined in ASTM Standards "the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances of petroleum products into the structures on the Property or into the ground, groundwater, or surface water of the Property. The term includes hazardous substances of petroleum products even under conditions in compliance with laws. This is not intended to include de minimis conditions that general do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate government agencies." Conditions determined to be de minimis are not RECs.

Historical RECs are defined as those that in the past would have been considered an REC, but may or may bot be considered an REC currently. If a past release of any hazardous substances of petroleum products has occurred in connection with the Property and has been remediated, with such remediation accepted by the responsible regulatory agency, this conditions shall be considered a historical REC.

"All Appropriate Inquiries" are intended to result in the identification of conditions indicative of releases and threatened release of hazardous substances on, at, in, or to the Property.

2.2 Terms and Conditions

The report is prepared on behalf and for the use of Tri-County Bank and Trust, and is subject to and issued in connection with the written agreement. Unless expressed authorized in writing by Sutter Environmental, Inc., no one else is permitted to rely upon the findings and conclusions found herein.

2.3 Limitations and Exceptions

It must be recognized that to definitively establish the presence or absence of contaminants in soil or groundwater at any site an extensive amount of work is required. Also, other User requirements of AAI must be fulfilled in order to obtain liability protection under the rule.
A Phase I Environmental Site Assessment is intended to provide only a general indication of the potential for environmental concerns based on surficial appearance, recollections, and opinions. While these sources provide valuable information, no warranty, expressed or implied, can be made as to their accuracy.

According to ASTM Standards, "the performance of this practice is intended to reduce, but not eliminate, uncertainty regarding the potential for RECs in connection with a property."

It must be understood and accepted that the client, Tri-County Bank and Trust, and any other relying on the report must indemnify and hold harmless Sutter Environmental against any past, present, and/or future claims arising from environmental concerns unless a complete subsurface investigation is conducted, excepting only those damages, liabilities, and costs attributable to the sole negligence or willful misconduct of Sutter Environmental.

A Phase I Environmental Site Assessment is not intended to be a complete review of regulatory compliance or an environmental audit.

2.4 Scope of Services

In order to achieve the objectives of the Phase I Environmental Site Assessment, the following tasks were performed in accordance with ASTM Practice E 1527-05.

Property information was obtained from the Wayne County Auditor website and the Wayne County Tax Map and Auditor's Offices. The Wayne County Soil Survey Map and Hydric Soil Lists, USGS Topographical Maps, and Ohio Department of Natural Resources Groundwater Resources Map for Wayne County were reviewed. Questionnaires were completed by the User, the Property owner (and Key Site Manager), and local officials were contacted. A Regulatory Database Review was obtained from Environmental Data Resources, Inc. A Site History Review was conducted by reviewing directory information, aerial photographs, historical maps, and ownership information. Additionally, a Site Inspection was conducted to determine if any evidence of environmental impacts is present at or near the Property.

2.5 Limiting Conditions, Deviations from ASTM Practice E 1526-05, and Data Gaps

No deviations were made from the standard practice of ASTM Practice E 1527-05. The nonscope (ASTM) issues of wetlands and asbestos were included as part of the Phase I. No significant Data Gaps were encountered, except that interior of the house was not accessed.
III. SITE DESCRIPTION

3.1 Location and Legal Description

The Property is located on the west side of Wooster Road, between Young Drive to the north and Nupp Drive to the south, in Wooster (Wayne Township), Wayne County, Ohio (see Figures 1-3). The Property consists of 4 parcels: parcel #71-002555.00, which totals .4299 acres, parcel #71-002556.000, which totals .4304 acres, parcel #71-002557.000, which totals .3444 acres, and parcel #71-002558.000, which totals .4304 acres. Total acreage of the Property is 1.6351.

3.2 Site and Vicinity Characteristics and Environmental Setting

The Property is located north of the City of Wooster in an area of mixed residential and commercial uses. The topography of the Property is relatively flat. An "L" shaped retail store/warehouse building is located on the north and east sections of the property, residence is located near the center of the Property, and a small office building, a parking lot, and warehouse/garage are located on the south section of the Property.

The Soil Survey for Wayne County (1981) indicates that the soils at the Property consist mainly of Canfield-Urban land complex, 2 to 6% slope (CfB). According to the soil survey, CfB is a deep, gently sloping, moderately well drained Canfield soils with areas of Urban land on slightly convex knolls. CfB are generally intricately mixed Canfield silt loam (approximately 55%), Urban land (approximately 35%), and somewhat poorly drained Ravenna soils (<15%). The Canfield soil has a fragipan at a depth of 15 to 30 inches. Most areas of this complex are artificially drained by sewer systems, gutters, subsurface drains and surface ditches; in areas that are not drained, a perched seasonal high water table is between depths of 18 to 36 inches during extended wet periods. Permeability is moderate above the fragipan and slow in the fragipan. CfB is included on the Wayne County List of Hydric Soils.

The Ohio Department of Natural Resources Groundwater Resources Map of Wayne County shows that the Property is located in an area where groundwater is usually obtained from sandstones. Bedrock is covered with 20 to 80 feet of unconsolidated material which may supply domestic yields in glaciated portions of the county.

3.3 Description of Structures, Roads, and Other Improvements to Site

Property information was obtained from the Wayne County Auditor's website. The Property is composed of 4 parcels totaling 1.6351 acres. Multiple buildings are located on the Property: parcel #71-002555.00 reportedly with no improvements; parcel #71-002556.000 reportedly has a 9,616 square foot retail store/warehouse building built in 1984 and a 2,500 square foot paved parking area constructed in 1984; parcel #71-002557.000 reportedly has a 1,348 square foot house built in 1925 and remodeled in 1970, a 290 square foot chicken house built in 1925, a 480 square foot tool shed built in 1984, a 720 square foot machine/implement shed built in 1987, and a 240 square foot attached storage structure built in 1987, a 2464 square foot pole-barn built in
1995; and parcel #71-002558.000 reportedly has a 6,000 square foot storage warehouse/garage built in 1961.

During the site visit it is noted that the chicken coop and the sheds are not located on the Property. The chicken coop was reportedly removed approximately one year ago. Also, a large child's play house is located on the Property and could possibly be one of the reported sheds. Additionally, the 2,464 square foot pole-barn (built in 1995) is an addition to the 9,616 square foot retail store/warehouse building (built in 1984).

3.4 Current Use of the Property

The north and east building is currently vacant; the house is occupied by the owner's family; and the south warehouse building is being used to store two classic automobiles (no automotive service is reportedly conducted at the Property), but is otherwise empty.

3.5 Current Uses of the Adjoining Properties

To the adjoining north, across Young Road, is a Dairy Queen fast food restaurant. To the adjoining northeast and east are residences along Young Road. To the south, an empty lot and residence. To the adjoining southwest, across Wooster Road, is AVI Food Systems. To the adjoining west, across Wooster Road, is Willo'dell Nursery.
IV. RECORDS REVIEW

A review of applicable federal, state, local, and historical records for environmental concerns related to the Property and surrounding properties has been conducted.

