This report summarizes the activities and duties performed during my internship with Advanced Testing Laboratory, contracted to Proctor & Gamble in Cincinnati, OH. The primary tasks of this internship included conducting quality assurance and market comparison testing on established products, as well as learning and conducting research and development projects on new and changing P&G products. These objectives were completed through utilization of seven established industry techniques and development of new testing methodologies. Test descriptions are compiled of the reasoning for their requirement, the work entailed, and a summary of procedure. Also found within is the summary of the part Miami University’s Institute for the Environment and Sustainability played in the procurement and completion of my internship with Advanced Testing Laboratory.
A REPORT:

FLUSHABILITY TECHNICIAN INTERNSHIP WITH P&G VIA ADVANCED TESTING LABORATORY IN CINCINNATI, OH

An Internship Report

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by

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Introduction

Earth is comprised of approximately 70 percent water, with only three percent being fresh water. Of this three percent, two percent is locked in glaciers (USGS 2014). One percent is left for the world to utilize for the purposes of bathing, drinking, waste collection, industry, recreation, etc. Wastewater is used water. This includes water laden with human waste, food scraps, oils, soaps, chemicals, and storm runoff (USGS 2014). While Earth’s waters have an innate ability to cope with small amounts of water pollution, the amount produced by the world’s human population far exceeds its potential for natural treatment. Therefore, the treatment of wastewater is of the highest import.

Wastewater treatment is a process that has been extremely important throughout human history. Each civilization has had its own method of disposing of wastewater, and as time passed, the disposal methods have become more complex. Ancient civilizations of the Far East and Egypt had rudimentary ways of disposal, such as latrine systems or direct disposal into waterways. The Romans developed sewers which led directly into receiving waterways (Wright 2014). However, as cities grew and urban populations became more concentrated, a new way of disposing of and eventually treating wastewater became essential.

In the early 19th century, the United States saw its population grow from five to 75 million people (Wright 2014). This increase in urban concentration led to an increase in wastewater production. The old collection techniques which were utilized became inadequate, leading to increased societal nuisance and possibility for disease contraction. Because of the risk to human health, the issue of waste disposal became an important issue to understand and address. To combat these emerging problems, engineers developed underground sewer systems to transport the wastewater away. In 1887, the first biological filtering system, an intermittent sand filter was installed in Medford, Massachusetts (Silverstein 2010). The first federal regulation of sewage was imparted in 1899. The Rivers and Harbors Appropriation, or “Refuse Act”, prohibited discharge of solids to navigational waters without permit from US Army Corps of Engineers (Silverstein 2010). From these initial implementations, wastewater filtration rules and systems have been added to and improved upon. Wastewater treatment is now generally completed at large wastewater treatment facilities and is domestically mandated by the Clean Water Act of 1972, specifically the National Pollutant Discharge Elimination System (NPDES) Permit Program (Silverstein 2010).

The term wastewater describes used water of any variety. Although the treatment plant is the final destination of wastewater, it and associated products must pass through a myriad of passageways to get there first. Wastewater has many avenues be introduced into sewage systems, including toilets and drain lines. Products which are flushed down a toilet need to go through a small residential drain line, which leads to larger municipal drain lines. These larger drain lines
are found underground on public property. All of the residential sewage lines empty into these larger lines, along with most of the storm water inlets found along streets.

Wastewater then flows to a wastewater treatment plant, where water is sent through a large metal sifter. The sifter stops large objects that can’t be processed, such as non-disposable wipes, stones, female hygiene products, etc. Wastewater that moves on is left in a large tank to separate by density. Solid particles fall to the bottom, where they are fed on by bacteria. These bacteria produce methane during the decomposition process. Burning this methane creates steam, which is then used to power the pumps in the wastewater treatment plant. Liquid left is pumped through filter beds comprised of stone layers covered by bacteria. Any waste remaining in the water is decomposed by these bacteria. Once the water passes through these filter beds, it is collected and pumped back into navigable waterways (Answers 2014).

This process may be hindered if items that are not safe to flush are flushed down the toilet. Such items include feminine hygiene products, paper towels, and many types of wipes. Companies who produce such items have worked to create and market “flushable” wipes. These products are wipes which have undergone rigorous testing and passed an array of tests that were created to determine whether the product will break down before causing problems for wastewater treatment plants. However, wastewater treatment plants around the country have seen an increase in clogs which have cost their counties millions. New York City alone spends $18 million a year collecting and discarding debris caught in machinery at its 14 wastewater treatment plants (Boniello 2014). Last year, London’s sewer systems were paralyzed due to a 15-ton, bus-sized mass of wipes and congealed grease (Boniello 2014). Due to the social and monetary issues associated with “flushable” wipes, work to determine these items’ disintegration rate and “flushability” is very important for not only cities, but also for the industry.

I used a position as a contracted flushability technician for Proctor & Gamble (P&G) from October 2012 to August 2013 for my internship/professional experience for the IES program. A flushability technician is essentially a laboratory technician who tests products that are flushed down the toilet for their ability to move through toilet/sewage lines and potential to disintegrate/biodegrade. During this internship, I was responsible for running research and development testing, quality assurance testing, method/equipment development, extensive record keeping, technical report writing, and other related clerical work. The careful documentation and record keeping tasks were especially important to track progress and help identify problems with the products that came through the lab. The goals were to uphold the standard of excellence that P&G has achieved in the nonwoven industry and help develop new and innovative testing for the flushable industry.

