RYERSON UNIVERSITY
PUBLIC HEALTH AND SAFETY

A COMPARISON OF SPLASH AND SPRAY PARK WATER SYSTEMS
FOR THE REGIONAL MUNICIPALITY OF YORK

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I. Introduction

A. What are Splash and Spray Pads

Splash and spray pads have become very popular in many cities in North America (City Commission Agenda, 2009). A splash and spray pad can be defined as, any structure intended to have potable or treated water sprayed but not contained in an artificial body of water that may or may not be filtered and recycled (MOHLTC, 2008). These facilities provide cooling from water sprays from above and below the participants. It is one of the most entertaining recreational water activities for kids, especially to cool off during the summer time. Estimated attendance at North American water parks during the summer 2009 season was about 80 million (includes United States, Canada and Mexico), with growth averaging 3-5 percent each year (World Waterpark Association, 2009). It is an increasing component in North American tourism. Swimming pools are considered to be more of a health and safety concern for young toddlers and children because drowning is a main concern, however in spray parks, drowning would be less likely because water would be directed into the drains without any accumulation.

Spray parks can be found in private or public locations. Private locations include resorts and trailer parks, and public locations include local parks. According to one article, spray parks fit with any public space, whether it is an open park environment or beside a pool (February, 2004). As a stand alone aquatic facility, they offer an exciting and a cost effective alternative to pools, which require full time maintenance expenditures. In addition, spray parks operate through computerized control systems and do not require a lifeguard (February, 2004). All of these reasons contribute to the
growing interest of spray parks, especially since children of all ages are able to play. Unfortunately, there are health concerns that can affect the public, and these must be considered in more depth. The public health responsibility for regulating the operation and design of water parks facilities involves injury prevention and reduction and control of the spread of waterborne communicable disease (Davis, 2009).

B. Contributing Risks in Spray Parks

Even though drowning is less likely to occur in spray parks, there may still be pathogens and bacteria similar to a swimming pool that pose a risk to users. Children are the main contributors to illness in spray parks as most of them are still wearing diapers. Children who have diarrhea are not allowed in spray parks, and if they wear a diaper, they should be changed regularly to prevent the spread of disease agents (Knox, 2009). Some bacteria that can be found in spray park water and the environment are *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*. Parasites can also contribute to outbreaks in spray parks, and the two most commonly found are *Cryptosporidium* and *Giardia*. These causative agents end up in the water system of spray parks in various ways. Animals in the surrounding area can contribute to illnesses by releasing pathogenic organisms in their feces (such as birds and dogs and wildlife). Canada goose droppings, collected in parks to which the public had access, were screened for a range of bacteria that could be pathogenic in man (Bishop *et al*, 1999). These organisms may also be introduced to the pool from sick swimmers who unknowingly defecate in the water. Warm-blooded animals such as dogs or deer can contaminate the area along with contaminated soil tracked in by swimmers can cause more problems (Arko, 2008). Since
spray parks are connected to the municipal water system, there can also be a risk of sewage contamination or cross contamination of unsanitary water. In a large outbreak of gastrointestinal illness at Crater Lake National Park, in June-July, 1975, approximately 100,000 persons were exposed to sewage-contaminated water (Koplan et al 2009). Outbreaks related to recreational waters usually reflect deficient control of the system: a low level of disinfectant, or the use of an inappropriate disinfectant, insufficient maintenance and cleaning of the installation, higher than recommended usage, and failure of the disinfectant dosage system (Domenech Sanchez et al, 2008). Therefore it is vital to have an effective recirculation system, which includes filtration installed into water parks.