4.1 Federal and State Regulatory Records

All the following databases were searched within the various required radii surrounding and including the Property: National Priorities List (NPL), including delisted sites; Resource Conservation Recovery Act (RCRA) Hazardous Waste Treatment, Storage, and Disposal (TSD) List, including those with Violations/Corrective Actions (CORRACTS); Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) List; Resource Conservation Recovery Act (RCRA) Hazardous Waste Generators List, including those with Violations/Corrective Actions (CORRACTS); Emergency Response Notification Systems (ERNS) List; Ohio EPA Division of Emergency and Remedial Response Master Sites List (DERR – state equivalent of CERCLIS); Ohio Department of Commerce, Division of State Fire Marshal, Bureau of Underground Storage Tank Release Incidents (LUST); Ohio Department of Commerce, Division of State Fire Marshal, BUSTR List of Registered Petroleum Underground Storage Tank (UST); Ohio EPA List of Licensed Solid Waste Facilities (SWF/LF); and State and Federal Registries for sites with institutional/engineering controls, including Voluntary Action Program (VCP) and Brownfields Sites. Some additional non-ASTM databases were also reviewed. Most of this information was obtained from Environmental Data Resources, Inc. (See Appendix A).

The Property is listed on the UST and LUST databases. The UST and LUST listing refer to three UST systems removed in 1993. A copy of the BUSTR UST closure report was provided by the Property owner.

The closure report, prepared by Petroleum Industry Consultants, Inc., documents the removal of three USTs systems in April 1993. The report indicates the tanks, which had been installed in 1968-1969, showed no visible holes upon removal and inspection; however, signs of contamination were present in the tank cavity. The tank cavity was over excavated and approximately 925 tons of contaminated soils were removed and disposed of at a landfill. After over excavation, soil samples were collected from the sides and bottom of the excavation and analyzed for gasoline parameters (TPH and BTEX) no groundwater was reportedly encountered. Sample analysis showed only low concentrations of TPH and BTEX, which were below Action Levels.

The report does not include any sampling and analysis from beneath the piping and dispenser areas, as required by the Bureau of Underground Storage Tank Regulations (BUSTR) standards for closure reports. Dispensers and piping were reportedly removed at the same time of the tank removal.

A “No Further Action” (NFA) letter was issued by BUSTR in 1997; however, it is not known if the NFA letter was issued for the above incident or for a separate incident as the release incident
on the NFA letter lists an initial date of 1991, which does not coincide with the removal of the USTs in 1993.

The north adjoining property (across a road) listed as Madisonburg Dairy Queen is on the general FINDS database. The FINDS listing (Facility Index System-a pointer to other sources that may contain more detail) is likely related to the water well on the property.

The southwest adjoining site listed as Automatic Vendor, Inc. and AVI Food Systems is reported on the UIC, UST, and LUST databases. The UIC listing refers to a large capacity septic system in the property. The UST and LUST listings refer to 2 UST systems (a 2,000-gallon gasoline tank and a 2,200-gallon gasoline tank) that were removed in Mark 1993 and October 1993. A No Further Action (NFA) letter was issued in June 2000. NFA status denotes BUSTR requires no additional investigation or remediation of the incident.

A nearby property to the northwest listed as Wayne Township Garage, is reported on the UST and LUST databases. The listings refer to undisclosed UST system(s) that were formerly on the property. An NFA letter was issued in June 2000. NFA status denotes BUSTR requires no additional investigation or remediation of the incident.

Another nearby property to the north listed as Ashland Branded Marketing is reported on the UST and LUST databases. The listings refer to two 4,000-gallon gasoline UST systems that were removed in December 1993. An NFA letter was in June 2000. NFA status denotes BUSTR requires no additional investigation or remediation of the incident.

Another nearby property to the north listed as Morris Auto Care, is reported on the UST and LUST databases. The listings refer to a UST 3 gasoline UST systems removed in 1997. An NFA letter was in June 2000. NFA status denotes BUSTR requires no additional investigation or remediation of the incident.

Numerous other sites in the surrounding area appear on the General FINDS database. Most of these listings likely refer to public use water wells.

Two SPILLS incidents are reported in the area. The Ohio EPA Initial Pollution Incident Reports were requested and reviewed. A spill was reported on October 2, 1998 at 1600 Smith Drive. The report states that an individual reported an oil/water separator on the property, but stated that it was not hooked up or used and there is no known dumping or discharge currently coming from the facility. The report states that there is "no spill".

A spill was reported on March 27, 1992 near 5555 Young Drive at the end of the street. The report shows that a citizen made a complaint of a manhole overflowing every time it rains. The citizen noticed that sewer system design is the cause, and that the city is aware of the problem, but is not willing to fix the problem.
4.2 Local Records

The records Officer with the Wooster Fire Department was contacted on December 13, 2010. He stated that the fire department records showed no fire calls, records of hazardous materials, or use of USTs for the Property. He stated that the Wooster Fire Department has had the Property under its jurisdiction for the last 15 years and has no records related to the Property prior to that time. He stated that he did not known of any environmental concerns for the surrounding area.

Fire Chief of the Central District Fire Department was contacted on December 13, 2010. He stated he had records of 3 UST systems removed in 1993, but had no files or reports regarding the details of the removal of these systems. He stated that he had no record of fire calls, spills, or other concerns at the Property. He stated that the Property is currently covered by the Wooster Fire Department, but was formerly under the Central District/Smithville jurisdiction. He said he has been with the fire department for over 20 years and did not know of any environmental concerns in the surrounding area.

The Wooster City Engineers' Office was contacted on December 13, 2010 and reported that the Property was connected to the sanitary sewer system on June 1, 1992.

The Environmental Division of Wayne County Health Department was also contacted. She stated that they had no records or nuisance complaints on file for the Property and no records of the water wells of the former septic system.

4.3 Records Review Summary

The Property is listed on the UST and LUST databases. The Listings refer to three gasoline UST systems (two 6,000-gallon USTs and one 8,000-gallon UST), including associated piping and dispensers were installed in 1968-1969 and removed in 1993. A closure report documenting the removal of the USTs was prepared by Petroleum Industry Consultants, Inc. The report indicates the tanks showed no visible holes upon removal and inspection. The tank cavity was over excavated and contaminated soils were removed and disposed of at a landfill. Soil samples were then collected from the sides and bottom of the excavation and analyzed for gasoline parameters (TPH and BTEX). Sample analysis showed only low concentrations of TPH and BTEX, which were below Action Levels.

A “No Further Action” (NFA) letter was issued for the Property by BUSTR in 1997; however, it is not known if the NFA letter was issued for the above incident or for a separate incident as the release incident on the NFA letter lists an initial date of 1991, which does not coincide with the removal of the USTs in 1993.

The southwest adjoining property is reported to the UST and LUST databases with No Further Action status and 2 UST were reportedly removed in 1993. Based on the status of the LUST incident and removal of the UST, the listings do not pose a significant concern to the Property. Two other nearby properties appear on the UST and LUST databases are reported, both with NFA status.
Two spills are recorded in the area, neither of which is likely to significantly impact the property.

A local fire department had records of 3 UST systems having been removed from the Property in 1993. Other local officials reported no concerns regarding the Property or the surrounding area.
V. HISTORICAL USE INFORMATION

An overview of the history of the Property was conducted by reviewing directory information, aerial photographs, historical maps, and ownership information.

5.1 City Directories

Wayne County Directories were reviewed at the Wooster Public Library. The directories were reviewed at 5-year intervals or less from 2009 back to 1955, which was the oldest available volume at the library.


All of the current adjoining and nearby addresses on Young Drive were residential from 2009 back to 1966.

Listings for nearby properties to the north include: Doerfler Auto Sales (2005-1997), Morris Auto Center (1993), Jack's Auto Service (1990-1983), Frank's Auto Service (1982), Ashland Oil Service Station (1980-1961), and Sohio Service Station (1955) at 4775 Wooster Road.