The main responsibility for my internship was to work alongside both researchers and technicians to help continue the growth and progression in the flushables field.
To maintain the level of excellence that P&G had previously exhibited, I completed the following tasks:

- Complete and stay updated with monthly safety training to work in the lab
- Review and understand all of the INDA/EDANA standards for testing flushable products
- Get hands-on training from seasoned technicians who had conducted the testing for an extended period of time
- Learn how to operate and maintain equipment
- Obtain instruction from the principle researcher on how to write technical product reports

Many factors influenced my decision to select the internship at P&G. The most important was the opportunity to learn about the inner workings of a professional lab and how a large corporation went about upholding environmental standards set in place not only by the industry as a whole, but also by the company itself. I have extensive academic training in the interdisciplinary field of environmental science, but hadn’t had the opportunity to utilize this training in a professional manner until this internship. My background in food service, management, and teaching gave me skills that could be utilized in a professional environmental setting, but I wanted to obtain direct experience in my desired field. I believed this industry experience would allow me to make a more informed decision about my future career choices. Laboratory work conducted during this internship allowed me to experience many facets of the environmental field and gave me a first-hand look into how large corporations were achieving green initiatives. Learning about and conducting tests helped me understand how the progress of this industry is making products our country has become accustomed to using more efficiently and environmentally friendly. For this reason, the lab work I was doing was not only related to environmental science, but to my area of concentration for my Master’s degree, conservation.

Although I was tasked to do many things for the internship, the most useful for me moving forward was the ability to experience the research and development process used for creating, implementing, and revising products. Insights gained in this internship helped me to understand the inner workings of creating products and adhering to environmental standards on a practical, professional level.

When I began this internship, I created both short-term and long-term goals for the experience. The short-term goals focused on the skills I wished to gain during the internship. The long-term goals were associated with what I wanted to gain from this experience that would be applicable to my career. The following were the professional and academic goals I wished to complete by the time of my defense:

- To see directly how the testing done in my lab may affect the evolution, movements and marketing of products, as well as see how the results from lab work interact and adhere to the green initiatives and conservation efforts set in place by the company.
• To better understand and gain experience working in the environmental field, such as how a professional lab adheres to and coordinates it’s every day workings with legislation that regulates production of flushable products.
• To hone my laboratory skills in the areas of extended data analysis, professional report writing after data analysis, and working with industry-specific machinery such as slosh boxes, agitators, and anaerobic and aerobic desiccation and disintegration techniques to assess samples.
• To garner skills that may be transferrable throughout my career, regardless of assignment.
• To interact with and gain insight from established professionals while building networking relationships for later in my career.
• To utilize professional skills I’ve learned in academia in a real-world experience.
• To completely finish and fulfill the requirements for my Master of Environmental Science (MEnvSc) degree through Miami University.

Company Overview

P&G, based in Cincinnati, Ohio is a world-renowned company serving over 180 countries around the globe. Since its creation in 1837, P&G has continued to grow and create better products for its consumers (P&G 2014). P&G is a world leader in household products, ranging from detergents and toilet tissue, to diapers and soaps. It has been ranked #15 among the “World’s Most Admired Companies” and #1 in the soaps and cosmetics industry by Fortune magazine, as well as #41 on Forbes list of World’s Most Reputable Companies (P&G 2014). P&G’s market capitalization is larger than the GDP of many small countries, and such wealth brings immense responsibility and opportunity (P&G 2014). P&G has not only undertaken many philanthropic endeavors around the world in its almost two hundred year existence, but has continued to better the communities where it calls home. P&G partners with the Cincinnati Reds Community Fund to do renovations of community centers around the city annually. This year’s project is the Millvale Recreation Center. Over 400 volunteers will utilize a budget of $300,000 help to upgrade the facility, baseball fields, and other recreational areas on August 6th, 2014 (Watkins 2014). Recently, P&G has also been working to achieve its sustainability goals proposed in 2010. These include powering their plants with 100 percent renewable energy, using 100 percent renewable or recycled materials for all product packaging, and maximizing conservation of resources (P&G 2014).

Research and development is continuously undertaken to ensure that P&G evolves with the times environmentally and is able to uphold its sustainability mission. The environmental division of P&G ensures that best management practices are upheld in research and development. It also works to create the most environmentally friendly, while still profitable, products possible.

The environmental division of P&G is a coalition of individuals stationed around the world. My supervisor has over 20 years of experience in the environmental division of P&G and
is a Principle Researcher/Lab Manager for the flushability lab at the Winton Hills location. Figure 1 shows the sectoring structure.

My position of contractor to P&G meant that I was under contract with Advanced Testing Laboratory (ATL) to conduct testing and report the results I found to P&G. Upon completion of initial training, I spent my time working almost independently in the lab. Other technicians generally worked in couples or teams on testing or with consultants on novel test development for unrelated projects. I would, however, consult with our clients in the research and development sector of the company when I found problematic results that were time sensitive. I also reported findings to my supervisor on a weekly basis.

I had a contracting supervisor from ATL who worked on site. I interacted with him when necessary or monthly, whichever came first. I generally spoke with him about working conditions, any problems I’d found with the working structure, and my mentality toward the position. It was his duty to make sure each party (P&G and I) was satisfied with the arrangement in place (Figure 1).

My contract was an open/continuous contract, which meant that I would stay employed as long as there was need of my services and/or P&G had enough testing to be done to justify my position. As with any open contract, there was no terminal time period, and no potential for employment with P&G directly unless I applied to and followed protocol to gain an opportunity with the company.
My work centered on seven main tests that were established as standards by the International Nonwovens and Disposables Association (INDA) & the European Disposables and Nonwovens Association (EDANA), the governing non-woven industry authorities. These tests were designed to determine if a product could be given the seal of approval for being sold as flushable in the consumer market. To obtain this approval, the product needed to pass a series of tests which referred to the product’s ability to deteriorate and dissipate quickly enough to avoid line damage, pump failures, and clogging which could lead to backup of a sewage system.

