

The Clean Streams Project:
Tributary Sampling for *E. coli* in Allegheny County:
Toms Run, Squaw Run, Streets Run, Saw Mill Run and Pine Creek

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3 RIVERS 2ND NATURE

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Abstract

The 3 Rivers 2nd Nature project conducted watershed sampling in 5 watersheds with a primary interest in *E. coli*: Five watersheds: Toms Run, Squaw Run, Streets Run, Saw Mill Run and Pine Creek were selected to provide a variety of conditions of watershed size, stream order and relative percentage of development. The goals of this sampling program were to develop a low-cost strategic testing program that will identify substandard water quality as well as the likely sources of impairment. We present this as the first step to a regional water quality monitoring program.¹ The sampling plan was designed to determine if these watersheds meet the ORSANCO *E. coli* standard by sampling 5 times within a 30-day period and based on geographical information system databases for sample site selection. Sampling was performed regardless of weather to keep within the 30-day period. The USEPA approved Colilert *E. coli* methodology was used to enumerate *E. coli* because of its relative analytical ease, relative rigor and possible application with community and watershed groups.

Only 4 sampling locations out of all of the watersheds met the monthly geometric mean standard of 130/100ML for a minimum of 5 samples/month: Streets Run Locations STE and STD (STD affected by low pH and mine drainage); Saw Mill Run Location 16F, also affected by mine drainage; and Toms Run Location 4C, although only 4 samples were taken and does not meet the minimum 5 samples/month.

Squaw Run and Pine Creek were sampled during rain events. The wet weather *E. coli* results for Squaw Run increased to 10³ or 10⁴ MPN/100ML at all sites. The 3R2N macroinvertebrate study undertaken in 2001 indicated that Squaw Run is moderately impaired. This level of *E. coli* concentrations (10³ or 10⁴ MPN/100ML) would indicate a human source of fecal contamination, rather than animal runoff.

Wet weather also impacted Pine Creek. The lower end of Pine Creek at 18A and C and West Little Pine Creek were most affected by the rain events, reaching *E. coli* concentrations of 10⁴. This is not surprising due to sewer problems in these areas, including obvious sanitary sewer overflows. Other locations had increased *E. coli* concentrations during the rain events, though sources cannot be confirmed.

Overall, each watershed, except for Toms Run, had locations with high *E. coli* concentrations. Wet weather dramatically affected Squaw Run and sites along Pine Creek. These *E. coli* impacts warrant further investigation.

¹ The rationale and organizational strategy for a regional water quality program is spelled out in the regional water policy report which accompanies this document, "Where the Three Rivers Converge: Unassessed Waters and the Future of EPA's TMDL Program – A Case Study, by William V. Luneburg, for 3 Rivers 2nd Nature.

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I. INTRODUCTION

3 Rivers 2nd Nature is a 5-year research project within the STUDIO of Creative Inquiry at Carnegie Mellon University. Interdisciplinary teams have been assembled to study the Allegheny, Monongahela and Ohio Rivers, their riverbanks and tributary streams throughout Allegheny County. A water quality component of the project analyzed the rivers and streams for pathogen indicators of fecal pollution, as a measure of recreational opportunities in the county. Overall, the results indicate that many of the streams are contaminated with fecal pollution (3R2N Water Quality Reports 2000-2003 are available online at <http://3r2n.cfa.cmu.edu>). However, the sampling protocol only allowed for the sampling of streams just above the confluence with (and influence of) the rivers. With 59 streams sampled, no watershed sampling was done beyond this one sampling location. Additional macroinvertebrate sampling was performed at similar locations along each stream.

With the streams providing significant public access and recreational opportunities as they flow through parks and neighborhoods, it becomes an important task to gather more information on the water quality issues, that may affect public health amongst users of streams in Allegheny County. Regulatory agencies have not been able to fill the void of knowledge on this subject. Thus many watershed, community and school groups have begun to collect data, but their tools and resources are minimal and expertise many times lacking. With no one organization taking an interest in this aspect of water quality, data needs will continue to go unfulfilled.

Goals

The goals of the 3R2N Clean Streams program, as it is relevant to this report, are 1. to develop a low-cost strategic testing program that will identify substandard water quality as well as the likely sources of impairment, and 2. to begin a regional water quality monitoring program that will enable cost-effective remediation and ongoing monitoring rather than costly legal action.

The objective is to develop a strategic program of sampling and analysis which is replicable, targets public health and is available to community and watershed groups.

To meet the goals and objectives, an analysis of the Geographic Information System (GIS) for each watershed was undertaken as outlined in the report, by Lee and Toonkel "Urban Stream Impact Protocol: A Methodology for Assessing Water Quality and Source Determination." A simple protocol was developed that is intended to give interested parties the resources and information needed to assess the water and environmental quality of their watersheds. GIS is a computerized system that visually places data in relationship to mapping. Information, such as land use and soil type, can be layered on a map to understand the relationships between these various factors.

The protocol uses GIS mapping of a watershed with the following layers of information: land use including mining, housing density, topography or slope, land imperviousness, and industrial and sewage outfalls. These layers of information may help determine sampling locations based on potential sources of pollution. For example, housing density and land use can indicate where runoff is likely from roads, parking lots, or golf courses which may cause high levels of pesticides, fertilizers, oil and litter in the watershed. The referenced report describes each layer in detail. Since GIS software is prohibitively expensive and technically challenging, each of the five maps of the 56 watersheds will be available in a adobe.pdf format on the 3R2N website (<http://3r2n.cfa.cmu.edu/>). This allows access of the maps by various community groups to begin to analyze their neighborhood watersheds.

Watershed Selection

The 3R2N project team sampled five watersheds from July to September 2003 in order to test this mapping protocol and develop a more comprehensive database for these watersheds. In order to select five watersheds for sampling from 56 watersheds analyzed with GIS, three factors were initially considered: stream order, watershed area, and a development ratio (Lee and Toonkel, 2003). Watersheds with varying size, stream order and development were selected to test the protocol in various types of watersheds. Additional criteria considered were that the travel distance to and from Carnegie Mellon University be less than an hour, that the entire watershed boundary be located within Allegheny County to utilize comprehensive GIS databases, and that the access to the watershed be safe and feasible by car. The following 5 watersheds were selected for field sampling: Toms Run, Saw Mill Run, Street Run, Pine Creek, and Squaw Run.

- Toms Run is located in the western part of the county, in Kilbuck Township. It meets the Ohio River near the former Dixmont Hospital along Route 65. This watershed was selected because of its small area - 1,448 acres, undeveloped watershed with a built ratio of 1. It is a second order stream with 1% impervious surface.
- Squaw Run is located in O'Hara Township – Fox Chapel area. It meets the Allegheny River near the intersection of Freeport Road and Fox Chapel Road. This watershed was chosen because of its larger area – 5,472 acres, and undeveloped, low-density housing land use pattern with numerous parklands and a built ratio of 1. It also has easy access to Route 28. It is a third order stream with 3.5% impervious surface.
- Streets Run is located in the City of Pittsburgh, West Mifflin, Baldwin, Whitehall, and Brentwood. It flows into the Monongahela River near the Glenwood Bridge next to Sand Castle water park. It is similar in size to Squaw Run watershed, 6436 acres, yet development in the upper watershed consists of high density housing. It is a third order stream with 10% Impervious surface. 3R2N studies have indicated fecal pollution problems at the lower end of the stream.

- Saw Mill Run is located in several municipalities including the City of Pittsburgh, Castle Shannon, and Whitehall. It has a larger watershed (12,431 acres) than Squaw Run but has more development with a built ratio of 5. It is a second order stream with a 17.5% impervious area. The main stem flows along the Route 51-Saw Mill Run Blvd business corridor and Route 88. It has a very high housing density and large areas of impervious surfaces. It has numerous combined sewer overflows along the main stem. Sewer upgrades and flood control levies have been built to address some of the chronic problems in the watershed. It also has easy access from Routes 51 and 88.
- Pine Creek is located in several municipalities including Schaler, O'Hara, Ross, McCandless, Hampton, and Pine Townships, Franklin Park and Bradford Woods. It flows into the Allegheny River in Etna. It is one of the 3 largest watersheds in Allegheny County, 43,028 acres and the only one of these three that lies entirely within the county. It is a 4th order stream with a built ratio of 1 and a 5.5% impervious surface. Several sub-watersheds are relatively undeveloped or have low density housing. North Park, a major county park, lies within the watershed as does Route 8, a major business corridor and the Pennsylvania Turnpike. Access is relatively easy through many suburban streets.

Sampling Site Selection

In order for sampling to be strategic, the protocol developed by Lee and Toonkel outlines first level and second level sampling locations. The purpose of the first level priority points is to separate the stream into major zones. Points are selected along the main leg of the stream to assess the impact of sub-watersheds and potential pollution sources. It is suggested that the first level priority points be limited to quickly assess the most impacted zones of the watershed.

Second level priority points isolate specific sections of the main stem of the stream that may be more impacted and also sample sub-watersheds that may be impacting the stream. With the GIS information, more specific pollution sources can be isolated with sampling points. Third level points can be chosen to further assess impacted areas and potentially isolate the pollution sources.

Initial sampling sites in the 5 watersheds were selected based on the above protocol. Sites were field-verified and adjusted based on safety and accessibility. Because of the number of watersheds tested, the short sampling period for this study, July to September 2003, and the need to sample each watershed 5 times within a 30 day period to conform to the ORSANCO's regulations for *E. coli* (the main parameter tested), the first and second priority points were sampled at the same time.