5.2 Aerial Photographs


All of the currently existing buildings are visible on the Property in the 2010 aerial photograph. 2006, 2004, and 2000 aerial photographs are similar to the 2010 aerial photograph, except that a small building, reportedly a chicken coop, is located to the west of the house on the Property. No significant changes are apparent in the surrounding area.
The 1994 aerial photograph the addition to the retail store/warehouse building on the central east section of the Property has both been constructed. A much smaller building is located directly to the east of the residence; this building is not present on the Property as of the site visit. The 1993 aerial photograph is of poor resolution but looks similar to the 1994 aerial photograph. No significant changes are apparent in the surrounding area.

The 1986 aerial photograph shows the residence, chicken coop, south warehouse/garage building, and small building east of the residence are unchanged from the 1994/1993 aerial photographs. A likely gasoline dispenser canopy is located to the immediate north of the warehouse/garage building. The north retail store/warehouse building is much smaller, with only the west section of it constructed at this time. An additional small building is present on the Property northeast of the residence.

The 1977 aerial photograph shows no buildings on the Property to the north of the residence. The two additional buildings to the north and northeast of the residence noted in the 1994 and 1986 aerials are not present on the Property at this time. The south warehouse/garage building and the dispenser island canopy appear similar to the 1986 aerial. A different sized small building and a swimming pool are present to the east of the residence. Additionally, the building to the adjoining north (across Young Drive) is much larger, like it has a canopy off to the east of the building. No other significant changes are apparent in the surrounding area. The 1973 and 1965 aerial photograph is similar to the 1977 aerial photograph, except that the nursery to the west of the Property is not present.

In the 1958 aerial photograph, only the residence and chicken coop are present on the Property, the south warehouse had not been constructed at this time. Additionally, one of the east adjoining residences and the southwest adjoining building (across Cleveland Road) have not been constructed at this time. Also, there are far fewer commercial buildings and residences in the surrounding area.

The 1951 aerial photograph shows the Property similar to the 1958 aerial, but major differences are in the surrounding area. Young Drive is much shorter, and no residences have been constructed on it. Nupp Drive has not been constructed and no buildings are to the west of the Property.

5.3 Historical Maps

Sanborn Maps were not available for the Property area (see no coverage letter in Appendix B). United States Geological Survey (USGS) Topographical Map of the Wooster, Ohio Quadrangle dated 1994, 1961, and 1903 were reviewed (see Appendix B).

The 1994 topographical map depicted 2 buildings near the center and south of the Property. Small building symbols are shown to the north and south along Wooster Road and to the west across Wooster Road. Additionally, buildings are depicted along Young Drive to the north and east of the Property. Contour intervals show the topography of the Property is relatively flat.
The 1961 topographical map depicts no building symbols on the Property. Buildings are depicted to the north, east, and south of the Property.

The 1903 topographical map depicted no building symbols on the Property or in the immediate surrounding area. Additionally, Young Drive and Nupp Drive are not present on the 1903 topographical map.

5.4 Historical Use Summary

The Property has been used for numerous commercial operations (furniture sales and storage, antique sales and auctioneers, carpet sales, and a barber shop) since at least 1965, between the early 1968 and 1993. The southern portion of the property was used as an auto filling and service station between at least the 1960s to 1993. Additionally, the Property has had a residence since at least 1925. Prior to 1925, the use(s) of the Property are not known, but based on the surrounding area in the 1951 aerial photograph and 1903 topographical map it was likely farm of vacant land.

The north adjoining property has been used for a restaurant/snack shop since the 1960s. The east and south adjoining areas has been mainly residential since at least the 1950s. The southwest adjoining property has had a commercial building with various commercial businesses since the mid 1960s. The west adjoining property has been a nursery since the 1970s.

The surrounding area has had various commercial operations, some of which included the long term use of USTs since at least the mid 1950s.
VI. SITE RECONNAISSANCE

Mr. James Sutter, Environmental Geologist with Sutter Environmental, visited the Property on November 30, 2010. The weather was cool with light precipitation at the time of the site visit. Photographs taken during the visit are presented in Appendix C.

6.1 Methodology and Limiting Conditions

The entire Property was viewed. Surrounding sites were viewed from public roadways, the Property, and other accessible vantage points.

6.2 General Site Setting

The Property is located north of the City of Wooster in an area of mixed residential and commercial uses. The topography of the Property is relatively flat. Three buildings are located on the Property: a retail store/warehouse, a residence, and a warehouse/garage. Additionally, a large child's play house is present on the Property.

6.3 Pits, Ponds, Lagoons, and Wetlands

No pits, ponds, lagoons, or obvious wetlands were observed on the Property.

6.4 Hazardous Substances, Petroleum Products, and Other Materials

No containers of hazardous substances, petroleum products, or other materials were observed inside the buildings or outside at the Property, but the interior of the residence was not accessed.

6.5 Storage Tanks

No evidence of current underground (UST) or above ground tank (AST) use was found, except a large propane tank is located in the center of the Property. Three UST systems were removed from the Property in 1993 (see records review section). Based on some of the former uses of the Property, the possibility of other abandoned UST systems (ex: waste oil) remains.

6.6 Indications of PCBs

Before the late 1970s, polychlorinated biphenyls (PCBs) were commonly manufactured in the United States for use in such things as transformers, capacitors, hydraulic fluids, lubricants, and other products. Remnants of 2 in-ground hydraulic lifts are in the existing warehouse (former garage) building. Based on the age of the building, it is likely that PCB containing hydraulic fluids were used in these lifts.

Additionally, a utility company owned pole-mounted transformer (PMT) is present on the Property. The PMT was not labeled regarding PCB content, but shows no signs of leakage and is reportedly owned by the utility company.
6.7 Building Systems

The north retail store/warehouse has central air conditioning and is heated with natural gas with an auxiliary propane heated fueled by the propane tank in the center of the Property. This building is not serviced by water or sewer. The residence is heated/cooled with natural gas, a heat pump, and has window mounted air conditioning units. The home has a water well and is serviced by municipal sanitary sewer. The south warehouse/garage building is heated with natural gas, has a water well, and is serviced by municipal sanitary sewer.

Two on-site water wells supply potable water to the Property (see Section 6.11).

6.8 Indications of a Release

Oily staining was present on the floor of the warehouse/garage building mainly by the in-ground hydraulic lifts and hydraulic lines. Some minor staining was also present outside of the buildings on the asphalt and concrete parking lot.

6.9 Drains and Sumps

All drains on the Property discharge into the sanitary sewer. No sumps were observed on the Property.

6.10 Disposal Methods

No waste materials, other than normal sanitary and garbage, are currently generated on-site. Prior onsite operations likely generated waste automotive fluids (oils, coolants, etc.).

6.11 Wells

Two operating water wells are located on the Property. Water well log and drilling reports were not available on ODNR's website.

No other wells (monitoring, dry, oil, gas, etc.) were observed or reported on the Property.

6.12 Fill Material

Fill material is presumably present in the former tank cavity associate with the former filling operations and UST systems. It is not known if any former building had basements that were filled upon demolition. Such materials are generally not a significant environmental concern unless lead and asbestos-containing building debris exists or if the fill material originated from a contaminated source.

6.13 Asbestos-Containing Materials

Based on the age of the house and south warehouse, many of the building materials must be assumed or presumed to be asbestos-containing materials (ACMs). All viable materials were in
relatively good condition, but the interior of the residence was not accessed. Roofing materials are suspect ACMs. It is like that few, if any, asbestos-containing materials exist in the newer constructed showroom building or the child's play house.