**Law and Guideline Compliance**

Over the course of this internship, I worked within the allocation of the laws and guidelines set forth by multiple entities to do my job to code. As earlier stated, INDA and EDANA are the governing bodies for the non-woven industry and set forth guidelines for the work I completed on the products that were sent to the lab. I also needed to follow national guidelines on how to treat and dispose of wastewater that was used in the testing, which alludes to the Clean Water Act.

INDA, originally called “The Disposables Association”, was created on April 16, 1968. Companies in the associated field decided to come together to form a non-profit organization to obtain and develop factual data that supports the creation of programs to solve problems found to be common in the industry on a legally sanctioned forum (INDA 2013). Since the advent of INDA, the nonwovens industry has grown immensely. This has facilitated the creation of multiple other associations dedicated to INDA and EDANA’s flushability cause around the globe. The other major complementing association, EDANA, was created in 1971 when INDA realized the tasks of managing the world’s nonwoven industry was too great a responsibility to continually perform alone. EDANA is responsible for the European, Middle Eastern, and African regions of the world (EDANA 2008). There are also Asian region nonwoven entities that can be found but are not as prevalent.

Currently, INDA/EDANA’s original goals have expanded to include becoming a leading consultant for the industry. The associations are in place to not only give guidance to member companies, but to be utilized specifically as the primary source for education, global product forecasting, testing guidelines and trend reports for the nonwoven fabrics industry (INDA 2013). My main interaction with INDA/EDANA was the testing standards and guidelines which shaped the research I undertook on a daily basis. Along with the BMPs (Best Management Practices) for lab work and safety, these guidelines explained how to test the products in the best way to comply with industry standards for determination of flushability.

INDA/EDANA began to work on guidelines in 2004 to standardize the determination of flushability for nonwoven products on the market. A special task force of 31 companies focusing on flushability was charged with creating these initial guidelines. The first guidelines by this group were published in 2008, closely followed by an update in 2009. The 2009 guidelines are
currently under review to update them with current market and industry trends. However, my work was based on the 2009 guidelines (McIntyre 2012).

The current guidelines are set up as a tiered, progressive system for products to pass through before they can be designated as flushable. This tiered system and flushable designation are very important for the continued progress by industry leaders to make products more environmentally friendly. Through standardized disintegration rates, the ultimate goal of reducing residential/municipal pump energy consumption and paper conservation throughout communities around the world could be achieved. Figure 2 illustrates the tiered testing system I followed during my internship.

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<tr>
<td>Aerobic Biodisintegration/Biodegradation Test</td>
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<td>Anaerobic Biodisintegration/Biodegradation Test</td>
<td>Fail Not Flushable. “Do not Flush” label required</td>
</tr>
<tr>
<td>Municipal Sewage Pump Test</td>
<td>Fail Not Flushable. “Do not Flush” label required</td>
</tr>
<tr>
<td>Flushable Claim Appropriate</td>
<td>Pass</td>
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Figure 2. INDA/EDANA Standard Tests Chart (INDA and EDANA 2013)

Surface waters become degraded from water pollution and become unsafe for drinking, fishing, swimming, and other activities. As the nation’s navigable waters became more polluted, officials decided that legislation was essential to cleaning them up. The answer to this problem was the creation of the Federal Water Pollution Control Act. As time passed, it was found that
this act wasn’t comprehensive enough to control many sources of pollution. Therefore, a 1972 amendment to the Federal Water Pollution Control Act, The Clean Water Act (CWA), was set in place by Congress for the conservation and continued constitution of the country’s water supplies. Within the CWA lies the National Pollutant Discharge Elimination System (NPDES) (EPA 2012). This program regulates point sources that discharge pollutants and issues permits to all wastewater dischargers and treatment facilities. Point sources are areas of direct outflow of wastewater into navigable surface waters of the United States, and are generally pipes or man-made ditches. Permits that are given out determine discharge limits for the specific location, amount of testing (duration and interval) needed for the site, and designate if the specific location will require special actions to offset or protect the environment from harmful pollutants discharged or leaked from the location. The NPDES permit program is responsible for significant improvements to our Nation’s water quality since its introduction in 1972 (EPA 2014). Due to the use of different types of wastewater and sludge used in the testing done in the development of flushable wipes and tissues in the lab, I had to follow the standards established in these permits. This is important to make sure products on the market do not influence or cause pollution of the water being treated at wastewater facilities.
Section 1

Toilet and Drainline Clearance Test

The Toilet and Drainline Clearance Test is the first test in the INDA/EDANA series which ultimately decides whether a product may be labeled as flushable in the consumer market. Created from this test, the Bowl Clearance Test and the Ten Flush Screen are less involved tests conducted in the lab. These tests were conducted to ascertain amounts of product needed to clog the toilet bowl and how product moved throughout drainage lines, respectively. Interactions within drainage lines were also recorded.

For all of these tests, toilet tissue was uniformly folded from a strip of tissue down to the size of a single square. Uniformity of folding reduced variability in the testing. For an initial strip of five squares (the most common amount), two squares were folded over, followed by the single square on opposite side, ending by folding the stack over once more. These five-square stacks were denoted as a 1x5 folded stack, one sheet by five squares. These were the base unit for most of the flush testing done in the lab, though sometimes orders would come in for 1x6, 1x7, etc.