Sampling and Analysis Protocols

Since public health issues are a main concern in this study, at each location, samples were taken for *E. coli*. A multi-probe YSI 556 MPS meter was used to measure the field parameters of

pH, dissolved oxygen, temperature and conductivity. It is time efficient, and provides superior quality assurance and quality control over other methods. As a result it is an excellent match to the Colilert system.

GPS

Sampling sites were recorded by a geographical positioning system (GPS) that allowed the site locations to be downloaded into the Geographical Information System (GIS). The GPS accompanied each sampling run to verify sampling locations.

E. coli

The fecal coliform bacteria group is used as indicators of possible sewage contamination because the bacteria are commonly found in human and animal feces. Although they are generally not harmful themselves, they indicate the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoans that also live in human and animal digestive systems. Therefore, their presence in streams suggests that pathogenic microorganisms might also be present and that swimming and other forms of recreation might pose a health risk. Since it is difficult, time-consuming, and expensive to test directly for the presence of a large variety of pathogens, water is usually tested for fecal coliforms instead. Sources of fecal contamination to surface waters include wastewater treatment plants, on-site septic systems, domestic and wild animal manure, and storm runoff.

For recreational waters, fecal coliform was the primary bacteria indicator until relatively recently, when EPA began recommending *E. coli* and enterococci as better indicators of health risk from water contact. *E. coli* is a species of fecal coliform bacteria that is specific to fecal material from humans and other warm-blooded animals. Fecal coliforms are still being used in many states as the indicator bacteria, including Pennsylvania. The Ohio River Valley Water Sanitation Commission has set *E. coli* standards for the Ohio River basin of 240/100ml for any single sample and 130/100ml as a monthly geometric mean, based on no less than 5 samples per month. (ORSANCO Pollution Control Standards for discharges to the Ohio River, 2003 Revision.)

Sampling protocols were taken from EPA's "Volunteer Stream Monitoring: A Methods Manual" (EPA 841-B-97-003, November 1997). This is a comprehensive manual for stream monitoring. It was used so that community and watershed groups can reference the manual and, if desired, conduct a more detailed analysis of their watersheds.

The sampling vessel was a 100-ml plastic disposable sterile bottle from Thomas Scientific (#9853Q40) that was either directly placed in the middle of the stream for sample collection or placed in a sampling pole to collect the sample from a bridge or other location when the stream was inaccessible. The sampling pole was disinfected and rinsed after each use.

Sample bottles were labeled with the sample location, and date and placed on ice. Samples were taken directly to the laboratory at the STUDIO for Creative Inquiry where the sampling team

processed the samples for analysis. A bound log book was maintained to record the sampling times and date along with samplers' names, weather and any other noteworthy conditions. Sample information was also placed in the Chain of Custody log book used for the STUDIO for Creative Inquiry's river sampling program.

Field Parameters

Per the manufacturer's instructions, the YSI multi-probe meter (556 MPS) was calibrated daily for pH, DO, and conductivity, with the calibration information recorded in a bound log book at the STUDIO for Creative Inquiry's laboratory. Short and long-term storage was followed per the manufacturer's instructions.

The probe was placed directly into the stream to take measurements. It was then rinsed with DI water after each sample and inspected for any damage that might have occurred during sampling. The probe has an internal data logger that recorded the field parameters at each location. The data was downloaded to a database when the sampling team returned to the laboratory.

Sampling teams

The sampling team included Kathy Knauer, environmental scientist, along with Noel Hefele and Jon Toonkel of the STUDIO for Creative Inquiry. Training included sampling techniques for *E. coli* as described in the EPA's volunteer stream monitoring manual (EPA 841-B-97-003, November 1997), calibration and use of the YSI multi-probe meter, per manufacturer's instructions, and *E. coli* sample analysis following the EPA-approved Idexx defined substrate method.

For Pine Creek watershed, an additional sampling team was provided by the Environmentally Active Senior Initiative (EASI). This group already conducts sampling in this watershed.

Analytical equipment

A laboratory was set up in the STUDIO for Creative Inquiry at CMU to perform the *E. coli* analysis. All of the equipment was on loan from the Allegheny County Sanitary Authority purchased from a PADEP Growing Greener Grant. The following equipment was used:

Supplies: Quanti-Tray®/2000, sterile disposable pipettes, 100-ml plastic sterile bottle from Thomas Scientific (#9853Q40)

Analytical areas were disinfected with laboratory-grade bleach spray before and after each use. All reagents were inspected for proper expiration dates.

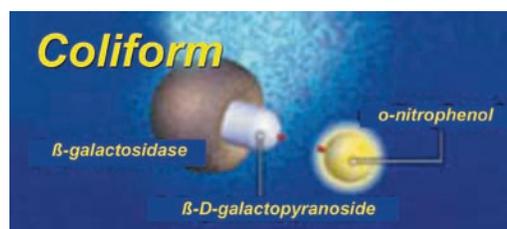
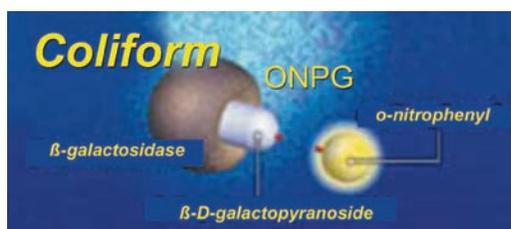
Samples were diluted with DI water that was autoclaved. All DI water batches were tested for *E. coli* and total coliform to assure no contamination was present. Autoclave dates and results were recorded in bound log books. Dilutions were performed with sterile graduated cylinders and sterile, disposable pipettes.

All of the equipment was maintained per manufacturer's instructions. The incubator was monitored for proper temperature that was recorded daily in bound log books.

***E. coli* analysis**

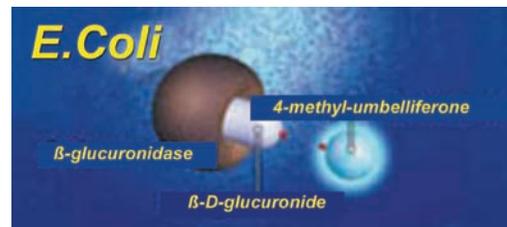
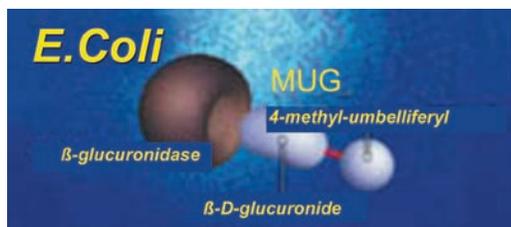
The analysis for *E. coli* followed the Colilert system of Defined Substrate Technology® (DST®) to simultaneously detect total coliforms and *E. coli*. Although both total coliform and *E. coli* were detected and measured, only *E. coli* is reported here.

Two nutrient-indicators, ONPG and MUG, are the major sources of carbon in Colilert and can be metabolized by the coliform enzyme β -galactosidase and the *E. coli* enzyme β -glucuronidase, respectively. As coliforms grow in Colilert, they use β -galactosidase to metabolize ONPG and change it from colorless to yellow (see below –obtained from www.idexx.com)



E. coli use β -glucuronidase to metabolize MUG and create fluorescence. Since most non-coliforms do not have these enzymes, they are unable to grow and interfere.

(see below – obtained from www.Idexx.com)



The few non-coliforms that do have these enzymes are selectively suppressed by the Colilert's matrix.

E. coli analysis followed Idexx procedures:

One *E. coli* nutrient reagent packet is added directly to the 100ml sterile container of sample, or diluted sample, and shaken. Samples were diluted by removing the sample from the sampling container using a sterile, disposable pipet and placing it into another sterile sampling container and adding an amount of sterile water with a 100-ml sterile graduated cylinder to bring the final volume to 100ml. When the reagent dissolves, the sample is poured into a sterile Quanti-Tray®/2000 that consists of small and large wells. The tray is then sealed by passing it through a tray sealer, and placed in a 35° C incubator (Thermolyne Type I42300) for 24-28 hours.

After 24-28 hours, the tray is removed, and under normal light, the number of yellow wells is counted as positive for total coliform. The tray is then placed in a fluorescence analysis cabinet (Spectroline® Model CM-10) with a 6-watt 365 nm UV lamp (Spectroline® E-Series Ultraviolet Hand Lamp). Wells that fluoresce yellow are counted as positive for *E. coli*. Results for both total coliform and *E. coli* were recorded in bound log books with the sample date, time tray was placed in the incubator and time and date tray was removed, and samplers names and tray readers names. A software package available from Idexx was used to calculate the most probable number of total coliform and *E. coli* per sample.

QA/QC

Each sampling run consisted of duplicate samples, field blanks, and laboratory analytical blanks. As stated above, each new batch of dilution water was tested for contamination. All of the equipment was maintained and calibrated per manufacturers' instructions and recorded in a bound log book.

II. WATERSHED RESULTS

Data for each watershed is presented in tables as well as 2 watershed maps. The first map shows *E. coli* data at each sampling site in the watershed along with land use data and the second map shows *E. coli* data at each sampling site along with slope. Both maps are to illustrate watershed conditions compared to *E. coli* data.

Toms Run

Toms Run watershed is located within Kilbuck Township along the Ohio River downstream from the Emsworth Lock and Dam. This relatively small watershed, 1,448 acres or 2.26 square miles with 1% of the land impervious. It has a simple stream order and relative undeveloped landscape. As shown on the Toms Run map, land use is primarily low density housing on the fringes of the watershed, with much of it undeveloped, steep hillsides. Near its mouth, a 4-lane roadway, Route 65, crosses the watershed. An abandoned state hospital facility known as Dixmont, sits along Route 65.