6.14 Site Reconnaissance Summary

No hazardous substances or petroleum products are currently used or stored on the Property. Floor drains and the remnants of 2 in-ground hydraulic lifts are located inside of the garage/warehouse building. Floor drain systems and in-ground lifts have a propensity to leak and contaminate the subsurface. Oily staining was present on the floor of the garage, mainly by the in-ground hydraulic lifts and hydraulic lines. Some minor staining was present outside of the buildings on the asphalt and concrete areas in the parking lot. Three UST systems were reportedly removed from the property in 1993. Additionally, the possibility for additional UST systems (ex: waste oil) and additional in-ground lifts remains. The Property is currently connected to the sanitary sewer system, but a former on-site septic systems may be present. All drains on the Property reportedly discharge into the sanitary sewer. Two water wells service the residence and south warehouse building; no ODNR well logs are available for these wells. A large propane tank that was used for auxiliary heating is present in the center of the Property; this tank is currently not in use.
VII. USER PROVIDED INFORMATION

In order to qualify for one of the Landowner Liability Protection (LLPs) offered by the Brownfield Amendments, the User of this report, Tri-County Bank, has provided most of the following information (see User Questionnaires in Appendix D).

7.1 Title Records

An official title search was not conducted, but an unofficial search of title records for the Property was conducted on the Wayne County Recorder's website by Sutter Environmental.

7.2 Environmental Liens or Activity and Use Limitations

No known environmental liens or activity and use limitations (AULs) were reported by the User, and none were found in the online records searched.

7.3 Specialized Knowledge or Experience

The User reported no specialized knowledge or experience regarding the Property or nearby properties.

7.4 Evaluation of Purchase Price

The Property is not being sold at this time.

7.5 Commonly Known or Reasonably Ascertainable Information

No commonly known or reasonable ascertainable information regarding the identification of possible environmental impacts to the Property was reported by the User of the report, except the known former use as an auto filling station.

7.6 Reason for Performing the Phase I

The Phase I is being conducted at the request if Tri-County Bank and Trust.
VIII. INTERVIEWS

8.1 Owner Interview

The current owner of the property completed an Owner Questionnaire (see Appendix D). He said he purchased the Property five years ago for furniture retail and storage. He stated that as long as he owned the Property no hazardous materials or petroleum products were used or stored on the Property, except that a large propane tank was used to help heat the north retail store/warehouse; while this tank is present on the Property, he stated that it was no longer in use. He stated that some of his family is living in the residence on the Property and he is using the south warehouse to store two classic automobiles, but is not servicing the vehicles on site. He stated that he is not aware of any environmental cleanup leans, land use limitation, or any other environmental concerns for the Property, except for the 3 UST systems that were removed from the Property in 1993. He provided a UST closer report for this incident (see records review section).

8.2 Key Site Manager Interview

The owner is the key site manager of the Property.

8.3 Occupant Interview

Some of the owner’s family live in the residence on the Property, but were unavailable for interview.

8.4 Other Interviews

See Section 4.2 and 5.4.
IX. FINDINGS

Sutter Environmental, Inc., was retained by Mr. Andy Dodd with Tri-County Bank and Trust to conduct a Phase I Environmental Site Assessment of 1234 and 1235 Wooster Road, Wooster, Ohio (herein referred to as the Property). Five buildings are located on the 1.6351-acre Property. The Property inspected on November 30, 2010, by Mr. James Sutter, Environmental Geologist.

The purpose of this Phase I Environmental Site Assessment is to identify, to the extent feasible pursuant to the processes described herein, recognized environmental conditions (RECs) and historical recognized environmental conditions (HRECs) in connection with the Property, as well as other potential environmental concerns.

Sutter Environmental derived the data in this report primarily from examining records in the public domain, visually inspecting the Property, and conducting interviews with persons familiar with the Property. No Data Gaps or other significant limiting conditions were encountered, except the interior of the residence was not accessed.

Records Review Summary – The Property is listed on the UST and LUST databases. The Listings refer to three gasoline UST systems (two 6,000-gallon USTs and one 8,000-gallon UST), including associated piping and dispensers were installed in 1968-1969 and removed in 1993. A closure report documenting the removal of the USTs was prepared by Petroleum Industry Consultants, Inc. The report indicates the tanks showed no visible holes upon removal and inspection. The tank cavity was over excavated and contaminated soils were removed and disposed of at a landfill. Soil samples were then collected from the sides and bottom of the excavation and analyzed for gasoline parameters (TPH and BTEX). Sample analysis showed only low concentrations of TPH and BTEX, which were below Action Levels.

A “No Further Action” (NFA) letter was issued for the Property by BUSTR in 1997; however, it is not known if the NFA letter was issued for the above incident or for a separate incident as the release incident on the NFA letter lists an initial date of 1991, which does not coincide with the removal of the USTs in 1993.

The southwest adjoining property is reported to the UST and LUST databases with No Further Action status and 2 UST were reportedly removed in 1993. Based on the status of the LUST incident and removal of the UST, the listings do not pose a significant concern to the Property. Two other nearby properties appear on the UST and LUST databases are reported, both with NFA status.

Two spills are recorded in the area, neither of which is likely to significantly impact the property.

A local fire department had records of 3 UST systems having been removed from the Property in 1993. Other local officials reported no concerns regarding the Property or the surrounding area.

Historical Use Summary – The Property has been used for numerous commercial operations (furniture sales and storage, antique sales and auctioneers, carpet sales, and a barber shop) since at least 1965, between the early 1968 and 1993. The southern portion of the property was used
as an auto filling and service station between at least the 1960s to 1993. Additionally, the Property has had a residence since at least 1925. Prior to 1925, the use(s) of the Property are not known, but based on the surrounding area in the 1951 aerial photograph and 1903 topographical map it was likely farm of vacant land.

The north adjoining property has been used for a restaurant/snack shop since the 1960s. The east and south adjoining areas has been mainly residential since the at least 1950s. The southwest adjoining property has had a commercial building with various commercial businesses since the mid 1960s. The west adjoining property has been a nursery since the 1970s.

The surrounding area has had various commercial operations, some of which included the long term use of USTs since at least the mid 1950s.

Site Reconnaissance Summary – No hazardous substances or petroleum products are currently used or stored on the Property. Floor drains and the remnants of 2 in-ground hydraulic lifts are located inside of the garage/warehouse building. Floor drain systems and in-ground lifts have a propensity to leak and contaminate the subsurface. Oily staining was present on the floor of the garage, mainly by the in-ground hydraulic lifts and hydraulic lines. Some minor staining was present outside of the buildings on the asphalt and concrete areas in the parking lot. Three UST systems were reportedly removed from the property in 1993. Additionally, the possibility for additional UST systems (ex: waste oil) and additional in-ground lifts remains. The Property is currently connected to the sanitary sewer system, but a former on-site septic systems may be present. All drains on the Property reportedly discharge into the sanitary sewer. Two water wells service the residence and south warehouse building; no ODNR well logs are available for these wells. A large propane tank that was used for auxiliary heating is present in the center of the Property; this tank is currently not in use.

The nonscope (ASTM) issues of wetlands and asbestos were included as part of the Phase I. No obvious wetland areas were observed on the Property.