The Bowl Clearance Test was the most common test done in the lab. This test was created to determine how much product it would take to clog a toilet bowl. This test was prepared by folding 1x5 stacks of tissue and placing them into groups predetermined by the product’s principle researcher. The toilets used were calibrated before the test began to ensure the volume of water released per flush printed on the tank was correct. The starting point for most tissue was a group of five-square stacks (5x5). These groups would increase by one stack until clogging occurred (i.e. 6x5, 7x5, etc.). Each stage consisted of ten runs to ensure repeatability. A run consisted of placing a 1x5 stack in the center of the toilet bowl, allowing 10 seconds for wetting of the product (to avoid sticking caused by placing stacks together) and placing the next stack. This was done until the group was completely in the toilet bowl. The product would then be flushed. The results that could be recorded were a clear (tissue completely left toilet bowl and flush occurred), a labor flush (product clogged initially but cleared after a moment), or a clog (product stopped flush from occurring). Once the ten runs were finished, the stage was completed. To finish a round, three stages were completed. The test was considered complete once 100 percent clogging occurred during a stage.

The Ten Flush Screen was much the same as the Bowl Clearance Test in application, but expanded on it by focusing not on how the product reacted in the bowl, but how well the product moved through the drain line. Beginning the test consisted of calibrating the toilet that would be used to ensure volume per flush was the same and folding product that would be used. Amount of product in groupings would be pre-determined on the testing request by the product’s researcher. However, the standard testing grouping was 4x5. This ensured a product would make it through the toilet bowl without much hesitation, but would react in the drain line based on
product chemistry and weight. A group was placed into a toilet bowl and flushed as in the Bowl Clearance Test. The product would exit the toilet bowl into a 24.5 meter long transparent drain line that was created in the lab and marked at each meter. Once the product stopped moving, its distance was recorded. This was done ten times and the recorded numbers were averaged to get the mean distance traveled for the product.

The Toilet and Drainline Clearance Test is a combination of the previous two tests. This test takes aspects from both the Bowl Clearance Test and the Ten Flush Screen and expands upon them. During this test, a family of four’s normal two-day toilet usage is simulated and replicated three times. This test contains three types of flushes, including water only, water with product, and water with product and simulated fecal matter (SFM). A test log contains how a product reacts in the bowl and trap of a toilet, as well as in the drain line. Since the product is not expected to make it completely through the drain line each time, the interaction of the product in the drain line is also recorded. Following each flush, the location and distance traveled by each product in the drain line is recorded to determine the center of mass for all products in the drain line relative to the toilet. At least 35 flushes are required to complete this test, however, if product is left in the drain line upon completion of the standard flushes, the test and recording continues until the product has left the drain line.

For a product to meet the criteria to earn a pass for this test and move onto the next test in the series, two standards must be met. First, there must be a less than five percent occurrence of clogging on flushes containing product. Second, over five consecutive flushes, the center of mass calculations for distance product movement must not continuously decrease.
Section 2

Slosh Box Test

The Slosh Box Test, the second test conducted under the INDA guidelines is meant to determine the dispersibility of a product. Dispersibility is defined as the ability of a product to break apart or scatter. Based on the product being examined, test durations of 30 seconds, 1 minute, 2 minute, 5 minutes, 10 minutes, 30 minutes, 1 hour, and/or 6 hours were undertaken.

There were two slosh box apparatuses available for use. The first was an apparatus made by a lab product distributor that contained three simultaneously-moving plastic boxes on a platform. The second apparatus was made at the P&G Winton Hills location from the schematics taken from the existing equipment to ensure uniformity (Figure 3 & 4).
Many different products were tested using these apparatuses. However, the most commonplace products tested were toilet tissue and flushable wipes.

For toilet tissue, the presence of the holding glue on the rolls was a concern. Since this substance changed the composition of the tissue, the tissue was rolled out and the squares were examined for any presence of the binding substance. Only the squares that were solely paper were used. Once the compromised squares were gone, five 1x5 (one strip comprised of five tissue squares) samples were taken from different parts of the roll. This was done to ensure the uniformity of the tissue throughout the roll. Each 1x5 strip was then folded the same way down to a single square for initial weighing. These weights were recorded on the test record and the respective samples were denoted as 1 through 5.

Much the same as the toilet tissue that was tested, flushable wipes being tested were taken from multiple places in a single package. Since there wasn’t a binding agent for wipes, they would be placed directly into the slosh box upon commencement of the test.
Before the test was started, a baseline weight for the product had to be calculated. This baseline weight was achieved differently for toilet tissue and wipes. Obtaining a toilet tissue baseline was achieved by taking the average of the weights gathered from the samples being tested in that sequence. Gaining an average for a wipes sequence was a bit more complicated. To obtain a wipe product baseline, ten samples were taken from multiple packages of the same product in different locations in the package. These samples were sent through a flush and drain line sequence and collected at the end of the pipe. The samples were then dried in an oven overnight (at least twelve hours) and then sent to a desiccator for at least an hour to complete the drying process. The samples were then collected and each sample was weighed. The final weights for each sample were compiled and averaged, giving the baseline weight for the product.

To begin the test, two liters of water at a temperature of 20 degrees Celsius were placed into a slosh box apparatus set to 26 rpm. Each respective sample was taken and placed into a slosh box and left to be agitated for a time period pre-determined by the researcher who had sent the test request. At the completion of each respective test period, boxes were taken off the agitator and contents were poured into stacked sieves of 12.5 mm, 6 mm, 3 mm and 1.5 mm. Boxes were sprayed out with faucet water and contents were poured into sieves to ensure no product was left in box. Sieves were then washed for 30 seconds at a flow rate of 4L/minute. The wash was conducted to allow the variable sizes of the dispersed product to fall to the different-sized sieves. Once the wash was completed, the product left in each sieve was collected and placed into sample boats labeled with the size of the sieve from which the product was taken. Upon completion of the sample collection, the sample boats were placed into an oven set at 400 degrees to dry overnight.