Table 1 is a summary of the data for Toms Run. Each site is listed on the Toms Run maps. Appendix A contains all of the data collected for Toms Run including field parameters. Laboratory error for the August 14, 2003 *E. coli* samples rendered the results unreportable.

**TABLE 1: GEOMETRIC MEANS OF TOMS RUN *E. COLI* DATA
FROM JULY 15 TO AUGUST 12, 2003**

Sampling Locations	MPN/100ML
4A - Toms Run	162
4BB - Toms Run	213
4C – Tributary	127
4D - Toms Run	326

All locations have 4 data points within 30 days -
5th sampling event invalid due to lab error

Sampling Dates: 7/15/03, 8/7/03, 8/11/03, 8/12/03

All data considered dry weather

Sampling locations are shown on the Toms Run maps.

- Location 4A: Lower end of Toms Run
- Location 4BB: Toms Run downstream from the confluence of the 2 upper branches, 0.77 miles upstream of 4A
- Location 4C: Tributary
- Location 4D: Toms Run

Rainfall data for the sampling dates for Tom's Run were obtained from 3 Rivers Wet Weather, Inc.'s calibrated rain fall system (<http://www.3riverswetweather.org>.) Three rain gauges were used to assess the rainfall amounts for Toms Run: gauge 1 at West View and gauge 21, Moon Township across the river. No rainfall beyond trace amounts (<0.01 inches) was recorded within 48 hours of sampling Toms Run for all sampling dates, except for August 11, 2003: gauge 1 recorded 0.68 inches of rain 48-49 hours prior to sampling, gauge 21 recorded no rain for that period. All sampling dates are considered dry weather.

Referencing Maps 1 and 2 of Toms Run, site 4D at upper Toms Run has the highest *E. coli* results. However, a geometric mean of 326 is not unexpected in an undeveloped watershed. The sources in such a watershed would most likely be animal waste. Septic systems are also present in this watershed and may also be a source of *E. coli*. The field parameters are within state water quality criteria, though the pH is slightly elevated in Location 4A.

In 2003, sampling also occurred at Toms Run five times in dry weather during the recreational season as part of the river monitoring program of 3 Rivers 2nd Nature (3R2N Water Quality Report, 2003, draft). This sampling site is at the mouth of Toms Run, below the overpass for Route 19 and downstream of Location 4A. Toms Run was sampled for *E. coli*. The results ranged from 67 to 248 MPN/100ML with a geometric mean of 147 MPN/100ML. Toms Run was also

sampled for fecal coliform at the same time as *E. coli*. Fecal coliform results ranged from 35 to 685 CFU/100ml with a geometric mean of 148 CFU/100ml. These results are similar to the watershed data presented above.

The Army Corps of Engineers along with 3R2N conducted a macroinvertebrate survey in the Ohio River in 2003 (Biological Assessment Of Aquatic Invertebrate Communities Of Streams Tributary To The Ohio River In Allegheny County, Pennsylvania, 2003). More than 6,558 invertebrate organisms from 68 different taxa were collected, identified, and enumerated at 18 Ohio River tributary stations. Condition scores were then developed from the invertebrate data for each station, where a score greater than 80% indicates that a stream is non-impaired, 60-79% slightly impaired, 40-59% moderately impaired, and less than 39% severely impaired. Toms Run had a condition score of 77% indicating slight impairment, the highest score for the Ohio River tributary streams surveyed in 2003. The authors also observed Northern dusky salamanders in Toms Run as well as Louisiana Waterthrushes, generally associated with high quality streams.

SQUAW RUN

Squaw Run is located along the Allegheny River with in Fox Chapel borough and O'Hara Township. It has 5,472 acres, or 8.55 square miles of watershed, with a total of 3.5% of the land impervious with primarily low density residential in the upper watershed, and a commercial corridor near the mouth of the stream. Table 2 contains data for Squaw Run. Each site is listed on each of the maps for Squaw Run.

Table 2 is a summary of the data for Squaw Run breaking out wet weather and dry weather data from the combined database. Each site is listed on the Squaw Run maps. Appendix A contains all of the data collected for Squaw Run including field parameters.

Table 2: Geometric Means of Squaw Run *E. coli* Data from August 12 to September 8, 2003

Sampling Locations	Combined Data MPN/100ML	Wet Weather Data MPN/100ML	Dry Weather Data MPN/100ML
20A - Squaw Run	586	7,272	166
20B - Squaw Run	225	2,235	72
20C - Tributary	575	3,662	228
20D - Tributary	542	5,629	168
20E - Squaw Run	279	6,694	57
20F - Stony Camp Run	201	9,221	44
20G - Squaw Run	629	16,461	123
20H - Glade Run	238	5,555	49
20I - Squaw Run	222	24,196	69

All locations have 6 data points within 30 days unless noted

20I: 5 total points, 1 wet, 4 dry

Sample dates:

8/12/03, 8/18/03, 8/25/03, 8/27/03, 9/3/03, 9/8/03

8/29/03 and 9/3/03 are wet weather days as defined as rain within 24 hours

- 20A: Lower end of Squaw Run along Old Freeport Road
- 20B: Squaw Run below confluence of Squaw Run and small tributary at Rockwood Drive, 1.36 miles upstream of 20A
- 20C: Small tributary at Deer Brooke Lane
- 20D: Small tributary flowing next to a tennis club
- 20E: Squaw Run below confluence of Squaw Run and Stony Camp Run, 0.91 miles upstream of 20B\
- 20F: Stony Camp Run on Squaw Run Road in the Trillium nature preserve
- 20G: Squaw Run in upper watershed along Old Mill Road, 1.08 miles upstream of 20I
- 20H: Lower end of Glade Run
- 20I: Squaw Run below confluence of Squaw Run and Glade Run, 0.61 miles upstream of 20E

Rainfall data for the sampling dates for Squaw Run were obtained from 3 Rivers Wet Weather, Inc.'s calibrated rain fall system (<http://www.3riverswetweather.org>.) Three rain gauges were used to assess the rainfall amounts for Squaw Run: gauge 3, Shaler, in the Pine Creek watershed just west of Squaw Run and gauges 10, Highland Park, and 19, Penn Hills North, across the Allegheny River. Either no rain or trace amounts of rain were recorded for all dates except for two sampling occasions, 8/27/03 and 9/3/03. According to the three gauges, an average of 1.13 inches of rain fell during the 12 hours prior to and during sampling on 8/27/03. For the

9/3/03 event, an average of 0.48 inches of rain fell during the 48 hours prior to and during sampling. These two dates are considered wet weather sampling events.

The results for Squaw Run indicate that during the dry weather sampling events, the geometric means of all sites are below 225 MPN/100ML. However, when rain occurred during 2 sampling events, *E. coli* results increased 10, sometimes 100-fold. The sections of stream most impacted by the wet weather events were 20G and 20I. Location 20G is the upper portion of the watershed with mostly low density residential developments and 40 acres of agricultural land. 20I is downstream of the upper watershed and Glade Run.

Location 20H is along Glade Run which is 74% forest and 16% open grasslands which consist of golf courses and playing fields. Glade Run's watershed is 1504 acres or 2.3 square miles with 9.6% impervious surfaces mostly from low density housing. This site has an *E. coli* geometric mean in dry weather of 49 MPN/100ML and in wet weather 11,199 and 2,755 MPN/100ML.

Location 20F is along Stony Camp Run, with a 573 acre or 0.9 square mile watershed that is 83% forested with 5.4% impervious surfaces mostly from low density housing. Most of the stream valley runs through the Trillium Trial nature preserve. In dry weather, the geometric mean is 46, in wet weather, the concentrations increased to 5,475 and 15,531 MPN/100ML. Even locations along small unnamed tributaries (20C and 20D) with very little development showed a 10 fold increase in *E. coli* in wet weather.

The increase in *E. coli* results in wet weather could be the result of both animal waste runoff, (deer are notoriously overpopulated) and human waste. However, with wet weather *E. coli* results exceeding 10^3 and even 10^4 at some sites, human sewage and septic systems are most likely major the culprit.

Field parameters showed that temperature, pH and DO fall within state water quality criteria. Conductivity ranged from 600 to 1600 $\mu\text{mhos/cm}$ with the highest site being 20C, a small unnamed tributary to Squaw Run. On the wet weather events, most sites showed a decrease in conductivity.

In 2002, Squaw Run was sampled five times during the recreational season in dry weather as part of the river monitoring program of 3 Rivers 2nd Nature (3R2N Water Quality Report, 2002). The sampling site was accessed by boat and was just downstream of Location 20A, and also downstream of an ALCOSAN pump station. The *E. coli* results ranged from 184 to 1,986 CFU/100ML with a geometric mean of 490 CFU/100ML. These results are higher than the results reported here. Squaw Run was also sampled for fecal coliform at the same time as *E. coli*. The fecal coliform results ranged from 95 to 1,800 CFU/100ml, with a geometric mean of 419 CFU/100ml.

The Army Corps of Engineers along with 3R2N conducted a macroinvertebrate survey in the Allegheny River in 2002 (Biological Assessment Of Aquatic Invertebrate Communities

Of Streams Tributary To Pools #2, #3 and #4 on the Allegheny River in Allegheny County, Pennsylvania, 2002.) More than 8,213 invertebrate organisms from 70 different taxa were collected, identified, and enumerated at 22 Allegheny River tributary stations. Condition scores were then developed from the invertebrate data for each station, where a score greater than 80% indicates that a stream is non-impaired, 60-79% slightly impaired, 40-59% moderately impaired, and less than 39% severely impaired. The condition score for Squaw Run was found to be 49.3% which indicates moderate impairment.