There are many strains of *Escherichia coli* (*E. coli*) some of which are commensal and others that cause illness. Some *E. coli* can cause diarrhea, while others cause urinary tract infections, respiratory illness and pneumonia (CDC, September 2008). The most commonly found bacterial strain of *E. coli* is the Shiga toxin producing form (*Escherichia coli* 0157:H7), and this form is mostly identified in North America (CDC, September 2008). One notable outbreak of *Escherichia coli* 0157:H7 in British Columbia occurred in July 2004, the first Canadian outbreak associated with a children’s water spray park (PHAC, 2005). It had started with a nationally distributed beef product, being suspected but further investigation lead to the spray park as the source. There were eight confirmed and two probable cases, seven cases were children (70%), ranging from 2 to 9 years of age, the remaining three cases (30%) were adults, ranging from 20 to 35 years of age (PHAC, 2005). All cases reported having diarrhea (80% bloody diarrhea), additional symptoms included nausea and vomiting (60%), abdominal cramps (50%), and fever (30%), over half of cases were hospitalized (60%), and in one case hemolytic uremic
syndrome subsequently developed (PHAC, 2005). Several children had attended a children's festival in the city in the week before their symptoms began. On re-questioning these cases, it was discovered that the children had played in a water spray park adjacent to the festival. When all cases were questioned, a total of six of the seven children and all three adults identified in the outbreak had a history of exposure to water in the spray park (90% of all cases) (PHAC, 2005). The spray park was inspected and a structural problem was identified- an overloaded and blocked storm sewer - to be the most likely contributing factor to the outbreak. This resulted in wastewater backing up onto the surface of the spray park and surrounding lawn, creating standing water in which the children played. As reported in other outbreaks, inadequate disinfection may also have played a role because of the falsely elevated readings on the spray park's test kit for free chlorine residuals (PHAC, 2005). After closure of the spray park, recommendations were made such as wastewater from the park would be discharged to the main sanitary sewer for disposal; replacement of the test kit for detecting chlorine free residuals; maintenance of the residual chlorine level at 2 ppm; regular submission of water samples for bacteriologic analysis; development of a procedural manual to outline system operation and maintenance for staff; and improvement of documentation of operations, maintenance, and incidents (PHAC, 2005). Having been the first outbreak related to a spray park, the health unit took these measures in changing the inspection practices for spray parks to prevent another outbreak from happening again.

During 2005–2006, a total of 78 outbreaks were identified, affecting 4,412 people and resulting in 116 hospitalizations and five deaths (MMWR, May 2009). The two main parasites detected in spray parks were *Giardia* and *Cryptosporidian*, which cause
gastrointestinal illnesses similar to illness caused by *Escherichia coli*.

*Cryptosporidian* is a communicable disease transmitted by the fecal-oral route and results in the ingestion of the protozoa *Cryptosporidium* oocysts through the consumption of fecally contaminated water or food or through person-to-person, or animal-to-person transmission (CDC, June 2010). Symptoms of infection include watery diarrhea, stomach cramps, and fever followed by dehydration over a period of several days. Preschoolers and people with immune system deficiencies are particularly vulnerable (Knox, 2009, p.50). Even with the right chlorine treatment, parasites are often resilient to destruction. Filtration is the method that captures parasite cysts and oocysts.

Over the last five years there have been numerous outbreaks of *Cryptosporidium* in North America. One major outbreak occurred in August 2007, when Idaho's Central District Health Department (CDHD) received a complaint of several ill persons with watery diarrhea consistent with cryptosporidiosis after attendance at a municipal splash park on July 26 (CDC, June 2009). The splash park was located within a municipal park in a suburban community. Unfortunately, in Idaho’s splash park design, construction, and operation are not government regulated. An investigation revealed five immunofluorescence assay (IFA)-confirmed and 45 clinically compatible cases of cryptosporidiosis among 154 persons interviewed (32% attack rate). Water samples collected from splash features and an adjacent drinking fountain tested positive for *Cryptosporidium hominis* (CDC, June 2009). This outbreak could have been prevented if there were municipal regulations and standards for splash parks, with regular filtration, maintenance and surveillance of its water quality and equipment.