After the minimum drying time of 12 hours was obtained, the samples were placed into a desiccator for at least an hour to make sure all of the moisture in the samples was gone. The product samples were then taken from the desiccator and each was weighed and recorded into the test log. Once the numbers were recorded, they were divided by the baseline weight of the product to determine the percentage of the product that was found in each sized sieve. For a product to achieve a pass on this test by INDA/EDANA standards, more than 25 percent of the initial dry mass must be found to have passed through the 12.5mm sieve.
The Household Pump Test is used to determine how a product interacts in a household sewage ejector pump system. Clogs, interference of system operations and basin accumulation are all areas of concern that are monitored. Products being tested under this application were almost unanimously wipes.

The pump system used was created in-house and was comprised of a toilet which had its drain line empty directly into a 26-gallon trash can that served as the accumulation basin. Inside the basin, a household pump system consisting of an activation buoy and an ejector pump was secured to a steel pole in the center on the bottom. The household pump was connected to a vertical pipe that rose approximately 10 feet from the basin and turned into a five foot horizontal pipe with a two-degree downslope at an elbow. Another elbow at the end of the horizontal pipe led to a five foot vertical pipe that terminated over a 26-gallon trash can (basin) with a large metal filter in the middle and a drain at the bottom.

This test lasted six days, with two test application periods each day. Each application period consisted of twelve flushes, with six of these flushes containing product. On each product flush, two articles would be placed in the toilet and flushed. The product would move directly into the drain line and expel into the connected basin. The product in the basin was recorded as being floating, sunk (on the bottom of the basin), or on the pump. Two minutes were given between each flush to allow time for the product to settle. Once the basin filled enough to trigger the buoy, the ejector pump would activate. Records were kept of whether the pump worked without incident and how product in the basin moved throughout the drainage line. Upon completion of each day’s testing, the number of wipes in the basin were counted and left in the basin.

After the final loading on the sixth day, the toilet was flushed until the basin had enough water to trigger the pump a final time. Articles in the basin were then counted, recorded, and extracted. The recorded numbers of articles from days two through six were averaged to determine how well the product interacted with the pump and moved wipes through the system.

For a product to pass this test and continue moving through the flushable test series two standards needed to be met. The first standard was that the average number of articles left in the basin from days two to six could not exceed the amount of articles that were loaded any one day. The second was that the system could not be stopped in its operation by the product at any point during the testing.
Section Four
Settling Test

The Settling Test was created to determine if a product will settle in septic tanks, settling chambers, or any holding areas associated with wastewater treatment plants or residential waste holding basins. This test was run on both hygienic wipes and toilet tissue. For wipes, an individual wipe was used, while toilet tissue was assessed as a strip of three.

The test occurred inside a transparent column, which had a tape measure attached to the back with which to give accurate measurement of settling distance (Figure 5). The distance settled per unit time was used to calculate settling speed.

Before testing, the articles of product in question would be swirled in either tap water or wastewater for two minutes, allowing for full absorption of water into or adsorption of fecal material onto the product. Once this process had been completed, the article would be placed into a beaker filled with tap water and poured into the column. A stopwatch would be started and the amount of time it took the article to sink to the bottom of the column would be recorded. The final settling velocity for the product would then be calculated as an average of the settling velocities from the ten articles used in the test.

If after five minutes the article did not sink to the bottom, an extra beaker of water would be poured into the column over the article. This process would also be completed at the ten minute and twenty minute mark if needed. If after the third pour the article was still floating, the test would be deemed a fail for the article and the next run would begin after draining the excess water from the column.

Although many products initially passed the column settling test and sank within the allotted time frame, some products posed a delayed buoyancy problem. Due to this, only articles of the same product were allowed to be tested on the same day. Upon completion of the testing for the day, the sunken articles were left in the column overnight. If an
article from the previous day of testing was found to have begun floating again, the test was
deemed a failure and the product was tested again to check for repeatability.

To pass this test and meet the guideline requirements, articles that were tested needed to
settle at an average rate of more than 0.1 cm/second, 95 percent of the total articles tested were
required to settle, and 95 percent of the tested articles were not allowed to become buoyant
enough to rise to a height of 30 cm from the bottom over a 24 hour period.
Section Five

Aerobic Biodisintegration Test

The Aerobic Biodisintegration Test is a test designed to determine a product’s ability to deteriorate biologically in sewers and municipal wastewater treatment facilities where aerobic (oxygen present) conditions would commonly be found.

To prepare for this test, activated sludge (biologically active, aerated wastewater) was collected from a municipal wastewater facility, brought back to the lab, and poured through a 1mm sieve to separate biological material too large for the test. Shaker tables to be utilized in the testing and located in the lab were calibrated to 75 rpm. Shaker tables were used to ensure adequate and continuous oxygenation of the activated sludge used in the testing. Products tested were feminine hygiene products, hygienic wipes, and toilet tissue. Cotton balls were used as a control for each test. For the feminine hygiene products and wipes, a single article was used in the test application. Toilet tissue was separated into strips containing three tissue squares. All product articles were weighed before the test commenced to gain a baseline mass. Three-liter baffled flasks which allowed for the greatest amount of aeration potential were placed on the shaker table and labeled according to product found inside.

The test was started by placing product articles and cotton balls into empty baffled flasks secured to the shaker table by springs then adding one liter of sifted activated sludge. Triplicates of each article were tested to ensure viability of results that were found. The shaker table was turned on and left to aerate the articles for 14 days. Two times a week the shaker table was paused and the baffled flasks were shaken to re-incorporate any biological material that was stuck to the glass above the agitation line.