STREETS RUN

Streets Run is located along the Monongahela River in several municipalities including the City of Pittsburgh, West Mifflin, Baldwin, Whitehall, and Brentwood. It has 6,436 acres, or 10.1 square miles of watershed, with a total of 10% of the land impervious with primarily low density residential housing (27%). High density residential housing exists in the upper watershed. 45% of the watershed is considered forested. A portion of the Allegheny County Airport is located within the southeast section of the watershed.

Table 3 is a summary of the data for Streets Run. Each site is listed on the Streets Run maps. Appendix A contains all of the data collected for Streets Run including field parameters.

Table 3: Geometric Means of Streets Run Data from July 14, 2003 to August 7, 2003

Sampling Locations	Combined Data MPN/100ml	Wet Data MPN/100ml	Dry Data MPN/100ml
ST01 - Streets Run	440	483	426
ST02 - Streets Run	1,033	981	1069
ST03 - Streets Run	591	188	994
ST04 - Streets Run	179	163	190
ST05 - Streets Run	418	748	284
STA - Glass Run	188	110	323
STB - Tributary	1,170	917	1376
STC - Tributary	1,184	2582	704
STD - Tributary	5	8	4
STE - Tributary	87	56	116

All locations have 5 data points within 30 days unless noted

ST01: 4 points due to lab error

Sampling dates: 7/14/03, 7/15/03, 7/17/03, 8/5/03, 8/7/03

7/17/03 and 8/5/03 considered wet weather

- ST01: Streets Run before it flows into the Monongahela River – access at the Sand Castle waterpark parking lot.
- ST02: Streets Run at Ashby Street above where Streets Run flows into a culvert under industrial complex, 0.55 miles upstream of ST01
- ST03: Streets Run at Baldwin Street above a large tributary, 0.39 miles upstream of ST02
- ST04: Streets Run at Streets Run Road below upper watershed, 0.70 miles upstream of ST05
- ST05: Streets Run between ST03 and ST04 – first access to Streets Run from ST03, 1.44 miles upstream of ST03
- STA: Glass Run Road at lower end of tributary
- STB: Lower end of tributary at Hillburn Street at a playground and ballfields
- STC: Lower end of tributary at Brentwood Road
- STD: Lower end of a small tributary
- STE: Lower end of a small tributary

Rainfall data for the sampling dates for Streets Run were obtained from 3 Rivers Wet Weather, Inc.'s calibrated rain fall system (<http://www.3riverswetweather.org>.) The two rain gauges used for rainfall data are gauge 12, Baldwin Borough, and gauge 16, Castle Shannon. For the sampling dates of 7/14/03, 7/15/03, and 8/7/03, no rain was recorded for 48 hours prior to sampling. For the 7/17/03 sampling event, an average of 0.20 inches of rain was recorded at the two rain gauges approximately 36 hours prior to sampling. For the 8/5/03 sampling event, an average of 0.17 inches of rain was recorded approximately 24 hours prior to sampling.

The data in Table 3 does not show a difference between wet and dry weather dates. In many sites, the results are lower for the two wet weather dates. The rain for these two dates was short in duration, 1-2 hours, and 24-36 hours prior to sampling, and appears to not affect *E. coli* results.

Location ST04 has the lowest geometric mean for *E. coli* in the mainstem stream, the only location below 200 MPN/100ML. This section of watershed includes the most development with low to high residential land uses and includes Route 51, a major commercial roadway. Locations ST02 and ST03 have *E. coli* results above 1,000 MPN/100ML/100ml, with ST02 having the highest geometric mean in the mainstem stream of 1,033 MPN/100ML. The high *E. coli* results for ST02 may be influenced by the flow from the upstream STB tributary, which also has a high geometric mean for *E. coli* of 1,170 MPN/100ML.

Along the tributary locations, STC and STB have the highest geometric means of 1,184 and 1,170 MPN/100ML, respectively. STC is located along a tributary that has wooded steep hillsides and low density residential developments. STB is located at the lower section of a tributary with steep wooded hillsides and low and medium density developments.

The main sewer line along Streets Run Road has had a history of maintenance problems which

would account for *E. coli* results for most sites exceeding 1,000 MPN/100ML in dry weather. However, 3 Rivers Wet Weather, Inc awarded the municipalities of Balwin, Whitehall and West Mifflin a grant to rehabilitate 1 mile of this degraded sewer line in 2003. Therefore conditions after this sampling project may have improved.

Location STD is a small tributary which is mostly wooded but also consists of strip mining areas. This stream was milky white, which an average pH of 4.83. The *E.coli* geometric mean was 5 MPN/100ML. The conductivity averaged 1560 µmhos/cm. These results indicate the influence of mine discharges.

Location STE, another small tributary, has low *E. coli* results, with a geometric mean of 87 MPN/100ML even though the sampling team noted a sewage smell at this location during the sampling events.

Field parameters of pH, temperature and DO (dissolved oxygen) fell within the PA DEP water quality criteria. The Dissolved Oxygen for STA along Glass Run Road was 2.06 mg/L on 8/5/03 due to extremely low flow, the sampling team noted stagnant water. Conductivities for most sites averaged above 1,000 µmhos/cm.

In 2000, Streets Run was sampled four times in dry weather during the recreational season, as part of the river monitoring program of 3 Rivers 2nd Nature (3R2N Water Quality Phase 1 Report – 2000). The sampling location was access by boat and was in close proximity to Location ST01. Three results exceeded the maximum detection limit of 2,419 MPN/100ML and one result was 517 MPN/100ml. The reported geometric mean of *E. coli* was 1,645 MPN/100ml. Street Run was also sampled for fecal coliform at the same time as *E. coli*. Those results were 470, 3,400, 66,000, and 460,000 CFU/100ML with a geometric mean of 14,841 CFU/100ML. At the time of sampling, ALCOSAN was repairing a sewer line above the sampling location and may have been discharging untreated sewage at the time of sampling. The results of 10^4 and 10^5 for fecal coliform clearly indicate human sewage contamination. The results reported here from sampling in 2003 shows an improvement over these results.

The Army Corps of Engineers along with 3R2N conducted a macroinvertebrate survey in 2001 (Biological Assessment Of Aquatic Invertebrate Communities Of Streams Tributary To The Emsworth Dam Pool (Pittsburgh Pool) on the Ohio, Allegheny, and Monongahela Rivers and to the Pools of Dams #2 and #3 on the Monongahela River.) More than 15,000 invertebrate organisms from 67 different taxa were collected, identified, and enumerated at 35 Allegheny River tributary stations. Condition scores were then developed from the invertebrate data for each station, where a score greater than 80% indicates that a stream is non-impaired, 60-79% slightly impaired, 40-59% moderately impaired, and less than 39% severely impaired. The condition score for Streets Run was found to be 36.6% which indicates severe impairment.

SAW MILL RUN

Saw Mill Run is located along the Ohio River in several municipalities including the City of Pittsburgh, Greentree, Mt. Lebanon, Dormont, Baldwin Township, Castle Shannon and Whitehall. It has 12,431 acres, or 19.4 square miles of watershed, with a total of 17.6% of the land impervious consisting of mostly residential housing. The main stem of Saw Mill Run consists of 20 combined sewer overflow structures of the Allegheny County Sanitary Authority. The City of Pittsburgh also has CSO's throughout the watershed.

Table 4 is a summary of the data for Saw Mill Run. Each site is listed on the Saw Mill Run maps. Appendix A contains all of the data collected for Saw Mill Run including field parameters.

Table 4: Geometric Means of Saw Mill Run Data from July 15 to August 11, 2003

Sampling Locations	Combined Data MPN/100ML	Wet Weather Data MPN/100ML	Dry Weather Data MPN/100ML
16A - Saw Mill Run	717	1,700	403
16B - Saw Mill Run	967	1,064	1,202
16C - Saw Mill Run	532	1,118	324
16D - Saw Mill Run	2,800	4,240	1,849
16E - Saw Mill Run	2,715	7,137	1,426
162E - Saw Mill Run	752	823	708
16F – Tributary	92	68	112
16G - Saw Mill Run	310	282	331

All locations have 5 data points within 30 days unless noted
16B and 16D have 4 samples due to laboratory error

Sampling dates: 7/15/03, 7/17/03, 8/6/03, 8/7/03, 8/11/03

All sampling dates considered dry weather, except 7/17/03 and 8/6/03
which had rain within 48 hours of sampling

- 16A: Lower end of Saw Mill Run in the West End neighborhood of the City of Pittsburgh at Skid Way
- 16B: Saw Mill Run at Woodruff and Lewis Streets, 1.1 miles upstream of 16A
- 16C: Saw Mill Run in Seldom Seen Greenway, 0.29 miles upstream, of 16B
- 16D: Saw Mill Run downstream of small tributary and Edgebrook Avenue, 2.07 miles from 16C
- 16E: Saw Mill Run, 0.28 miles upstream of 16D
- 16E2: Saw Mill Run downstream of confluence of SMR and tributary, 1.25 miles upstream of 16E
- 16F: tributary of Saw Mill Run along Provost Road, 0.38 miles upstream of 16E2

- 16G: Saw Mill Run near Killarney Drive and Route 88, 0.95 miles upstream of 16E2

Rainfall data for the sampling dates for Pine Creek were obtained from the 3 Rivers Wet Weather, Inc.'s calibrated rain fall system (<http://www.3riverswetweather.org>.) The two rain gauges used to determine rainfall for the sampling dates are located in the Saw Mill Run watershed: gauge 7 – Greentree and gauge 16 – Castle Shannon. No rain was recorded for 48 hours for all dates except for July 17 and August 6, 2003. For the July 17 rain date, an average of 0.17 inches of rain fell 38 hours prior to sampling. For the August 6 rain date, an average of 0.39 inches of rain fell 48 hours prior to sampling. These dates are considered wet weather.