Based on the age of the house and south warehouse, many of the building materials must be assumed or presumed to be asbestos-containing materials (ACMs). All viable materials were in relatively good condition, but the interior of the residence was not accessed. Roofing materials are suspect ACMs. It is likely that few, if any, asbestos-containing materials exist in the newer retail store/warehouse or child's play house.
X. CONCLUSIONS

Sutter Environmental has performed the Phase I Environmental Site Assessment of 1234 and 1235 Wooster, Wooster, Ohio, in conformance with the scope and limitations of ASTM Practice E 1527-05. This assessment has revealed 2 recognized environmental conditions in connection with the Property: REC 1. Three gasoline underground storage tank (UST) systems were removed from the Property in 1993; REC 2. Former use of the Property for auto filling and service station operations.

REC 1. Three gasoline underground storage tank (UST) systems were removed from the Property in 1993.

Three gasoline UST systems (two 6,000-gallon USTs and one 8,000-gallon UST), including associated piping and dispensers were removed in April 1993. A closure report prepared by Petroleum Industry Consultants, Inc., documenting the removal of the USTs was provided by the Property owner. The report indicates the tanks, which had been installed in 1968-1969, showed no visible holes upon removal and inspection. The tank cavity was over excavated and approximately 925 tons of contaminated soils were removed and disposed of at a landfill. Soil samples were then collected from the sides and bottom of the excavation and analyzed for gasoline parameters (TPH and BTEX) no groundwater was reportedly encountered. Sample analysis showed only low concentrations of TPH and BTEX, which were below Action Levels. The report does not include any sampling and analysis from beneath the piping and dispenser areas, as required by the Bureau of Underground Storage Tank Regulations (BUSTR) standards for closure reports. Dispensers and piping were reportedly removed at the same time of the tank removal.

A “No Further Action” (NFA) letter was issued by BUSTR in 1997; however, it is not known if the NFA letter was issued for the above incident or for a separate incident as the release incident on the NFA letter lists an initial date of 1991, which does not coincide with the removal of the USTs in 1993.

REC 2. Former use of the Property for auto filling and service station operations.

The Property has been used for auto filling and service station operations since at least the 1960s. Three steel UST systems installed in 1968-1969 were removed from the Property in 1993. Floor drains and the remnants of 2 in-ground hydraulic lifts are located inside of the garage/warehouse building. Floor drain systems and in-ground lifts have a propensity to leak and contaminate the subsurface. Oily staining was present on the floor of the garage, mainly by the in-ground hydraulic lifts and hydraulic lines. Some minor staining was present outside of the buildings on the asphalt and concrete areas in the parking lot. Because the building was formerly used as an auto filling and service station, the possibility for additional UST systems (ex: waste oil) and additional in-ground lifts remains.

The following issues pose some potential environmental concerns to the Property, but do not meet the definition of an REC because it is possible, but not likely, that a release has occurred and significantly impacted the Property.
The presence of some commercial uses in the area, including a nursery, repair garages, a gas station, etc. Some of the adjoining and nearby commercial properties utilized UST systems and are recorded on the LUST and UST databases; all listings have NFA status.

Based on the findings of this report, it is the opinion of Sutter Environmental that there is sufficient likelihood of significant contamination to the Property to warrant a Phase II Site Investigation including soil and groundwater sampling should be conducted to determine if any areas of contamination exist from the RECs. Additionally, a ground penetrating radar (GPR) survey should be conducted to help determine if any abandoned USTs remain on the Property.
Pre-Unit Environmental Site Assessment Survey

Class Period: _____  |  Number: ________  |  Gender: M□ F□

Directions: Please circle the answer that best represents how you feel about the statement. Please answer all the questions. Please be honest and circle the first thought that comes to mind. These surveys are completely anonymous, so feel free to put down any thoughts.

1) I enjoy science class.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

2) I think my science textbook is difficult to understand.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

3) I learn best when listening to my teacher explain a topic.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

4) I learn best when doing a hands-on project or experiment.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

5) I think science is useful to me.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

6) I think I will use what I have learned in science class in my adult life or career.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

7) I think science applies to my trade or vocational lab.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

8) I think the Phase I ESA was difficult to understand.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

9) I understood the information from the Phase I section titled “Records Review”
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree
9b) Please explain your understanding of the risks presented the “Records Review” section.

10) I understood the information from the Phase I section titled “Site Reconnaissance”

   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

10b) Please explain your understanding of the risks presented the “Site Reconnaissance” section.

11) I understood the information from the Phase I section titled “Historical Use Information”

   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

11b) Please explain your understanding of the risks presented the Historical Use Information” section.

12) What is your overall understanding of the environmental risks mentioned in the Phase I ESA?
APPENDIX C:
Post-Unit Survey
Post-Unit Environmental Site Assessment Survey

Class Period: _____ | Number: _______ | Gender: M□ F□ |
Lab: ______________________________________

Directions: Please circle the answer that best represents how you feel about the statement. Please answer all the questions. Please be honest and circle the first thought that comes to mind. These surveys are completely anonymous, so feel free to put down any thoughts.

1) I enjoy science class.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

2) I think my science textbook is difficult to understand.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

3) I learn best when listening to my teacher explain a topic.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

4) I learn best when doing a hands-on project or experiment.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

5) I think science is useful to me.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

6) I think I will use what I have learned in science class in my adult life or career.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

7) I think science applies to my trade or vocational lab.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

8) I think the Phase I ESA was difficult to understand.
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

9) I understood the information from the Phase I section titled “Records Review”
   Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree
9b) Please explain your understanding of the risks presented the “Records Review” section.

10) I understood the information from the Phase I section titled “Site Reconnaissance”

Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

10b) Please explain your understanding of the risks presented the “Site Reconnaissance” section.

11) I understood the information from the Phase I section titled “Historical Use Information”

Strongly Agree -- Agree -- Slightly Agree -- Slightly Disagree -- Disagree -- Strongly Disagree

11b) Please explain your understanding of the risks presented the Historical Use Information” section.

12) What is your overall understanding of the environmental risks mentioned in the Phase I ESA?

13) Have you ever been exposed to the process of scientific writing in previous science classes?

   Yes □  No □
Appendix D:
IRB Consent
OHIO UNIVERSITY
INSTITUTIONAL REVIEW BOARD (IRB)
PROJECT OUTLINE FORM

Proposal Title | THE EFFECT OF EXPOSURE TO SCIENTIFIC DOCUMENTS ON STEM LITERACY IN HIGH SCHOOL STUDENTS.

1. Investigator(s) Information
Primary Investigator Name
First | James | Middle | A. | Last | Sutter

Department | Patton College of Education
Address | McCracken Hall, Athens, Ohio 45701-2979

(if off-campus, include city, state and zip code)
Email | js679313@ohio.edu | Phone | 330-329-7747
Training Module Completed? | Yes | No

Co-investigators

<table>
<thead>
<tr>
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<th>Department</th>
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</thead>
<tbody>
<tr>
<td>Address</td>
<td></td>
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<tr>
<td>Email</td>
<td></td>
</tr>
<tr>
<td>Training Module Completed?</td>
<td>Yes</td>
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Advisor Information (if applicable)

<table>
<thead>
<tr>
<th>Name</th>
<th>Ralph Martin</th>
<th>Department</th>
<th>Teacher Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>102C McCracken Hall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:martin@ohio.edu">martin@ohio.edu</a></td>
<td>Phone</td>
<td>740.707.8921</td>
</tr>
<tr>
<td>Training Module Completed?</td>
<td>Yes</td>
<td>XX</td>
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Office of Research Compliance 1 Rev. 12/2009
Research Assistants

<table>
<thead>
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<th>Department</th>
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2. Study Timeline

a. Anticipated Starting Date (Study, including recruitment, cannot begin prior to IRB approval. This date should never precede the submission date) 05-05-2014

b. Duration of Study Years Months 6

3. Funding Status

a. Is the researcher receiving support or applying for funding? Yes No XX

If YES

<table>
<thead>
<tr>
<th>List Source</th>
<th>N/A</th>
</tr>
</thead>
</table>

Describe any consulting or other relationships with this sponsor. N/A

Funding will be used for:

- Paying Participants (Provide further details in compensation section)
- Researcher Expenses (Postage, Equipment, Travel, etc.)
- Other

4. Review Level

Based on the definition in the guidelines, do you believe your research qualifies for?