In a study in Utah, the Utah Department of Health (UDOH) received 1,902 case
reports of laboratory-confirmed cryptosporidiosis during June--December 2007, compared with an annual median of 16 reports of laboratory-confirmed cases (range: six to 20) during 2002—2006. All 1,902 cases met the outbreak-related case definition (CDC, 2008). The median age of these cases was 9 years old. Of 1,506 patients for whom data were available, 1,209 (80%) reported exposure to a total of approximately 450 recreational water venues within 14 days before illness onset (CDC, September 2008). The patients were from 12 health units all across Utah. Most of these patients (90%) reported exposure to treated recreational water venues; approximately one third of patients (33%) reported exposures to multiple recreational water venues (CDC, September 2008). A contributing factor to the outbreak may have been visitors who attended the water facility who had diarrhea, a failure in water treatment, environmental factors, or water cross contamination. Since this outbreak, the UDOH has placed control measures such as advising the public not to swim while ill with diarrhea, hyperchlorination of recreational water venues, and communication with health care providers to request increased Cryptosporidium testing. Intensified measures were then implemented such as banning children less than the age of 5 or anyone needing a diaper while using the facility, and the posting of educational signs about healthy swimming and water-borne diseases (CDC, September 2008). The cryptosporidiosis incidence rate decreased after implementation of these intensified control measures.

In August to September 2004, a cryptosporidiosis outbreak affected more than 250 people who visited a California water park (Arrowood et al, 2007). The cause of this outbreak was improper monitoring (record keeping of water quality), maintenance of the waterpark, and Cryptosporidium oocysts in sand and backwash from the water slides
filter. Employees and visitors of the water park were affected, and some admitted that they attended the water park with diarrhea. The median illness onset date for waterpark employees was 8 days earlier than patrons, a case control study determined that getting after in one’s mouth was associated with the illness (Arrowood et al, 2007). This outbreak may have been prevented if proper filtering methods were in place, because people with diarrhea would still likely use the facilities.

Another parasitic illness that can be found in spray parks is giardiasis, which also is capable of producing gastrointestinal illness. This flagellated protozoan causes a generally self-limited clinical illness typically characterized by diarrhea, abdominal cramps, bloating, weight loss, and malabsorption; asymptomatic infection also occurs frequently (CDC, 2010, Giardiasis). It has the same route of transmission as Cryptosporidium. Persons at increased risk for infection include children in child care settings, close contacts of infected persons, persons who ingest contaminated drinking water, persons who swallow contaminated recreational water (e.g., water in lakes, rivers, and pools), persons taking part in outdoor activities (e.g., backpacking or camping) who consume unfiltered and untreated water or who fail to practice good hygienic behaviours (CDC, 2010, Giardiasis). Of all the ways to contract this illness, water is mentioned more often than any other risk. Cryptosporidium was responsible for the majority (61.8%) of the gastroenteritis outbreaks from treated venues, while Giardia accounted for only a small portion (2.6%) of these outbreaks. One outbreak (1.3%) reported both Cryptosporidium and Giardia as the causative agents (Einstein et al, 2008). Even though the percentage of outbreaks of Giardia is significantly lower, there is still a chance of it occurring; this is due to the fact that Giardia is easier to treat than Cryptosporidium.
There is a prevalence of *Giardia* in fecal material in pools and documented transmission of *Giardia* infection among diapered children who use swimming venues regularly, this seasonal variation also has been noted in state, Canadian provincial, and previous U.S. national surveillance data for giardiasis and cryptosporidiosis (CDC, 2010, Giardiasis). The age group most affected by these diseases are 1-9 years old. This is a great cause of concern because of their underdeveloped immune systems.

**C. Measures to Minimize Risks**

Waterborne outbreaks occur because of insufficient treatment of the water and failure of the filtering methods used in the spray parks. Children are a notable contribution to the spread of the disease because toddlers wear their diapers while they are using the spray park facilities. To prevent outbreaks, by capturing cysts and oocysts, a filtration system needs to be in place. Oocysts require a more extensive filtration system because they are more resistant to disinfection than cysts. Vegetative cells are the easiest to destroy because disinfection is a successful treatment.