Upon completion of the 14-day cycle, the shaker tables were turned off, baffled flasks were individually freed and the contents of each flask were again poured through a 1mm sieve. Product that was found on the sieve was collected and placed into labeled weigh boats. The weigh boats were then placed into an oven at 400 degrees and left for 24 hours. At the end of the 24 hours, the weigh boats were transferred to a desiccator for at least an hour where drying was completed. The weigh boats were then taken from the desiccator and each triplicate of product was weighed and averaged. The average product mass found post-test was divided by the average pre-test weight and the percent mass that remained was calculated.

In order to pass this test, product was required to have no more than five percent of the initial average dry mass remaining on the 1mm sieve upon completion of the 14-day testing period.
Section Six

Anaerobic Biodisintegration Test

The Anaerobic Biodisintegration Test is designed to determine a product’s ability to deteriorate biologically in sewers and municipal wastewater treatment facilities where anaerobic (oxygen absent) conditions would commonly be found.

To prepare for this test, anaerobic digester sludge was collected from municipal wastewater facilities around the Cincinnati area and was poured through a 1mm wire mesh sieve to initially extract larger pieces of biological material from the sludge. The large pieces of biological material were disposed of and the remaining digester sludge was collected in 5-gallon plastic containers. All products tested were weighed before testing to gain a baseline mass which would later be used in analysis. Products tested were feminine hygiene articles, hygienic wipes, and toilet tissue. Again, feminine hygiene articles and hygienic wipes were tested as single articles, and toilet tissue was tested as a strip of three tissue squares. Cotton balls were utilized as a positive control for this test.

To begin the test, three of each product and control cotton balls were placed into 2-liter containers and labeled. Sifted digester sludge was poured into the testing containers at a volume of 1.5 liters, which were plugged with stopper corks to ensure the preservation of the anaerobic environment. Triplicates of each product were created to ensure consistent results. After the anaerobic environment was established, containers were placed into an incubator set to 35 degrees Celsius and left static for 28 days.

At the end of the 28-day test period, the static containers were removed from the incubator and uncorked. The contents of each container was then gravimetrically sifted through a 1mm sieve and any product found on the sieve was collected and washed lightly to eliminate any biological material sticking to the product being tested. The product was then placed into a labeled weigh boat and put into a 400-degree oven to dry overnight. After this initial drying period, the weigh boats containing the product were again transferred to a desiccator for at least an hour to complete the drying period. Once the product was sufficiently dried, it was weighed and the triplicates were averaged to obtain the mean mass of product that remained. The average product mass found post-test was divided by the average pre-test weight and the percent remaining mass was calculated.

Product was required to have no more than five percent of the initial average dry mass remaining on the 1mm sieve upon completion of the 28-day testing period to pass this test and move on to the final test.
Section Seven
Municipal Sewage Pump Test

The Municipal Sewage Pump Test determines how well a product interacts with the small municipal sewage pump systems predominately found in wastewater treatment facilities.

The products assessed by this test were almost uniformly hygienic wipes and much preparation was required before they could be tested. Initially, 60 hygienic wipes were separated and pinned (using clothes pins) from packs that were from the same manufactured batch. This was done five times with each set of 60 being kept separate from others, for a total of 300 articles assessed over the duration of the test. Before the hygienic wipes were allowed to go through the municipal pump, they were required to soak in tap water for two hours to allow for the deterioration of surface lotions (since lotions would be gone by the time wipes arrive at wastewater treatment plant).

The ITT Flygt pump; model C-3085.183 was used as the municipal pump system in the lab. The pump was required to have a flow rate of 336 gallons/minute, its maximum efficiency, before the test was allowed to begin. After filling the tank with water, the system was turned on and this number was obtained by precisely adjusting the flow valve. A sensor connected to the flow meter in the tank collected the flow data and projected it onto an attached flow meter gauge.

Figure 6: Municipal Pump Test Apparatus Picture (INDA and EDANA 2013)
affixed to the tank apparatus, allowing for accurate measurement (Figure 6). Once the flow rate reached 336 gallons/minute, it was left for five minutes to ensure the flow rate stayed constant. Monitoring software connected to the pump and that measured power consumption, flow rate, and water temperature was turned on and an excel log sheet was created and named for the product and test date. Once this five minute assessment period was over, the test was allowed to proceed.

Upon completion of the assessment period, the monitoring program was started. It was left to run unabated for five minutes to determine baseline measurements for power consumption and flow rate of the pump. Data points were created every second by the software, transferring the data points to the excel log sheet, which allowed for easier analysis. While this was happening, the bucket that housed the first 60 articles of pinned product, for the first run, were brought over to the tank and placed on a removable metal shelf.

After the five minute baseline creation time, the articles of product were utilized. A timer set for ten minutes was started in coordination with the entrance of the first article. A metal pipe that fed into the pump was used to make sure product would go through the pump. Product was unpinned, placed into the pipe and forced down to the pump once every ten seconds (Figure 7).

![Figure 7. Municipal Pump Test Flow Graphic (INDA and EDANA 2013)
This was done until the timer sounded. Another technician was present during runs to clear off the screen in the return tank, which would begin to clog because of eviscerated product. This was an essential role because if it were left unattended, the water in the tank would overflow and introduce destroyed product into the entrance tank, which could allow extra product into the pump. This would ultimately render the test moot since the extra product could cause an incorrect power consumption reading for a single product.