<table>
<thead>
<tr>
<th>X</th>
<th>Exempt Review – See description of categories at: <a href="http://www">http://www</a> ohio ed u/research/compliance/Exemption-Categories cfm Category 2</th>
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<tr>
<td></td>
<td>Expedited Review - See description of categories at: <a href="http://www">http://www</a> hhs gov/ohr p/humansubjects/guidance/expedited98 htm</td>
</tr>
<tr>
<td></td>
<td>Full Board Review</td>
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</table>
5. Recruitment/Selection of Subjects

<p>| | | | |</p>
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<tbody>
<tr>
<td></td>
<td>Maximum Number of Participants to be Enrolled - If screening occurs, include number that will need to be screened in order to get the N necessary for statistical significance.</td>
<td>100</td>
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</tr>
<tr>
<td>b. Characteristics of subjects (check as many boxes as appropriate).</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>X</td>
<td>Minors</td>
<td>Disabled (Physically or Mentally)</td>
<td>Elementary School Students</td>
</tr>
<tr>
<td>X</td>
<td>Adults</td>
<td>Legally Incompetent</td>
<td>Middle School Students</td>
</tr>
<tr>
<td></td>
<td>Prisoners</td>
<td>Cognitively Impaired</td>
<td>X High School Students</td>
</tr>
<tr>
<td></td>
<td>Pregnant</td>
<td>Non-English Speaking</td>
<td>University Students</td>
</tr>
</tbody>
</table>

c. Briefly describe the criteria for selection of subjects (inclusion/exclusion). Include such information as age range, health status, etc. Attach additional pages if necessary. **All students in 4 class periods of Environmental Science will utilized in this study. I am the teacher of the course during this time of my Professional Internship.**

d. Please describe how you will identify and recruit prospective participants. **See above**

e. Records

<p>| | | |</p>
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</thead>
<tbody>
<tr>
<td>Are you accessing private, i.e. medical, educational, or employment records?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

If YES, Describe process for obtaining approval for the use of the records or for securing consent from the subjects. Attach a letter of support from the holder or custodian of the records (i.e. primary physician, therapist, public school official.) **N/A**

f. Please describe your relationship to the potential participants, i.e. instructor of class, co-worker, etc. If no relationship, state no relationship. **Professional intern/instructor of class**

Attach copies of all recruitment tools (advertisements, posters, etc.), label as APPENDIX B

g. Performance Sites/Location of Research

<p>| | |</p>
<table>
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<tr>
<td>Ohio University Facility</td>
<td></td>
</tr>
<tr>
<td>X Public Location</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other - Describe below and provide letters of cooperation and/or support</td>
</tr>
</tbody>
</table>

**Study conducted at Tri-County Career Center, 15676 State Route 691, Nelsonville, Ohio**
6. Project Description

a. Please provide a brief summary of this project, using non-technical terms that would be understood by a non-scientific reader. Please limit this description to no more than one page, and provide details in the methodology section.

Part of current and incoming high school science standards requires students to be literate in STEM (Science, Technology, Engineering, and Mathematics) topics. Part of this requirement is to be scientifically and technologically literate. The most likely environmental science related document that most individuals will encounter are Phase I Environmental Site Assessments (ESAs). Phase I ESAs are required for most commercial and some residential (home) bank loans. Additionally, the primary investigator was formerly an Environmental Geologist and preformed numerous Phase I ESAs during his prior occupation. For these reasons, Phase I ESAs will be utilized for the development of students' STEM literacy.

b. Please describe the specific scientific objectives (aims) of this research and any previous relevant research.

This purpose of this study is to answer the question: What impact does exposure to and replication of research-based writing have on the STEM literacy, interest in STEM-related fields, and attitudes towards STEM-related fields in high school students enrolled at a vocational school?

No prior research has been conducted on this topic by the primary investigator.
c. Methodology: please describe the procedures (sequentially) that will be performed/followed with human participants.

Students will be given a Phase I Environmental Site Assessment ESA to read without any prior knowledge outside of what they have covered in their current curriculum. They will then be given a survey asking them to describe the assessment, the site that has been assessed, and rate their understanding of the Phase I ESA. Care will be taken not to bias the students in any way, and students will be informed that their responses will remain anonymous and will not affect their grade or standing in the class.

Afterward the initial introduction, each class period will spend two weeks conducting their own Phase I ESA of the school, each student focusing on their individual vocational lab. They will be able to review historic aerials, have contact with various government officials and experts on site at the school. After the students assess their labs, they will present their findings to the class and collaborate to complete a Phase I ESA for the entire school.

A second survey will be given to the students to complete after they have completed a Phase I ESA of the school. It will be the same survey they were given prior to the assignment. Students are asked to respond with: Strongly Agree, Agree, Slightly Agree, Slightly Disagree, Disagree, or Strongly Disagree. These responses will be assigned numerical values to perform statistical analyses. The final four questions are opened ended, to assess their understanding of a Phase I ESA. All surveys contained identical questions. Answers will be analyzed from pre- and post-assignment survey to monitor for a change in student understanding and interest in the topic.

After the project was completed, I will randomly choose two students from each class period to conduct an interview (a total of eight students) on their knowledge and feelings about a Phase I ESA. Prior to each interview, I will explain to each student that his or her responses in the interview will not affect their grade or standing in any way, shape or form. All students will be asked the same questions in their interview. The interviews will be conducted during the class period.
d. Describe any potential risks or discomforts of participation and the steps that will be taken to minimize them.

As all necessary work will be conducted on school grounds during regular school hours and within the students regularly scheduled class periods, no additional discomforts outside of regular school days are anticipated for the students.

e. Describe the anticipated benefits to the individual participants. If none, state that. (Note that compensation is not a benefit, but should be listed in the compensation section on the next page.)

By completing the process of a Phase I ESA, it is hoped that students will be able to understand any future ESAs or other scientific literature that they may encounter in the future.

f. Describe the anticipated benefits to society and/or the scientific community in lay language. There must be some benefit to justify the use of human subjects.

In order to increase STEM literacy in the classroom, it is important to also increase the value of STEM topics in the students' minds. Increasing the importance of these topics will increase the value of being STEM literate, something students will need to pursue further education or a career in STEM-related fields. Increased exposure to STEM writing, involving students in more STEM-related projects and creating a more integrative classroom.
7. Confidentiality

a. Check all that apply

| X | Data is collected anonymously                              |
| X | Data will be recorded without possibility of identification |
|   | Data will be recorded with a code replacing identifiers and a master list connecting the code and the identifier exists for some period of time |
|   | Data will be recorded with identifying information, e.g. name, SSN, oak id, etc. |
|   | Nature of data makes it potentially identifiable (e.g. material with DNA, photographs) |

b. If master code list is used (3rd option); please provide detail, such as how/where code list is securely stored, when it will be destroyed, etc.).