Vegetative cells are bacterial cells that are capable of multiplying, unlike cysts and oocysts. *Escherichia coli* grow at a fast rate, its vegetative cell multiply and produce toxins in the intestinal tract to cause illness (Characteristics of Escherichia Coli, 2008). These cells can easily be destroyed cooking, but can survive at freezing temperatures. In spray parks, the best method of treatment of vegetative cells is the chlorination of the water. Some of these barriers for *Escherichia coli*, such as milk pasteurization and water chlorination, protect the bulk of the population effectively (Pennington, 2010). Bacteria can be treated by chemicals but parasites in recreational water require physical treatment.
Oocysts are shed in the feces, and have a hard shell to protect in the environment. Once ingested, the oocyst splits open, releasing sporozoites, these sporozoites invade the lining of the gastrointestinal tract. In the oocyst stage, Cryptosporidium is extremely resistant to disinfection; current disinfection levels have virtually no effect on the oocyst (MDNR, 2010). Preventing the oocyst from entering the microfiltration water system by means of filtering is currently the only effective treatment. In the case of the cryptosporidiosis outbreak in Idaho in 2007, the cause of the outbreak was attributed to the failure of water treatment filtration devices, and was unable to capture the oocyst. The outbreak described in this report involved a recently constructed, unregulated splash park, with contributing factors related to design and operation that prior consultation with health department staff might have identified and corrected (CDC, 2009).

Cysts are easier to treat than oocysts because they can be destroyed by effective chlorination, but there is still a need for a filtration system to physically remove them. Ingested by the host animal, the cyst develops into the adult protozoan life stage and attaches itself to the wall of the small intestine at the outlet of the stomach, there it reproduces cysts, which can develop and infect other hosts (Robillard et al, 2001). Removing Giardia cysts before they reach the tap usually involves disinfection to inactivate the cysts and filtration through a fine media to physically remove the cysts from the water, because Giardia cysts maybe resistant to normal disinfection, filtration is usually required (Robillard et al, 2001).

Filtration is a process of separating suspended particles from the fluid through a porous material in which the fluid can pass while the suspended particles are retained. Therefore, a proper system will help in the prevention of these outbreaks. One of the
defining qualities of Cryptosporidium oocysts, and a major reason it is so hard to control, is its size: 4 to 6 microns, for perspective, there are about 25,000 microns in an inch (Clark, 2007). The other critical quality is its resistance to chlorine. The result is a durable, microscopic parasite that necessitates a high level of filtration-ultrafiltration to remove particles to 1 micron-and a water-sanitizing system such as ozonation or ultraviolet light (Clark, 2007).

A popular growing method to destroy pathogens instead of using chemicals is ultraviolet light (UV light), a type of radiation. UV light is considered a viable treatment technology because it has been shown to effectively inactivate pathogens, while forming limited disinfection by-products (Slawson and Zimmer, 2002). UV light can be applied not only to water, but fresh produce, hospital equipment, and more. Low-pressure mercury UV lamps have traditionally been used in water treatment (Slawson and Zimmer, 2002).

Educating on the prevention of recreational waterborne illnesses is also a key factor. Signs and notices should forewarn visitors about the proper use of the facilities and how to prevent contamination of the water. In a study of modern water parks, play features that were tested and those designed for young children and babies were found to harbour the most bacteria (Davis, 2009). Fecal indicators were found frequently as well as skin indicators, Staphylococci aureus.

D. Introduction to Study

Problems with spray parks continue to increase. Water is mainly treated by chlorination, but such pathogens such as Cryptosporidium cannot be killed off by this
chemical. After an outbreak of *Cryptosporidium* at a splash park in New York during the summer of 2006, the state mandated the use of UV (ultraviolet) for all public splash park facilities (Arko, 2008). In order to decrease the levels of bacteria, viruses, and parasites in spray parks, the treatment of water is the last line of defence, so the best method is to have chlorine to kill bacteria and viruses and another method, such as filtration to capture cysts and oocysts. To determine the best method of filtering, a comparison of two splash and spray pads, each with different filtering methods and water systems were made. Water quality parameters and contributing environmental factors were also noted.
II. Methods

A. Outline

During the summer of 2010, a field study was conducted based on the circulation systems of splash and spray pads in the Regional Municipality of York. The focus of the study was to compare two different systems and analyze which of the two was more effective in destroying bacteria.