The two sampling locations with the highest *E. coli* concentrations are 16D and E, with results for August 6 greater than the maximum detection limit of 24,196 MPN/100ML. This day was considered wet weather. For the other wet weather date, July 17, neither site had *E. coli* results that showed an increase from dry weather results.

Locations 16A and 16B, downstream of 16D and 16E, and also downstream of the majority of CSO's did not have such a dramatic increase in *E. coli* for either wet weather event. Rain events for both of these to dates were not long in duration, 1-2 hours with less than a half inch of rain. Location 16C had an increase of *E. coli* for both of these days.

For all locations along Saw Mill Run Boulevard, 16A-16E2, all had at least one *E. coli* result above 1,000 MPN/100ML. These results most likely are sewage related, not animal related – especially considering that 72% of the watershed is developed and has combined sewer overflows.

Results for Location 16G did not see a significant increase in wet weather and had geometric mean results less than 500 MPN/100ML. Location 16F had low *E. coli* results, less than 200 MPN/100ML, for each sampling day. This site was observed to be bright orange with acid mine drainage.

Field parameters indicate that the stream meets the DEP criteria for temperature, dissolved oxygen and pH. Most sites were slightly alkaline with conductivities greater than 1000 μ mhos/cm.

In 2000, Saw Mill Run was sampled in dry weather during the recreational season as part of the river monitoring program of 3 Rivers 2nd Nature (3R2N Water Quality Phase 1 Report – 2000). The sampling location was access by boat and was slightly downstream from Location 16A. Sampling was done in 2000 prior to flood control measures, but after ALCOSAN's installation of the parallel interceptor project. Saw Mill Run was sampled three times for *E. coli*. Two of the results exceeded the 2,419 MPN/100ML detection limit and the other result was 1,414 MPN/100ML. The geometric mean was reported to be 2,023 MPN/100ML. Saw Mill Run was also sampled for fecal coliform at the same time as *E. coli*. Four results were reported: 14,000, 3,100, 1,300, and 785 CFU/100ML. The geometric mean for fecal coliform was reported to be

2,580 CFU/100ML. These results exceed the results for dry weather reported here for 2003.

The Army Corps of Engineers along with 3R2N conducted a macroinvertebrate survey in 2001 (Biological Assessment Of Aquatic Invertebrate Communities Of Streams Tributary To The Emsworth Dam Pool (Pittsburgh Pool) on the Ohio, Allegheny, and Monongahela Rivers and to the Pools of Dams #2 and #3 on the Monongahela River.) More than 15,000 invertebrate organisms from 67 different taxa were collected, identified, and enumerated at 35 Allegheny River tributary stations. Condition scores were then developed from the invertebrate data for each station, where a score greater than 80% indicates that a stream is non-impaired, 60-79% slightly impaired, 40-59% moderately impaired, and less than 39% severely impaired. Saw Mill Run had a condition score of 37.6%, severely impaired, which indicates severe impairment.

PINE CREEK

Pine Creek is located in several municipalities including Shaler, O'Hara, Ross, McCandless, Hampton, and Pine Townships, Franklin Park and Bradford Woods. It flows into the Allegheny River in Etna. It is one of the 3 largest watersheds in Allegheny County, with 43,028 acres. Almost 60% of the watershed is considered to be forested, 22% is low density housing developments, 8.3% is agriculture or pastures and 5.6% is open space. Almost 28% of the watershed consists of impervious surfaces.

Table 5 is a summary of the data for Pine Creek breaking out wet weather and dry weather data from the combined database. Each site is listed on the Pine Creek maps. Appendix A contains all of the data collected for Pine Creek including field parameters.

Table 5: Geometric Means of Pine Creek Data from August 13 to September 9, 2003

Sampling Locations	Combined Data MPN/100ML	Wet Weather Data MPN/100ML	Dry Weather Data MPN/100ML
18A - Pine Creek	982	10,267	205
18B - W Little Pine Creek	2,585	5,848	1,500
18C - Pine Creek	541	10,481	75
18D - Gourdhead R	324	750	185
18E - Pine Creek	671	1,281	671
18F - Pine Creek	175	757	66
18G - Montour Run	726	1,482	451
18I - Pine Creek	1,455	1,406	1,489
18J - Nork Fork	500	2,192	187
18K - Grouse Run	500	1,119	293
18L - E Little Pine Creek	997	3,044	473
18H2 - Pine Creek	201	773	52

18H3 - Willow Creek	259	1,300	259
18H5 - Pine Creek	449	1,104	183

All locations have 5 data points within 30 days unless noted

H2: 4 total points, 2 wet, 2 dry

H3: 3 data total points, 1 wet, 2 dry

H5: 4 total data points, 2 wet, 2 dry

Sampling Dates: 8/13/03, 8/12/03, 8/26/03, 9/2/03, 9/9/03

8/29/03 and 9/2/03 are wet weather days as defined by rain within 24 hours

The sampling locations for this project used the established points of the Environmentally Active Senior Initiative (EASI) program.

- 18A: Pine Creek at the bottom of Mount Royal Blvd – sampling point closest to the confluence with the Allegheny River
- 18B: West Little Pine Creek – at McElheny Road ball field
- 18C: Pine Creek – 2.97 miles upstream of 18A – across from the Glenshaw Presbyterian Church on Butler Plank Road
- 18D: Gourdhead Run at confluence with Pine Creek– adjacent to Allison Park Real Estate office on Duncan Road
- 18E: Pine Creek above 18D – 3.11 miles upstream of 18C – adjacent to Volunteer Fire Hall on Duncan Road
- 18F: Pine Creek – 2.12 miles upstream of 18E – along railroad tracks on Bryant Road
- 18G: Montour Run at confluence with Pine Creek at Hardt Road
- 18H5: Pine Creek – 2.4 miles upstream of 18F
- 18H3: Willow Creek at confluence with Pine Creek
- 18H2: Pine Creek - 1.36 miles of 18H5
- 18I: Pine Creek – 2.47 miles upstream of H2 – at McCandless Township Municipal Building complex - upper most site of Pine Creek
- 18J: North Fork of Pine Creek – 2.47 miles upstream of H2- above North Park Lake at Skating Rink
- 18K: Grouse Run – along Wickline Road
- 18L: East Little Pine Creek – along Saxonburg Road in upper Little Pine Creek watershed

Rainfall data for the sampling dates for Pine Creek were obtained from the 3 Rivers Wet Weather, Inc.'s calibrated rain fall system (<http://www.3riverswetweather.org>.) In the Pine Creek watershed there are three rain gauges: gauge 3 in Schaler Township in the lower watershed, gauge 30 in Franklin Park in the upper west watershed and gauge 31 in the mid watershed in Hampton Township. However, no data appears in the database for gauges 30 or 31, therefore only gauge 3 was used. None of the sampling dates, except 8/26/03 and 9/2/03, had more than trace amounts of rain (<0.03 inches) 48 hours prior to sampling. On the 8/26/03 sampling

date, 0.25 inches of rain were recorded in the 7:00 and 8:00 am hours. Sampling occurred from 9:55 am to 11:30 am. On the 9/2/03 sampling date, 2.26 inches of rain fell from 8/30 – 9/1/03, and 0.05 inches of rain fell from 12:00 am to 6:45 am on 9/2/03. Sampling occurred from 10:00 am to 1:00 pm. 8/26/03 and 9/2/03 are considered wet weather events.

E. coli dry weather results for Pine Creek main stem in six locations were below 200 MPN/100ML indicating very low contamination from fecal pollution. One location, 18E had a geometric mean of 671 MPN/100ML in dry weather which is located below a sewage treatment plant and Location 18I had the highest result of 1,489 MPN/100ML due to a result of 15,531 on September 9, 2003. 18I is downstream of Route 19 and the tributaries of Rinaman, Wexford and Fish Runs which consist of 24% low density residential development.

West Little Pine Creek had the highest dry weather *E. coli* geometric mean with 1,500 MPN/100ML. The development in this tributary consists of primarily of low density residential housing at 46% of its total acreage of 4,366 acres in Shaler, Ross and McCandless Townships. The *E. coli* geometric means for dry weather for the other tributaries sampled ranged from 185-473 MPN/100ML.

In wet weather, *E. coli* increased by a factor of 10 for most sites. Two sites along Pine Creek had increased *E. coli* geometric mean concentrations in wet weather to over 10,000 MPN/100ML. Location 18A at the lower end of Pine Creek increased to a geometric mean of 10,267 MPN/100ML in wet weather from a dry weather geometric mean of 187, and 18C, almost 3 miles upstream increased from a geometric mean for dry weather 75 to 10,481 MPN/100ML in wet weather.

Location 18I had no real difference between wet and dry *E. coli* results because of the high dry weather result of 15,531. On Aug 26, 2003 wet weather event, the result exceeded the maximum detection limit and no dilutions were performed on the sample. Therefore the result is reported as 2420 MPN/100ML which underestimates the wet weather result.

West Little Pine Creek had a wet weather *E. coli* result of 24,190 MPN/100ML, also exceeding the maximum detection limit with a dilution of 1/100. Therefore, wet weather results for Location 18B are also underestimated.