---

Data will be recorded without possibility of identification: Students will chose from a list of 3 digit numbers. When a student choses a number from the list, they will cross it off of the list so that there are no duplicate numbers. Students will write this number into their class notebooks. These number will be written on the top right corner of the surveys. I will not have a list of numbers associated with names. Students will be the only ones that know their individual number. I do not collect the notebooks from the students, it is for their own records that they keep the notebook to hold completed work.

---

d. Data Sharing

<table>
<thead>
<tr>
<th>Will identifiable data be shared with anyone outside the immediate research team?</th>
<th>Yes</th>
<th>No</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>If YES, please describe</td>
<td></td>
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</table>

e. Recording

<table>
<thead>
<tr>
<th>Will participants be audio recorded?</th>
<th>Yes</th>
<th>No</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video recorded?</td>
<td>Yes</td>
<td>No</td>
<td>X</td>
</tr>
</tbody>
</table>

If YES, please describe how/where recordings will be stored, who will have access to them, and an estimate of the date (month/year) that they will be destroyed.

---

f. Additional Details (if needed)

---

Office of Research Compliance

Rev. 12/2009
8. Compensation

a. Will participants receive a gift or token of appreciation?  
   Yes  No  X
If YES, list the item and its approximate value.

b. Will participants receive services, treatment or supplies that have a monetary value?  
   Yes  No  X
If YES, please describe and provide the approximate value.

c. Will participants receive course credit?  
   Yes  No  X
If YES, please describe non-research alternatives to earn the credit, the number of points awarded and what percentage of total points for the course it represents. If you are using the Psychology Pool, which has already established guidelines that provide these details to the IRB, simply write Psych Pool.

d. Will participants receive monetary compensation (including gift cards)?  
   Yes  No  X
If YES, please detail the amount per session and total compensation possible. Additionally, describe what compensation amount is paid to participants who discontinue participation prior to completion.*

* If University funds are used to compensate participants, minimally, the name and address of participants will need to be provided to the Finance Office at OU. If participants will be paid $100 or more in a calendar year, participant social security numbers must be provided to Finance. The consent form must reflect this.
9. Instruments
a. List all questionnaires, instruments, standardized tests below, with a brief description, and provide copies of each, labeled as APPENDIX C.

Environmental Site Assessment Survey: student will then be given a survey asking them to describe the assessment, the site that has been assessed, and rate their understanding of the Phase I ESA. The survey is a collection of statements. Students are asked to respond with: Strongly Agree, Agree, Slightly Agree, Slightly Disagree, Disagree, or Strongly Disagree. The four questions are opened ended, to assess their understand of a Phase I ESA.

10. Data Analysis
How will the data be analyzed? What statistical procedures will be used to test hypotheses; if qualitative, how will data be coded, etc.

Surveys will be given to analyze comprehension before and after the students complete their Phase I Environmental Site Assessment projects. At least half the questions on the survey will be ranked (rate 1-5). This will allow us to do a paired t-test of the scores to determine if there is a significant difference in students' self-assessment of their understanding and STEM literacy. Questionnaires are used to assess students' thoughts on STEM-related fields and STEM literacy. They will also be used to monitor students' reactions to the project, identify what students liked, what students did not like, and what students did not understand. The answers to these questionnaires will be used to suggest future improvements with this teaching style.
11. Informed Consent Process

a. Select One of the Following Options

<table>
<thead>
<tr>
<th>XX</th>
<th>I am requesting a waiver or alteration of Informed Consent (provide details below and attach information that will be provided to participants regarding the study (email, cover letter) as Appendix A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiver of signature</td>
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</tr>
<tr>
<td>___ Exempt study</td>
<td></td>
</tr>
<tr>
<td>___ Waiver needed to protect the privacy of participants</td>
<td></td>
</tr>
<tr>
<td>___ Waiver needed due to cultural norms (e.g. wary of forms needing signatures)</td>
<td></td>
</tr>
<tr>
<td>___ Impracticable (online or phone study)</td>
<td></td>
</tr>
<tr>
<td>___ Other</td>
<td></td>
</tr>
<tr>
<td>Deception (incomplete disclosure)</td>
<td></td>
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<tr>
<td>___ Necessary to avoid participants altering behavior (e.g. not informing of 2 way mirror; providing cover story)</td>
<td></td>
</tr>
<tr>
<td>XX</td>
<td>Complete waiver of consent</td>
</tr>
</tbody>
</table>

Provide additional information regarding the waiver, if needed.

The study will include all students in the 4 periods of the high school environmental science course. This study is a part of the customary instruction for the course and no alterations in the course work or assignments will be required. All students will benefit from the instruction.

All students will have the opportunity to ask any questions or for any clarification directly to the primary investigator during their class periods.

Attach copies of all consent documents or text and label as APPENDIX A. Please use the template provided at the end of this document.

b. How and where will the consent process occur? Will participants have an opportunity to ask questions and have them answered? What steps will be taken to avoid coercion or undue influence?

N/A
c. Will the investigator(s) be obtaining all of the informed consents? Yes | No | X

If NO, identify by name and training who will be describing the research to subjects/representatives and inviting their participation?

James A. Sutter, teaching intern and primary investigator will be describing the research to each class period in the study.

d. Will all adult participants have the capacity to give informed consent? Yes | No | X

If NO, explain procedures to be followed.

See above.

e. Will any participants be minors? Yes | X | No

If YES, include procedures/form for parental consent and for the assent from the minor.

f. Will participants be deceived or incompletely informed regarding any aspect of the study? Yes | No | X

If YES, provide rationale for use of deception.

If YES, attach copies of post-study debriefing information and label as APPENDIX D. Additionally, complete the questions related to a consent form waiver or alteration on page 11.
Investigator Assurance

I certify that the information provided in this outline form is complete and correct.

I understand that as Principal Investigator, I have ultimate responsibility for the protection of the rights and welfare of human subjects, conduct of the study and the ethical performance of the project.

I agree to comply with Ohio University policies on research and investigation involving human subjects (O.U. Policy # 19.052), as well as with all applicable federal, state and local laws regarding the protection of human subjects in research, including, but not limited to the following:

- The project will be performed by qualified personnel, according to the OU approved protocol.
- No changes will be made in the protocol or consent form until approved by the OU IRB.
- Legally effective informed consent will be obtained from human subjects if applicable, and documentation of informed consent will be retained, in a secure environment, for three years after termination of the project.
- Adverse/Unexpected events will be reported to the OU IRB promptly.
- All protocols are approved for a maximum period of one year. Research must stop at the end of that approval period unless the protocol is re-approved for another term.

I further certify that the proposed research is not currently underway and will not begin until approval has been obtained. A signed approval form, on Office of Research Compliance letterhead, communicates IRB approval.

Primary Investigator Signature: James A. Sutter Date: 04/29/2013

(Please print name) James A. Sutter

Co-Investigator Signature: Date: 

(Please print name)
Faculty Advisor/Sponsor Assurance

By my signature as sponsor on this research application, I certify that the student(s) or guest investigator is knowledgeable about the regulations and policies governing research with human subjects and has sufficient training and experience to conduct this particular study in accord with the approved protocol. In addition:

- I agree to meet with the investigator(s) on a regular basis to monitor study progress.
- Should problems arise during the course of the study, I agree to be available, personally, to supervise the investigator in solving them.
- I assure that the investigator will report adverse/unexpected events to the IRB in writing promptly.
- If I will be unavailable, as when on sabbatical or vacation, I will arrange for an alternate faculty sponsor to assume responsibility during my absence.