For the study, two types of splash and spray pads were selected; a fill and dump splash pad and a recirculating spray pad. Both facilities were located in the town of Whitchurch-Stouffville. The Town of Whitchurch-Stouffville is located in the east central York Region, 24 kilometres north of Metropolitan Toronto. It is comprised of smaller communities, and offers a unique country environment in the Greater Toronto Area. The landscape of Whitchurch-Stouffville consists of fertile rolling farmland, scenic ravines, kettle lakes and forested highlands (Town of Whitchurch Stouffville, 2010). Wells are predominantly found in this area, as well as private small drinking water systems. Both types of splash and spray pads are close in proximity. The first splash and spray pad is at Hoover Park, which is situated in a middle class suburb with many amenities nearby including schools and a shopping plaza. Hoover Park’s water supply comes from a municipal water line and is connected to a fill and dump system, which disposes water straight to waste after use. The second splash and spray pad is located in Cedar Beach Park which is privately owned. This splash pad has a recirculating system and is located in a trailer park resort only accessible to residents or incoming visitors with reservations. It is in a gated resort, which is connected to a small drinking water system. The area is located in a rural setting, and is situated on the sandy shore of
Musselman’s Lake. People of all ages flock to the resort especially during the summer season.

**B. Materials**

The materials used were:

- Taylor Swimming Pool Test Kit Model K-2005C (for recirculating system only)
- Six water bottles (200ml each) coded per site per sample day
- Field data Sheet
- HACH Turbidimeter Model 2100P (calibrated before use)
- Thermometer (calibrated before use)
- Cooler (4.5 litre size)
- 2 Ice Packs
- Ministry of Health and Long Term Care Laboratory Requisition Forms for Bacteriological Analysis of Water per site per sampling day
- HACH Chlorine (Free and Total) Pocket Colorimeter II Kit Cat No. 58700-00 (for fill and dump system only)

**C. Process**

The study and water testing of each splash and spray pad occurred between July 13, 2010 and September 2, 2010. A field data sheet was developed prior to this study and used on each sample day. The field data sheet recorded air and water temperature, general condition of the area (example, weather and condition of water devices), chemical parameters (pH, free available chlorine, etc.), as well as the number of bathers and animals present (Refer to Appendix A). Each facility had a different number of spraying devices (water park equipment); as a result, only six devices for each site were sampled. A total of six bottles were used for each facility, and these bottles were coded (Refer to appendix B). Codes were assigned to specific devices for the duration of the study for comparability. Prior to obtaining water samples, laboratory forms were
completed and bottles were coded according to site and device (Refer to Appendix C for sample).

Sampling occurred Tuesday afternoons, with Thursday afternoons as an alternate if necessary. The alternate data was used in the last week (week 8) of testing as no one was able to test Tuesday of that week. The splash and spray pad at Cedar Beach Park connects to a swimming pool, and shares one recirculating circulation system. The field data sheet was completed including questions about the general condition of the facility and weather at the time of sampling. Using the Taylor swimming pool test kit, pH, Free Available Chorine, Total Alkalinity, and Total Chlorine were all tested. Instructions provided with the test kits were followed. Since the facility is connected to an outdoor swimming pool, cyanuric acid was included in the testing. Using the Turbidimeter, water clarity was measured in NTU (Nephelometric Turbidity Units). Afterwards, the thermometer was placed in ponding water to record the temperature of the water coming out of the devices. Following this, devices were sampled according to its code and the device to which it was assigned. Water samples were collected according to the Public Health Inspector’s Guide to the Principles and Practices of Environmental Microbiology (OAHPP, March 2010, pg.15). The water bottles were filled up to the 200ml mark, making sure not to overfill, and then closed tightly (PHI GUIDE, 2010). Filled bottles were then deposited in a brown paper bag labelled Cedar Park, and then placed into the cooler with frozen ice packs. Delivery of the bottles would not occur until the next day; therefore the cooler was placed in a refrigerator overnight at a nearby health unit. The next day, they bottles were delivered by the public health beach students, along with their beach water samples, to the Ontario Ministry of Environment and Energy Laboratory.
located in Etobicoke. Results were faxed to the Newmarket public health unit the following day.