Many municipalities in the Pine Creek watershed have known wet weather problems of sanitary sewer overflows and general maintenance problems and are under USEPA consent decrees to solve these issues.

In 2000, Pine Creek was sampled four times in dry weather during the recreational season as part of the river monitoring program of 3 Rivers 2nd Nature (3R2N Water Quality Phase 1 Report – 2000). The sampling location was accessed by boat and is downstream from Location 18A, below Route 28. Pine Creek was sampled for *E. coli*. Three out of the four results were above the maximum detection limit of 2,419 MPN/100ML. The fourth result was 727 MPN/100ML. The

geometric mean was reported to be 1,791 MPN/100ML. Pine Creek was also sampled for fecal coliform at the same time as *E. coli*. Fecal coliform results were 620, 6,200, 11,500 and 23,000 CFU/100ml with a geometric mean of 5,647 CFU/100ml. These dry weather results, indicating human sewage contamination of the stream, are much higher than the results reported here for sampling in 2003.

Field parameters of pH, temperature and DO (dissolved oxygen) fell within the PA DEP water quality criteria for Pine Creek which is a designated trout stocked stream. Conductivities for most sites averaged below 1,000 $\mu\text{hos/cm}$.

The Army Corps of Engineers along with 3R2N conducted a macroinvertebrate survey in 2001 (Biological Assessment Of Aquatic Invertebrate Communities Of Streams Tributary To The Emsworth Dam Pool (Pittsburgh Pool) on the Ohio, Allegheny, and Monongahela Rivers and to the Pools of Dams #2 and #3 on the Monongahela River.) More than 15,000 invertebrate organisms from 67 different taxa were collected, identified, and enumerated at 35 Allegheny River tributary stations. Condition scores were then developed from the invertebrate data for each station, where a score greater than 80% indicates that a stream is non-impaired, 60-79% slightly impaired, 40-59% moderately impaired, and less than 39% severely impaired. Pine Creek was determined to be slightly impaired with a condition score of 71.3%, the highest score for the study area.

III. CONCLUSIONS

The goals of the 3R2N Clean Streams program were to develop a low-cost strategic testing program to identify substandard water quality as well as the likely sources of impairment, and to begin a regional water quality monitoring program that will enable cost-effective remediation and ongoing monitoring rather than costly legal action. The sampling methodology was to be available to community and watershed groups.

The sampling program developed here was based on GIS mapping data to determine watersheds and sampling locations. GIS mapping is helpful in determining overall development and impervious surfaces which may indicate the urbanization of the stream. Mapping to determine *E.coli* sources was useful to identify urbanized areas as well as undeveloped areas and steep hillsides that could contribute to overall *E. coli* concentrations through animal waste runoff. Also many sewer lines are being digitized and may become available to community groups doing sampling. This would add another layer of information to determine possible *E. coli* sources. The GIS database also identifies sub-watersheds to further understand the watershed. This allowed to target sampling to sub-watersheds as well as the main stream. This type of targeted sampling would help community groups with limited resources. The limitation to the Allegheny County GIS database is that the development data are from 1996 and may not reflect current conditions. Community and watershed groups should check with county development and municipal agencies to update this information and also work with municipalities to understand sewer problems.

Overall, all of the watersheds had samples that met ORSANCO's recreational contact maximum standard for a single sample of <240/100ML:

- Tom's Run: 10 out of 16 total samples or 62%
- Squaw Run: 30 out of 53 total samples or 57% (of dry weather data only: 83% were <240/100ML)
- Streets Run: 20 out of 48 total samples or 42% (5 samples w/low pH and acid mine drainage)
- Pine Creek: 19 out of 68 total samples or 28% (of dry weather data only: 47% were <240/100ML)
- Saw Mill Run: 9 out of 38 total samples or 24% (5 samples w/low pH and acid mine drainage)

Only 4 sampling locations out of all of the watersheds met the monthly geometric mean standard of 130/100ML for a minimum of 5 samples/month: Streets Run Locations STE and STD (STD affected by low pH and mine drainage); Saw Mill Run Location 16F, also affected by mine drainage; and Toms Run Location 4C, although only 4 samples were taken and does not meet the minimum 5 samples/month.

Squaw Run and Pine Creek were sampled during rain events. The wet weather *E. coli* results for Squaw Run increased to 10^3 or 10^4 MPN/100ML at all sites. The 3R2N macroinvertebrate

study undertaken in 2001 indicated that Squaw Run is moderately impaired. This level of *E. coli* concentrations (10^3 or 10^4 MPN/100ML) would indicate a human source of fecal contamination, rather than animal runoff.

Wet weather also impacted Pine Creek. The lower end of Pine Creek at 18A and C and West Little Pine Creek were most affected by the rain events, reaching *E. coli* concentrations of 10^4 . This is not surprising due to sewer problems in these area including sanitary sewer overflows. Other locations had increased *E. coli* concentrations during the rain events, though sources cannot be confirmed.

The methodology used here, as well as other methods that enumerate *E. coli* or fecal coliform do not differentiate between human or animal sources of the bacteria. There are more expensive and sophisticated methodologies available and being developed to determine sources, called Bacterial Source Testing, using molecular techniques (DNA fingerprinting) and non-molecular chemical and biochemical techniques (EPA, 2002). These techniques were beyond the budget and scope of this project and most routine monitoring projects. However, they would be most useful when performing Total Maximum Daily Load analyses for bacteria and determining the efficacy of wet weather controls.

The project was not initially designed to determine wet weather effects on watershed *E. coli* concentrations. Rather, the program was designed to sample each watershed 5 times within a 30-day period to meet the ORSANCO regulatory standard for *E. coli*. However, because rain events in the summer of 2003 were frequent, sampling occurred regardless of weather conditions. The disadvantage to sampling this way is that wet weather impacts cannot be more systematically determined. Because of the regional sewer issues and *E. coli* contributions from runoff, studying wet weather impacts should be a goal for any watershed monitoring plan. For example, without the wet weather data, Squaw Run would have been determined to have very low *E. coli* concentrations. Wet weather sampling illustrated that there are large contributions of *E. coli* that affect the stream quality. Designing a wet weather monitoring program may be difficult for a volunteer community group due to the unpredictability and frequency of sampling.

Improvements in water quality were seen when comparing dry weather results from this sampling program to dry weather sampling performed in past years by 3 Rivers 2nd Nature river monitoring program (3R2N Water Quality Report, 2000, 2002, 2003). In the river monitoring program, some of the *E. coli* data exceeded the maximum detection limit and fecal coliform results reached 10^4 - 10^5 CFU/100ml – indicating human sewage contamination. This level of contamination was not seen in this sampling program. But because of the small data sets for both programs and the differences in sampling locations, it is impossible to determine what may have caused the decreases in contamination.

Overall, the *E. coli* data collected here are some of the first for these watersheds. This is only a very small subset of the total water resources in Allegheny County. Watersheds are plagued

by sewer problems, mine drainage, urban runoff and physical disturbances. It is doubtful that regulatory agencies will study the 56 or so watersheds in the county to assess these problems. Community and watershed groups may be the only ones working in these watersheds. However, *E. coli* and fecal coliform sampling has not been part of community projects due to the expertise and equipment needed for analysis. The *E. coli* method used here can be performed by trained volunteers. Equipment used was purchased by ALCOSAN on a PA Department of Environmental Resources Growing Greener grant and should be made available to other community groups. Regulatory agencies should support and assist these groups in developing sampling plans, especially for bacteria.

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APPENDIX A

Tributary Data

TOMS RUN

Location 4A	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/15/2003	166	16.83	518	9.68	8.18
8/7/2003	86	17.15	585	9.78	8.08
8/11/2003	231	19.38	595	10.80	8.16
8/12/2003	210	18.19	593	9.01	8.18
8/14/2003	NA	18.74	593	9.27	8.03
Geometric Mean	162				
Average		18.06	580	9.71	8.13

Location 4BB	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/15/2003	225	17.24	519	9.12	8.03
8/7/2003	82	17.24	585	9.46	7.89
8/11/2003	326	18.85	596	10.35	7.95
8/12/2003	345	18.21	598	8.45	7.90
8/14/2003	NA	18.87	596	8.82	7.83
Geometric Mean	213				
Average		18.08	580	9.24	7.92

Location 4C	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/15/2003	69	16.57	497	9.18	8.05
8/7/2003	140	16.84	582	9.53	7.82
8/11/2003	172	18.55	642	10.01	7.98
8/12/2003	154	17.68	626	8.28	7.82
8/14/2003	NS	18.41	610	8.74	7.67
Geometric Mean	127				
Average		17.61	590	9.15	7.87

THE CLEAN STREAMS PROJECT: TRIBUTARY SAMPLING FOR E. COLI IN ALLEGHENY COUNTY:
TOMS RUN, SQUAW RUN, STREETS RUN, SAW MILL RUN AND PINE CREEK

Location 4D	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/15/2003	411	17.53	535	9.11	7.95
8/7/2003	260	17.31	593	9.09	7.74
8/11/2003	387	18.87	581	10.40	7.88
8/12/2003	272	18.48	581	8.24	7.81
8/14/2003	NA	19.18	592	8.60	7.67
Geometric Mean	326				
Average		18.27	580	9.09	7.81