After the product application period, the pump was left on and readings were taken for another five minutes to gain ending baseline power consumption and flow rate readings. Once the five minutes were up, the monitoring software was stopped. The pump was then turned off, raised, and cleaned to make sure there was no residual product inside which would cause problems on later runs. The pump was then lowered back into the tank. A static period of approximately 45 minutes was observed and the process began again. The test was run five times over the course of a day, each with 60 articles of the same product to ensure enough data was collected and repeatability was observed.

The percent power consumption increase was determined for each run in program then used to calculate the percent power consumption over the baseline. The percent power consumption over the baseline for each point was then averaged in Excel, giving the mean percent power consumption increase for the test.

For this test to be determined a success and the product to obtain a flushable label, there cannot be more than a 15 percent mean power consumption increase over baseline for the five runs.
Section Eight

Novel Projects - PIS & Corroded Drainline

Along with the INDA/EDANA guideline testing for determining flushability, I also was responsible for completing other testing for multiple products. The Paper Industry Standard (PIS) test, corroded drainline novel testing, and general quality analysis testing were assessments that helped to supplement my internship.

PIS Test

The PIS (paper industry standard) test was one of the responsibilities that I was almost entirely in charge of while working in the lab. This test was originally a Japanese standard that tissue in the Asian market was required to meet before going into circulation. It was designed to determine the dispersability of a product when placed into a beaker filled with water and a stir bar spinning at the base, causing a vortex that simulated an initial flush from a toilet bowl. Toilet tissue was the sole type of product assessed by this test.

Toilet tissues assessed by this test were domestic P&G products and the most commonly used Chinese/Japanese toilet tissues used in the Asian market. Each test consisted of at least ten initial runs. If paper wrapped around or inhibited the stir bar from rotating back to the initial speed, subsequent runs would be completed until ten completed runs were acquired. To prepare for this test, product to be assessed was separated into individual squares which were then cut into 100x100 mm squares. The cut tissue was then separated by ply (if it was multi-plied). When all product for the testing was collected and prepared, a 300 mL beaker was obtained and filled with 300 mL of 20 degree Celsius tap water. A stir bar measuring 8 cm x 40 mm was placed at the bottom of the filled beaker which was put onto a stir plate set to 700 rpm.

To begin the test, a single ply, 100x100mm square of tissue was placed into the center of the vortex created by the stir bar and a stopwatch was started. The first time noted was when the first piece of tissue broke from the original square. The introduction of the paper and initial contact with the stir bar would slow the stir bar’s speed, so the timer was stopped once the stir bar made it back to 700 rpm. If the stir bar was wrapped up and stopped by the tissue or if the stir bar never returned to 700 rpm, the run was deemed invalid and was repeated. This was done until there were ten viable runs for the ply. Upon gathering data from ten viable runs, the time it took for the first piece to break from each ply and the amount of time it took for 700 rpm to be regained by the stir bar were averaged. Once each ply had an average, an overall average for each coordinating tissue was calculated.

For a tissue to pass this test, the time between initial contact with the water in the beaker and the return to 700 rpm for the stir bar could not exceed 20 seconds for any ply.
The PIS test was a dynamic standard that was revised on multiple occasions while I was contracted with P&G. During the last month of my internship, a revision of the test was completed. This revision changed many of the specifics of the test, including the beaker size, amount of water used in the test, and the required rpm’s to be met. The beaker size was increased to 500 mL, with 500 mL of water to be added. The 700 rpm standard was also increased to 750 rpm. PIS testing was run under these conditions upon my knowledge of the change.

**Corroded Drain line Test**

I was also tasked with implementing a test to show how toilet tissues interacted with corroded drainlines, which were becoming more common in the degrading infrastructure which the product was subject to on a daily basis. For this project, I worked with an engineering consultant in our lab. Since we were not able to obtain actual corroded metal piping, we determined that the best way to simulate the degrading drain lines would be to introduce shingles into the already established drain line. The shingles were connected to each other with staples and gaps at the connecting points were covered in duct tape flush with the surface to ensure there would not be any areas of pre-determined backup. The manufactured shingle measured approximately ten feet and was inserted into the terminal end of the pipe which afforded product the opportunity to move through approximately 15 feet of smooth piping. This simulated a residential application where piping was newer closer to the house and the point of entry for the tissue, but degraded as it moved toward older municipal piping.

Established products that P&G had on the market were collected and ten flush screens were conducted with the shingle in place to determine how each product would interact with the increased amount of friction, uneven surface, and increased adhesion forces created by the simulated degrading surface. Since this was novel research, this testing did not have a pass/fail standard in place; it instead provided baseline data which could be utilized in later work.

Due to the continued research and development of this testing and many P&G products, I am not legally allowed to divulge any results for the testing I conducted while under contract at P&G.
Conclusion

Internship Reflection

This internship experience was one of substantial importance for my development as a professional in the environmental field. The work I was responsible for and conducted over the duration of the internship afforded me the opportunity to learn much and hone many skills that were and will continue to be very pertinent in the career I hope to gain in this most important of fields. I found there were many beneficial aspects to working in the professional environment, as well as a number of problems in how the company dealt with contractors in their labs.

Time spent in the professional lab at P&G gave me insight into how the industry works and is completed on a daily basis. Initially having a fast-paced testing environment helped to solidify the laboratory skills I had gained while in academia. Working with individuals in the field who were established and had knowledge of the inner workings of the industry helped to increase the efficiency and productivity of the testing I conducted on P&G’s behalf.

I learned about the importance of clerical work that goes hand-in-hand with testing as well. Documenting each and every result I found while conducting the testing helped to solidify the detail-oriented side of myself that had waned in academia. This aspect was one of utmost importance, not only for my personal development, but for the company as a whole.