When sampling took place in Hoover Park, the same steps were followed with the exception of using the swimming pool test kit. Instead, the Free Available Chlorine kit was used to detect the free available chlorine and the total chlorine in the water. Instructions found within the kit were followed carefully. This was due to the type of system of the splash and spray pad, which was a fill and dump system and it was not connected to a swimming pool. Reagents that were not tested were pH, Total Alkalinity and Cyanuric Acid because of the type of system being used.

The following day prior to receiving results, the information on the field data report was entered into a computer (Microsoft Excel Worksheet). Bacteriological Analysis of the results received from the Ontario Ministry of Environment and Energy Laboratory were charted. For *Staphylococcus Aureus* (*Staph A.*), if more than 200 colonies are found, 10 black colonies are chosen at random to subculture for *Staph A.* The colonies that were found to be negative for *Staph A.* were *Presumptive Total Staphyloccoci*. By comparing the levels of bacteria, and the environmental factors, an analysis was made, which is further explained in results and discussions.
III. Results and Discussion

The field data retrieved was graphed by week and sampling day to compare the two types of splash and spray pads.

The Bacteriological Analysis of Water results showed low levels of bacteria. There were only trace amounts of *Escherichia coli* (*E. coli*), but higher counts of *Presumptive Total Staphylococci (PTS)*, *Total Coliforms*, and *Heterotrophic Plate Counts (HPC)*. The focus of the results was mainly on *PTS*, as these counts were the highest among the three. This bacteria is indicative of whether or not the bather load and disinfection of the system is functioning properly (P. Boleszchuk, Personal Communication, April 7 2011). Therefore, if the results for *PTS* are high, then this could indicate a problem with the maintenance of disinfection. According to Boleszchuk, (Manager Enteric, Environmental, Molecular Surveillance and S.T.I at the Ontario Ministry of Environmental Health Laboratory), a count of *PTS* of >200 cfu/mL indicate deteriorating water quality in the splash and spray pads.

He further added that the interpretation of *PTS* in splash pad water is the same as for swimming pool water. As seen in Figure 1, Hoover Park had an alarmingly high count of *PTS* during week 7, from device YWSH6, which is the stream jet that comes from the ground. With a high count of 2000 cfu/100mL, and a HPC of 80 cfu/mL for this device, there is a cause for concern.

According to the OAHPP PHI Guide, An HPC >500 cfu/mL in a distribution system or other treated water is indicative of poor water quality and possible problems with the disinfection procedure, and for recreational water, it is recommended that public swimming pools that not more than 15% of samples collected during any 30 day period
shall have an \textit{HPC} count of <200 cfu/mL (PHI Guide, 2010). \textit{HPC} counts are used to assess the general microbiological quality of drinking water, since it is found in food, soil, and water, it is a naturally occurring bacteria; but studies are ongoing as to how harmless this bacteria can be to humans (Pavlove \textit{et al}, 2004).
Figure 1

Hoover Park Device vs Presumptive Total Staphylococci each week

Week

0 1 2 3 4 5 6 7 8

YWSH1
Blue Elephant
YWSH2
Green Elephant
YWSH3
Water Rainbow
YWSH4
Water Tree
YWSH5
Ground Spray Ring
YWSH6 - Ground Jet Spray

cfu/100ml

0 500 1000 1500 2000 2500
In Figure 2, the graph presents inconsistent counts of HPC for weeks 3 and 7 for Hoover Park. The result is within the guidelines for recreational water, but the spike in the graph in Week 7, could have been explained by the high count of PTS. In Figure 3, the bather load for Hoover Park in Week 7 was low at the time of sampling; hence, this does not explain the high counts of HPC and PTS. However, the bather load was recorded at the time of sampling, and could have been higher earlier in the day. In Figure 3, the numbers of bathers is graphed each week per sampling site. Hoover Park generally has a higher volume of bathers because it is located in a public park, while Cedar Park has a lower number of bathers because it is a private facility.

The next factor to examine is the maintenance of the disinfection or water system as well as the quality of the water.