SQUAW RUN

Location 20A	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
8/12/2003	109	21.47	870	8.31	8.13
8/18/2003	345	22.07	871	10.92	8.58
8/25/2003	153	18.32	1077	9.40	8.03
8/27/2003	7,701	21.39	609	8.23	7.81
9/3/2003	6,867	21.25	549	9.35	7.98
9/8/2003	133	17.87	709	10.16	8.17
Geometric Mean	586				
Geomean-Dry	166	Average			
Geomean-Wet	7,272	20.40	781	9.40	8.12

Location 20B	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
8/12/2003	172	21.62	817	8.20	8.07
8/18/2003	41	23.53	807	12.05	8.64
8/25/2003	151	17.84	982	9.50	7.95
8/27/2003	6,488	20.98	590	8.32	7.73
9/3/2003	770	20.58	601	9.81	8.02
9/8/2003	25	18.35	671	10.45	8.10
Geometric Mean	225				
Geomean-Dry	72	Average			
Geomean-Wet	2,235	20.48	745	9.72	8.09

Location 20C	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
8/12/2003	548	19.59	1274	8.10	7.93
8/18/2003	270	19.76	1400	8.23	8.01
8/25/2003	148	17.01	1596	8.88	7.88
8/27/2003	2,909	19.81	666	8.70	7.75
9/3/2003	4,611	19.86	1040	9.84	8.12
9/8/2003	122	16.87	1236	8.51	8.29

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Geometric Mean	575				
Geomean-Dry	228	Average			
Geomean-Wet	3,662	18.82	1202	8.71	8.00

Location 20D	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
8/12/2003	236	19.92	970	7.77	7.92
8/18/2003	387	19.69	985	8.07	7.97
8/25/2003	99	17.16	1089	8.72	7.98
8/27/2003	6,488	21.49	1223	6.89	7.71
9/3/2003	4,884	19.62	513	9.87	8.03
9/8/2003	89	17.00	810	9.17	8.24
Geometric Mean	542				
Geomean-Dry	168	Average			
Geomean-Wet	5,629	19.15	932	8.42	7.98

Location 20E	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
8/12/2003	88	22.11	680	8.27	8.14
8/18/2003	119	21.59	718	8.75	8.26
8/25/2003	16	17.90	779	9.48	8.08
8/27/2003	5,172	21.14	546	8.27	7.65
9/3/2003	8,664	20.44	480	9.60	8.04
9/8/2003	62	18.10	601	9.41	8.41
Geometric Mean	278				
Geomean-Dry	57	Average			
Geomean-Wet	6,694	20.21	634	8.96	8.10

Location 20F	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
8/12/2003	36	20.51	785	7.55	7.96
8/18/2003	132	19.84	794	7.40	7.99

8/25/2003	14	17.47	814	8.22	7.95
8/27/2003	5,475	19.21	483	8.47	7.75
9/3/2003	15,531	19.84	333	9.82	7.97
9/8/2003	69	17.16	604	9.03	8.27
Geometric Mean	268				
Geomean-Dry	46	Average			
Geomean-Wet	9,221	19.01	636	8.42	7.98

Location 20G	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
8/12/2003	260	21.34	712	7.76	7.90
8/18/2003	225	20.15	724	7.31	7.80
8/25/2003	68	17.70	760	8.80	7.84
8/27/2003	24,196	20.55	303	8.55	7.68
9/3/2003	11,199	20.95	323	9.44	7.90
9/8/2003	57	18.28	593	8.94	8.13
Geometric Mean	629				
Geomean-Dry	123	Average			
Geomean-Wet	16,461	19.83	569	8.47	7.88

Location 20H	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
8/12/2003	42	23.14	679	7.17	7.91
8/18/2003	52	22.53	761	7.61	8.04
8/25/2003	27	17.39	836	8.45	8.07
8/27/2003	11,199	21.97	513	7.85	7.57
9/3/2003	2,755	21.12	519	9.34	7.82
9/8/2003	101	19.22	664	8.81	8.21
Geometric Mean	238				
Geomean-Dry	49	Average			
Geomean-Wet	5,555	20.90	662	8.21	7.94

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Location 20I	E. coli MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
8/12/2003	35	22.50	668	7.77	8.20
8/18/2003	145	21.95	711	8.01	8.20
8/25/2003	57	18.47	739	8.88	8.02
8/27/2003	NS	21.37	540	8.40	7.74
9/3/2003	24,196	20.91	371	9.59	7.91
9/8/2003	78	19.03	605	9.32	8.36
Geometric Mean	222				
Geomean-Dry	69	Average			
Wet	24,196	20.71	606	8.66	8.07

STREETS RUN

Location ST01	E. coli MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/14/2003	548	20.45	1052	8.60	7.88
7/15/2003	659	17.68	1124	8.78	7.72
7/17/2003	NS	22.59	502	7.89	7.51
8/5/2003	483	20.61	1203	7.86	7.90
8/7/2003	214	22.12	1291	7.74	7.92
Geometric Mean	440				
Geomean Wet	483	Average			
Geomean Dry	426	20.69	1034	8.17	7.79

Location ST02	E. coli MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/14/2003	1011	20.76	855	9.09	8.01
7/15/2003	500	19.39	1164	9.00	8.13
7/17/2003	1046	20.49	1149	8.97	7.99
8/5/2003	921	22.03	1234	8.49	8.19
8/7/2003	2420	22.19	1351	8.99	8.18
Geometric Mean	1033				
Geomean Wet	981	Average			
Geomean Dry	1069	20.97	1151	8.91	8.10

Location ST03	E. coli MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/14/2003	866	21.73	1231	8.67	7.94
7/15/2003	1120	17.81	1259	9.05	7.91
8/5/2003	397	20.67	1232	8.91	7.93
7/17/2003	89	21.35	1319	8.42	8.08
8/7/2003	1011	21.63	1466	8.65	7.99
Geometric Mean	510				
Geomean Wet	188	Average			
Geomean Dry	994	20.64	1301	8.74	7.97

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Location ST04	E. coli MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/14/2003	135	22.36	1220	8.50	8.16
7/15/2003	248	19.36	1226	8.79	8.28
7/17/2003	54	21.06	1177	8.65	8.22
8/5/2003	488	22.14	1165	8.54	8.35
8/7/2003	204	21.56	1315	8.47	8.32
Geometric Mean	179				
Geomean Wet	163	Average			
Geomean Dry	190	21.30	1221	8.59	8.27

Location ST05	E. coli MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/14/2003	133	22.12	1244	8.45	8.04
7/15/2003	210	18.09	1279	9.17	8.02
7/17/2003	770	20.68	1251	8.68	7.96
8/5/2003	727	21.36	1344	8.37	8.03
8/7/2003	816	20.70	1484	8.72	7.87
Geometric Mean	418				
Geomean Wet	748	Average			
Geomean Dry	284	20.59	1320	8.68	7.98

Location STA	E. coli MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/14/2003	435	20.12	717	8.29	8.00
7/15/2003	184	18.43	742	7.05	7.97
7/17/2003	65	19.64	757	7.55	7.89
8/5/2003	240	19.48	880	2.60	7.49
Geometric Mean	188				
Geomean Wet	110	Average			
Geomean Dry	323	19.42	774	6.37	7.84

Location STB	E. coli MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/14/2003	4884	20.99	501	9.00	8.09
7/15/2003	411	18.44	795	8.97	8.06
7/17/2003	411	18.75	831	9.09	7.99
8/5/2003	2046	20.26	958	8.41	8.12
8/7/2003	1300	20.41	962	8.92	8.06
Geometric Mean	1170				
Geomean Wet	917	Average			
Geomean Dry	1376	19.77	809	8.88	8.06

Location STC	E. coli MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/14/2003	649	20.53	1245	8.94	7.63
7/15/2003	236	16.19	1285	9.49	7.66
7/17/2003	2420	19.50	1301	8.98	7.64
8/5/2003	2755	19.17	1483	9.01	7.81
8/7/2003	2282	18.60	1525	9.04	6.65
Geometric Mean	1184				
Geomean Wet	2582	Average			
Geomean Dry	704	18.80	1368	9.09	7.48

Location STD	E. coli MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/14/2003	1	17.28	1382	9.76	4.88
7/15/2003	5	15.30	1418	9.69	4.90
7/17/2003	3	16.96	1448	9.58	4.91
8/5/2003	24	16.81	1770	9.50	4.81
8/7/2003	11	17.09	1783	9.49	4.67
Geometric Mean	5				
Geomean Wet	8	Average			
Geomean Dry	4	16.69	1560	9.60	4.83

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Location STE	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/14/2003	59	19.61	1186	8.84	8.00
7/15/2003	86	17.98	1215	9.26	7.86
7/17/2003	75	19.85	1191	8.88	7.85
8/5/2003	42	19.44	1334	9.94	7.95
8/7/2003	308	20.23	1363	9.63	7.90
Geometric Mean	87				
Geomean Wet	56	Average			
Geomean Dry	116	19.42	1258	9.31	7.91

SAW MILL RUN

Location 16A	E. coli MPN/100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
7/15/2003	649	25.69	1312	9.06	8.41
7/17/2003	1,300	25.23	1218	9.21	8.09
8/6/2003	2,224	20.77	1505	8.35	7.91
8/7/2003	65	21.03	1578	7.43	7.84
8/11/2003	1,553	23.40	1543	10.64	8.19
Geometric Mean	717				
Geomean-Wet	1,700	Average			
Geomean-Dry	403	23.22	1431	8.94	8.09

Location 16B	E. coli MPN/100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
7/15/2003	727	24.14	1187	8.03	8.38
7/17/2003	1,120	23.09	1092	7.62	8.08
8/6/2003	1,011	20.16	1259	8.20	7.94
8/7/2003	NS	21.38	1318	8.34	7.99
8/11/2003	1,986	22.11	1309	10.03	8.01
Geometric Mean	1,131				
Geomean-Wet	1,064	Average			
Geomean-Dry	1,202	22.18	1233	8.44	8.08