I further certify that the proposed research is not currently underway and will not begin until approval has been obtained. A signed approval form, on Office of Research Compliance letterhead, communicates IRB approval.

Advisor/Faculty Sponsor Signature ____________________________ Date 5-2-2004

(Please print name) Ralph Martin ____________________________

*The faculty advisor/sponsor must be a member of the OU faculty. The faculty member is considered the responsible party for legal and ethical performance of the project.
Checklist:

X Completed and Signed Project Outline Form (this form)
N/A Appendix A - copies of all consent documents (in 12 pt. Font) including
  ___ Informed Consent to Participate in Research (adult subjects)
  ___ Parental Permission/Informed Consent (parents of subjects who are minors or children)
  ___ Assent to Participate in Research (used when subjects are minors or children)
N/A Appendix B - copies of any recruitment tools (advertisements, posters, etc.)
X Appendix C - copies of all instruments (surveys, standardized tests, questionnaires,
  interview topics, etc.).
N/A Appendix D - Copies of debriefing text
X Appendix E - Approval from other IRB, School District, Corporation, etc.
N/A Appendix F - Any additional materials that will assist the Board in completing its
  review
N/A Appendix G - Copies of any IRB approvals
X Appendix H - Copies of Human Subjects Research Training Certificates

All fields on the form must be completed, regardless of review level. If a field is not
applicable, indicate by inserting N/A. Incomplete forms will result in delayed processing.
Forward this completed form and all attachments to:

Human Subjects Research
Office of Research Compliance
RTEC 117

If you have the capability to scan the signed form and all relevant attachments, you may
submit by email to compliance@ohio.edu

Questions? Call us at 740-593-0664, or visit the website at
www.ohio.edu/research/compliance/ or email compliance@ohio.edu
Appendix C:
Environmental Site Assessment Survey
Environmental Site Assessment Survey

Class Period: _____ Number: _______ Gender: M/F  Lab: ________________

Directions: Please circle the answer that best represents how you feel about the statement. Please answer all the questions. Please be honest and circle the first thought that comes to mind. These surveys are completely anonymous, so feel free to put down any thoughts.

1) I enjoy science class.
   Strongly Agree/Agree/Slightly Agree/Slightly Disagree/Disagree/Strongly Disagree

2) I think my science textbook is difficult to understand.
   Strongly Agree/Agree/Slightly Agree/Slightly Disagree/Disagree/Strongly Disagree

3) I learn best when listening to my teacher explain a topic.
   Strongly Agree/Agree/Slightly Agree/Slightly Disagree/Disagree/Strongly Disagree

4) I learn best when doing a hands-on project or experiment.
   Strongly Agree/Agree/Slightly Agree/Slightly Disagree/Disagree/Strongly Disagree

5) I think science is useful to me.
   Strongly Agree/Agree/Slightly Agree/Slightly Disagree/Disagree/Strongly Disagree

6) I think I will use what I have learned in science class in my adult life or career.
   Strongly Agree/Agree/Slightly Agree/Slightly Disagree/Disagree/Strongly Disagree

7) I think science applies to my trade or vocational lab.
   Strongly Agree/Agree/Slightly Agree/Slightly Disagree/Disagree/Strongly Disagree

8) I think the Phase I ESA was difficult to understand.
   Strongly Agree/Agree/Slightly Agree/Slightly Disagree/Disagree/Strongly Disagree

9) I understood the information from the Phase I section titled “Records Review”
   Strongly Agree/Agree/Slightly Agree/Slightly Disagree/Disagree/Strongly Disagree

9b) Please explain your understanding of the risks presented in the “Records Review” section.

10) I understood the information from the Phase I section titled “Site Reconnaissance”
10b) Please explain your understanding of the risks presented in the "Site Reconnaissance" section.

11) I understood the information from the Phase I section titled "Historical Use"

11b) Please explain your understanding of the risks presented in the "Historical Use" section.

12) What is your overall understanding of the environmental risks mentioned in the Phase I ESA?
Appendix E:
Approval from School District
May 8, 2014

To Whom It May Concern:

This is a letter of consent for James Sutter’s project focused on promoting science literacy for students. He has explained the study to me and I approve of him conducting and teaching it as a unit with our lab teacher’s consent.

If you have any further questions, please feel free to contact me.

Thank you

Connie Altier, Principal
Appendix H:
Collaborative Institutional Training Initiative
Human Research Curriculum Completion Report
COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI)
HUMAN RESEARCH CURRICULUM COMPLETION REPORT
Printed on 10/24/2013

LEARNER
James Sutter (ID: 3835569)
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Unit A
Athens
Ohio 45701
United States of America

DEPARTMENT
Department of Education

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330-325-7747

EMAIL
js679313@ohio.edu

INSTITUTION
Ohio University

EXPIRATION DATE
10/29/2016

GROUP 2. SOCIAL AND BEHAVIORAL INVESTIGATORS AND KEY PERSONNEL

COURSE/STAGE: Basic Course/1
PASSED ON: 10/24/2013
REFERENCE ID: 11001258

REQUIRED MODULES
<table>
<thead>
<tr>
<th>Module</th>
<th>DATE COMPLETED</th>
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<tbody>
<tr>
<td>Introduction</td>
<td>10/24/13</td>
</tr>
<tr>
<td>History and Ethical Principles - SBE</td>
<td>10/24/13</td>
</tr>
<tr>
<td>Defining Research with Human Subjects - SBE</td>
<td>10/24/13</td>
</tr>
<tr>
<td>The Regulations - SBE</td>
<td>10/24/13</td>
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<td>Assessing Risk - SBE</td>
<td>10/24/13</td>
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<tr>
<td>Informed Consent - SBE</td>
<td>10/24/13</td>
</tr>
<tr>
<td>Ohio University</td>
<td>10/24/13</td>
</tr>
</tbody>
</table>

For this Completion Report to be valid, the learner listed above must be affiliated with a CITI Program participating institution or be a paid Independent Learner. Falsified information and unauthorized use of the CITI Program course site is unethical, and may be considered research misconduct by your institution.

Paul Braunschweiger Ph.D.
Professor, University of Miami
Director Office of Research Education
CITI Program Course Coordinator
A determination has been made that the following research study is exempt from IRB review because it involves:

Category 1: research conducted in established or commonly accepted educational settings, involving normal educational practices

Project Title: The Effect of Exposure to Scientific Documents on Stem Literacy in High School Students

Primary Investigator: James A. Sutter

Co-Investigator(s):

Advisor: Ralph Martin

Department: Education

Rebecca Cale, AAB, CIP
Office of Research Compliance

5/8/14

Date

The approval remains in effect provided the study is conducted exactly as described in your application for review. Any additions or modifications to the project must be approved (as an amendment) prior to implementation.
Appendix E:
Plagiarism Check
Check Your Paper for Plagiarism

Paste the text of your paper below and select the "Check Report" button to immediately receive an analysis of your paper. NOTE: if you would like to check grammar, spelling style, and plagiarism detection, then use our free proofreading tool.

Science, engineering, technology, and mathematics (STEM) education is an area that has been receiving increased attention in recent years. The term "STEM literacy" is used to describe the ability to understand and apply scientific knowledge. STEM literacy can be defined as the ability to read, write, and think critically about STEM-related problems. This paper appears to be original, but be certain that any included text is properly cited.

A low originality percentage is indicative of plagiarized papers. Sometimes the score is lower due to long quotations within the text. Please make sure that you use proper citations if this is the case. For more information on our originality scoring process, click here.