![Heterotrophic Plate Count](image)

*Figure 2*
In Figure 4, the temperature of the water for Hoover Park is seen to be lower than Cedar Park, averaging about 15 degrees Celsius for the whole study. The water was colder, allowing bacteria to grow at a slower rate than water at room temperature. In Week 7, the water temperature for Hoover Park was 18 degrees Celsius, higher than normal. It is more common for water that is warmer to have a higher amount of bacteria because they can easily multiply in these conditions, especially if it is at room temperature. Bacteria grow between 4 to 60 degrees Celsius, so both parks have these bacteria breeding conditions. If temperature was a factor for bacterial growth, there might have been bacterial levels much higher at Hoover Park.

Hoover Park splash and spray pad is a fill and dump water system. This means that the water that leaves from the spray park is drained into a tank that makes its way to the wastewater treatment plant for proper treatment. The amount of available water will influence park design, so consider tapping into the municipal water supply and draining used water into the sewer (Snider and Assoc. Inc, 2009). Hoover Park does not have
regular maintenance for the disinfection system; municipally disinfected tap water just fills into a tank and is then dumped.

![Water Temperature per sampling week](image)

**Figure 4**

The main factor that may have contributed to the high count of *PTS* in the water was water device YWSH6 that is located on the ground, and spray water. High count of *PTS* from YWSH6 could result from water that had touched users and surfaces and then fell down to contaminate the device. One might conclude that the ground spray devices have a greater chance of contamination as opposed to other devices that spray from fixtures.

*Total Coliforms* are indicative of a contaminated water supply, they can occur naturally in soil or decaying vegetation, but may also be associated with human or animal fecal contamination (PHI Guide, 2010). The allowable level of *Total Coliforms* is <2 cfu/100mL. For Hoover Park, each week the results for Total Coliforms were mainly 0 cfu/100mL or <2 cfu/100mL, suggesting that this count was not a cause for concern. Cedar Park on the other hand had a high *Total Coliform* count on August 10, 2010 (Week
5). It was one of the hottest days of summer with the air temperature reaching 30 degrees Celsius at the time of sampling, and rainfall measured at 18.8mm within the last 48 hours. It was also noted that the temperature in week 5 was the hottest recorded out of the 8 weeks during this study for Cedar Park. The number of bathers recorded that day in week 5 was 14, which is higher than normal at this facility (refer to Figure 3). In Figure 5, it can be shown that sampling device 6 (YCP6), had the highest count of *Total Coliforms* and *PTS*.

The type of splash and spray pad for YCP6 device was also a ground spray pad, water sprayed directly from the ground at a high pressure. This revelation relates to device YWSH6 from Hoover Park, both being ground devices and having high counts of *PTS*. Although Cedar Park is a gated facility, free from grass and soil, bathers that entered the facility may not have showered prior to use of the park.

![Cedar Park Week 5 Device vs Total Coliform and Presumptive Total Staphylococcus](image)

*Figure 5*
The pool is tested daily to ensure that the chemicals in the water is balanced, this includes pH, cyanuric acid, Total alkalinity, Total Chlorine and Free Available Chlorine (FAC). According to the Field Data Sheet from week 5, pH was 7.2, FAC was 3 ppm, Turbidity at 1.23 NTU, Total Chlorine was at 1.5 ppm and Cyanuric acid was below 30 ppm. These results in water chemicals do not show a risk for reduced water quality. In Figure 6, shows two devices in week 5 that have high counts of PTS, one already mentioned was the ground spray pad (YCP6), and the other YCP4, which is the short water tower, accessible to children who may have touched it.
As mentioned before, *PTS* can either be indicative of the bather load or the maintenance of the disinfection system. For this case, the high count was most likely due to the higher number of bathers in Cedar Park. Even though the operators appeared to show great concern for maintenance, they are not under surveillance at all times, so it is never certain how well the recirculating system is being looked after. However, the high count of bacteria is similar to that of Hoover Park because both devices are ground spraying devices. The problem could be that devices from the ground collect more debris and foreign particles, before draining. Children also kick dirt around the splash and spray pad area, as well, used band aids and litter can sometimes be found in the spray area. Maintenance and environmental factors may not be the problem, but rather the type of splash and spray pad device.