Location 16C	E. coli MPN/100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
7/15/2003	727	25.73	1185	8.14	8.55
7/17/2003	,203	24.62	1098	8.34	8.38
8/6/2003	1,039	19.98	1262	8.07	7.94
8/7/2003	57	20.91	1318	8.17	8.00
8/11/2003	16	22.59	1316	9.53	8.10
Geometric Mean	532				
Geomean-Wet	1,118	Average			
Geomean-Dry	324	22.77	1236	8.45	8.19

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Location 16D	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/15/2003	2,420	24.69	1198	9.33	8.47
7/17/2003	743	23.86	1146	9.64	8.31
8/6/2003	24,196	21.18	1303	4.60	7.69
8/7/2003	NS	23.25	1410	6.13	7.82
8/11/2003	1,414	24.12	1384	12.07	8.23
Geometric Mean	2,800				
Geomean-Wet	4,240	Average			
Geomean-Dry	1,849	23.42	1288	8.35	8.10

Location 16E	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/15/2003	2,420	23.89	1195	9.41	8.31
7/17/2003	2,105	23.93	1150	9.87	8.28
8/6/2003	24,196	20.40	1293	3.62	7.55
8/7/2003	691	21.76	1422	5.71	7.69
8/11/2003	1,733	24.72	991	11.92	8.43
Geometric Mean	2,715				
Geomean-Wet	7,137	Average			
Geomean-Dry	1,426	22.94	1210	8.11	8.05

Location 16F	<i>E. coli</i> MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/15/2003	135	15.27	1339	9.52	7.01
7/17/2003	35	15.64	1343	9.49	6.95
8/6/2003	133	15.21	1563	9.79	7.06
8/7/2003	75	15.15	1565	9.79	6.83
8/11/2003	138	14.94	1561	11.31	6.88
Geometric Mean	92				
Geomean-Wet	68	Average			
Geomean-Dry	112	15.24	1474	9.98	6.95

Location 16G	E. coli MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/15/2003	687	24.20	1206	7.93	8.43
7/17/2003	109	22.24	1110	8.13	8.20
8/6/2003	727	20.67	1364	8.19	8.08
8/7/2003	185	21.83	1418	8.42	8.09
8/11/2003	285	23.81	1320	11.93	8.41
Geometric Mean	310				
Geomean-Wet	282	Average			
Geomean-Dry	331	22.55	1284	8.92	8.24

Location 16E2	E. coli MPN/100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
7/15/2003	1,986	20.83	1249	8.65	7.56
7/17/2003	521	19.81	1222	8.99	7.49
8/6/2003	1,300	18.43	1425	8.02	7.39
8/7/2003	345	18.58	1477	8.13	7.34
8/11/2003	517	19.68	1454	10.16	7.43
Geometric Mean	752				
Geomean-Wet	823	Average			
Geomean-Dry	708	19.47	1365	8.79	7.44

PINE CREEK

Location 18A	E. coli PN/100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
8/19/2003	80	19.48	909	9.59	8.01
8/26/2003	7,270	22.71	881	11.97	7.92
9/2/2003	14,500	20.37	674	8.73	7.78
9/9/2003	435	19.84	844	12.95	8.13
Geometric Mean	1,385				
Geomean - Wet	10,267	Average			
Geomean - Dry	187	20.60	827	10.81	7.96

Location 18B	E. coli MPN/ 100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
8/13/2003	1,733	21.48	926	8.14	7.84
8/19/2003	1,986	18.09	1049	8.47	7.81
8/26/2003	24,190	21.85	558	10.78	7.85
9/2/2003	1,414	19.83	914	8.61	7.96
9/9/2003	980	19.03	1072	11.34	7.98
Geometric Mean	2,585				
Geomean - Wet	5,848	Average			
Geomean - Dry	1,500	20.06	904	9.47	7.89

Location 18C	E. coli MPN/ 100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
8/13/2003	82	22.05	919	9.86	8.16
8/19/2003	39	19.80	925	9.70	8.20
8/26/2003	10,462	21.85	806	11.07	7.86
9/2/2003	10,500	20.27	674	8.37	7.73
9/9/2003	131	19.65	847	12.52	8.08
Geometric Mean	541				
Geomean - Wet	10,481	Average			
Geomean - Dry	75	20.72	834	10.30	8.01

Location 18D	E. coli MPN/ 100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
8/13/2003	186	20.41	970	9.13	7.92
8/19/2003	308	18.22	1018	9.22	8.10
8/26/2003	1,370				
9/2/2003	411	18.50	894	8.88	7.87
9/9/2003	111	18.24	1038	12.41	7.95
Geometric Mean	324				
Geomean - Wet	750	Average			
Geomean - Dry	185	18.84	980	9.91	7.96

Location 18E	E. coli MPN/ 100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
8/13/2003	2,420	22.41	918	9.91	7.97
8/19/2003	53	19.43	917	8.88	7.85
8/26/2003	816	21.42	930	10.66	7.82
9/2/2003	2,010	20.37	651	8.19	7.68
9/9/2003	649	19.57	833	12.09	7.83
Geometric Mean	671				
Geomean - Wet	1,281	Average			
Geomean - Dry	436	20.64	850	9.95	7.83

Location 18F	E. coli MPN/ 100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
8/13/2003	70	22.63	897	10.44	8.12
8/19/2003	56	20.25	946	11.05	8.27
8/26/2003	1,046	21.50	968	11.32	8.13
9/2/2003	548	20.33	642	8.05	7.60
9/9/2003	74	19.46	815	11.72	7.85
Geometric Mean	175				

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Geomean - Wet	757	Average			
Geomean - Dry	66	20.83	854	10.52	7.99

Location 18G	E. coli MPN/ 100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
8/13/2003	687	21.21	660	9.09	7.93
8/19/2003	326	19.75	685	9.13	7.94
8/26/2003	1,553	20.77	739	8.35	7.84
9/2/2003	1,414	18.35	508	8.93	7.51
9/9/2003	411	17.62	466	9.58	7.62
Geometric Mean	726				
Geomean - Wet	1,482	Average			
Geomean - Dry	451	19.54	612	9.02	7.77

Location 18H2	E. coli MPN/ 100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
8/19/2003	64	24.38	730	6.59	7.72
8/26/2003	1,733	24.39	695	5.40	7.53
9/2/2003	345	21.43	569	7.32	7.52
9/9/2003	42	21.45	530	8.31	7.65
Geometric Mean	201				
Geomean - Wet	773	Average			
Geomean - Dry	52	22.91	631	6.91	7.61

Location 18H3	E. coli MPN/ 100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
8/19/2003	308	21.76	790	6.64	7.44
8/26/2003	NS	23.06	777	5.33	7.29
9/2/2003	1300	18.10	783	8.93	7.60
9/9/2003	219	20.47	603	7.60	7.19
Geometric Mean	444				
Wet	1,300	Average			

Geomean - Dry	259	20.85	738	7.13	7.38
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Location 18H5	E. coli MPN/ 100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
8/19/2003	517	19.71	1606	9.97	7.90
8/26/2003	1,986				
9/2/2003	613	20.81	587	7.68	7.42
9/9/2003	64				
Geometric Mean	449				
Wet	1,104	Average			
Dry	183	20.26	1097	8.83	7.66

Location 18I	E. coli MPN/ 100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
8/13/2003	461	21.76	975	10.07	8.12
8/19/2003	461	18.73	1013	9.81	8.03
8/26/2003	2,420	21.27	441	7.43	7.66
9/2/2003	816	18.13	701	8.80	7.46
9/9/2003	15,531	17.82	764	9.34	7.68
Geometric Mean	1,455				
Geomean - Wet	1,406	Average			
Geomean - Dry	1,489	19.54	779	9.09	7.79

Location 18J	<i>E. coli</i> MPN/ 100ml	Temperature °C	Conductivity µmos/cm	DO mg/L	pH SU
8/13/2003	101	22.18	689	8.67	7.74
8/19/2003	435	18.79	687	8.58	7.81
8/26/2003	2,420	20.68	682	8.02	7.60
9/2/2003	1,986	18.01	509	8.89	7.44
9/9/2003	148	17.78	486	9.48	7.44
Geometric Mean	500				

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Geomean - Wet	2,192	Average			
Geomean - Dry	187	19.49	611	8.73	7.61

Location 18K	<i>E. coli</i> MPN/ 100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
8/13/2003	276	24.03	1612	8.80	8.12
8/19/2003	488	23.43	1682	9.01	8.21
8/26/2003	2,420	22.09	704	7.87	7.90
9/2/2003	517	19.37	1078	8.65	7.90
9/9/2003	186	19.14	1351	11.03	8.09
Geometric Mean	500				
Geomean - Wet	1,119	Average			
Geomean - Dry	293	21.61	1285	9.07	8.04

Location 18L	<i>E. coli</i> MPN/ 100ml	Temperature °C	Conductivity µmhos/cm	DO mg/L	pH SU
8/13/2003	1,300	23.96	639	9.08	8.05
8/19/2003	411	22.09	633	8.83	8.21
8/26/2003	7,701	20.86	444	10.30	7.92
9/2/2003	1,203	19.17	519	8.36	7.62
9/9/2003	199	18.44	605	12.60	8.15
Geometric Mean	997				
Geomean - Wet	3,044	Average			
Geomean - Dry	473	20.90	568	9.83	7.99