Following the procedural applications of the INDA/EDANA guidelines concerning the flushability testing also allowed me to grow as a scientist. Attacking each task assigned to me with my full ability became a daily occurrence, which made the work I was doing very important to me. I reflected on my work after months of completion, and found that my results and observational skill increased, which gave me a sense of accomplishment that I had yet to experience in a professional environment. When I was able to see the big picture concerning the work I was doing, how the work would lend itself to my overall goal of helping with conservation efforts in the industry, my outlook on completing menial tasks shifted.

Working with the researchers who were employed with P&G on a weekly basis was one of the most important occurrences during my internship. I came to understand the true meaning of interdepartmental compliance, and grew as a communicator, which I will most certainly draw upon later in my career. Being able to learn, grow, and accept the procedural methodology set in place to make the company run efficiently was very important, and I enjoyed speaking and working with individuals who commissioned the testing in my lab.
The interdisciplinary aspect of any position in a company was revealed to me after only a short time of working in the lab and I found that I enjoyed this aspect implicitly. By having the opportunity to complete the assigned tasks I was given independently, I found that much more than mere lab work went into improving the products at P&G. To complete the tasks at a high level, I needed to work with individuals in multiple fields, and I feel I was enlightened in how to truly be a scientist at the professional level.

However, I also noticed a lack of communication between ATL and P&G, as well as between P&G employees. Due to a contractual obligation, P&G supervisors were not permitted to directly critique ATL contractors in their work. The only time I was made aware of any discrepancies my P&G supervisor felt were present in my work was when I spoke to my ATL supervisor. The lack of communication between P&G employees and the lab led to technicians becoming overencumbered with work, with unrealistic expectations for test completion. This stemmed from employees not being educated about how involved the tests were and how long they took to complete.

The skills that I had gained throughout my time in academia are what I brought to the company, such as determination, instructor-level lab skills, attentiveness to detail, and an aptitude for learning. My interdisciplinary and problem solving skills were also very important to many of the tasks I completed during my internship. I feel these skills and theoretical knowledge of multiple scientific disciplines helped me to make an overall positive impact on the company. I feel most of these skills were heightened over the course of my internship and helped me to become a better professional, regardless of some negative situations I was faced with during my employment.

**IES Reflection**

Many of the courses I took while in the IES program helped me during my internship, but the ones that really stand out in my mind are Environmental Measurements and Environmental Problem Solving. I found that these two classes were the most applicable during my internship because of the nature of work I was conducting.

All of the testing I conducted was determined by my ability to accurately and efficiently measure the product I was testing through utilization of multiple instruments. The Environmental Measurements class gave me the background to use a multitude of environmental measuring tools, such as biological indicators, dissolved oxygen meters, and pH meters. Without this knowledge and training, the testing I conducted would not have the possibility of completion.

The skills and principles I learning in Environmental Problem Solving have been applicable to every aspect of my life. The ability to discern a problem and work through it is knowledge that I’ve found to be invaluable. Throughout my internship, and especially concerning the novel projects I undertook, I was required to figure out the best way to conduct testing and yield applicable results. By having the background in problem solving and many
ways to approach a problem at hand, I was able to efficiently determine a solution that would lead to the completion of the task.

The Professional Student Project was also an invaluable learning tool in the IES curriculum. The ability to work with my peers in the program and individuals in the environmental profession allowed me to learn how to best approach and execute a project that has multiple levels and facets. Interaction with environmental professionals during the experience also gave me the opportunity to learn how to network and conduct business on a professional level, which I utilized weekly when working with researchers from P&G.

The IES program had a well-constructed curriculum that afforded me the opportunity to learn about many aspects of the environmental field, as well the general knowledge that was applicable after I left academia. The theoretical knowledge and practical application in the core classes laid the groundwork for a career in the environmental field, and the ability to choose from so many concentrations solidified the detailed knowledge I know I’ll use later in my career.

*Future Projection*

This internship helped to hone the laboratory skills I already possessed, and taught me many things about the professional environment. It also provided me the groundwork to become a much more productive and enlightened professional. The stringent application of procedures for the testing I conducted and the interaction with individuals in the scientific profession have allowed me to grow as a person. The challenges have also allowed me to grow and learn how to best deal with adverse professional situations.

I look forward to moving into and growing in the environmental field, and know that these base skills will be paramount in my success. After learning how to best discern and solve problems, work with members of a team as well as individually, and communicate in the most efficient and productive way, I know I have the knowledge and ability to be a success.

Along with the practical knowledge from the internship, the academic knowledge I gained from Miami was also very important. Conservation was the area of concentration for my degree for a few reasons. I’ve always loved the outdoors and being able to fully embrace nature without distraction from human beings, so I wanted to make sure that one day my children, and the generations beyond, would be able to do the same thing without fear of being disturbed by extensive noise pollution or overwhelming distractions from developed areas. By extension, if said areas are protected and conserved, then the many species of flora and fauna that reside in them may have the opportunity to continue propagating. Ever since I was a little kid, I’ve always had an inexplicable interest in animals and grew up learning as much as I could about any and all of them. I feel that obtaining knowledge about the natural world around us is of paramount importance, not only for reasons of research and development, but also for spiritual purposes and self-enlightenment.
Although my exact career path is uncertain, I know I am better suited for what comes next after going through the IES program and this internship with P&G. I went into the Institute of Environmental Sciences with a base knowledge of a multitude of scientific disciplines, and I come out of the Institute for the Environment and Sustainability as a significantly more informed and practical individual, with the skills to achieve my goals of becoming an environmental professional.
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