In *Figure 7*, Free Available Chlorine (FAC) was charted in parts per million (ppm) every week for each splash and spray pads. It can noticeably be seen that Cedar Park has a higher amount of FAC because of its recirculation system. According to Regulation 565 of the Health Protection and Promotion Act (HPPA), there must be a residual of free available chlorine in every part of the pool of not less than 0.5 milligram per litre. The level of FAC in Cedar Park meets the standards from the HPPA. However, since it is an outdoor pool, cyanuric acid is usually recommended. “Where cyanurate stabilization is maintained, there is a residual of free available chlorine of not less than one milligram per litre in association with a cyanuric acid concentration of not greater than sixty milligrams per litre” (HPPA, Regulation 565). Cedar Park meets these criteria, as seen in *Figure 8*, with the level of cyanuric acid consistently around 30 ppm, and FAC at 3 ppm. On August 3, 2010, during week 4 when water parameters were measured in Cedar Park, the
air temperature was 26 degrees Celsius, and mostly cloudy, with only a small amount of rainfall in the last 48 hours. The number of bathers that day was higher than usual, with a count of 19.

**Figure 7**

**Figure 8**
Hoover Park had a lower level of FAC shown in Figure 1, to be expected since it is not a recirculating system, but a fill and dump system has water at the end of the day that goes directly to waste. The amount of chlorine cannot be higher than the municipal water system since there is no additional source of chlorine.

![Turbidity Graph](image)

*Figure 9*

Turbidity refers to the clarity of the water. Suspended solids contribute to turbidity and can come from dirt and particles brought in by bathers or by chemicals added or from the air (Design Guidelines for Drinking Water System, 2008). In *Figure 9*, Hoover Park had regular levels of turbidity, averaging around 1.3 NTU. On the other hand, Cedar Park has increased to 2.2 NTU in week 7 which is in correlation with a higher than normal *PTS* count. On this day of sampling, certain factors could have contributed to the rise of NTU, but looking at the Field Data report, nothing seems out of the ordinary. The temperature of air was 24 degrees Celsius, and water temperature was 20 degrees Celsius, with no rainfall for the last 48 hours, and only 4 bathers were sighted during sampling time, although it is not known how many bathers might have used the facilities earlier.
During this study, both spray parks functioned properly and met the standards for recreational water and non-regulated water.

The main finding was tracing the elevated counts of PTS to the devices that were found spraying from the ground. In the Public Health Inspector’s Guide to the Principles and Practices of Environmental Microbiology, PTS is not mentioned. For Cedar Park, YCP6, the ground spray pad, had the highest count of PTS during the sampling study, while for Hoover Park it was YWSH6, which is also a ground jet spray from the ground. This suggests that devices from the ground probably accumulate more debris and contamination. If the device sprays contaminated water onto children this could be considered a potential health risk.

Contamination levels could not be correlated with weather conditions or chemical parameters.

There is a need for further ongoing study. This is the first year that the Region of York has completed this type of study on splash and spray pads. One summer of sampling is inadequate to make definitive conclusions. Better cleaning of ground spray devices could be put into place, as more levels of PTS and debris such as band aids and other foreign materials were found on the ground. Further study between turbidity and bacterial levels might be undertaken. It is easier and quicker to do a field test for turbidity than for the lab to test for bacteria. The findings for this study could have also been contributed by maintenance of the spray parks or lack thereof, as this was not observed.

In conclusion, the comparison of splash and spray pads for a recirculating system and a fill a dump system did not present many findings. Ground spray devices need to be
further examined as they can capture bacteria and expel contaminated water, but this is probably a minor hazard.
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Town of Whitchurch-Stouffville An Ideal Location. 2010.

Appendix B

Splash and Spray Pad Codes for Lab Forms

**Hoover Park Bottles**

YWSH1 – Blue elephant
YWSH2- Green elephant
YWSH3- Water Rainbow
YWSH4 – Water Tree
YWSH 5 – Ground Spray Ring
YWSH 6 – Ground Jet Spray

**Cedar Park Bottles**

YCP1 – Water Arch Bar
YCP2- Water Arch
YCP3- Tall Water Tower
YCP4 – Short Water Tower
YCP5 – Ground Jet Spray
YCP6 – Ground Spray Pad