

**“How Animal Wastes Pollute Water,
and What You Can Do About It”:
An Integrated Monitoring and Education Project**

Fecal Coliform Data Report

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**With support from US Gulf of Maine Association
and the US Environmental Protection Agency.**

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PROJECT DESCRIPTION

Nonpoint source pollution carried by the Ipswich River has significant adverse impact on water quality in the Ipswich coastal region. High concentrations of fecal coliform bacteria in the river and its tributaries have severely impacted the shellfishing industry in Ipswich. Almost 180 acres of highly productive shellfish beds in the Ipswich River estuary are currently closed to shellfishing due to fecal coliform contamination. Contamination of the Ipswich River threatens other prime shellfishing areas as well, including productive growing areas in Plum Island Sound and at Crane Beach.

This report focuses on the impact of domestic animal wastes on fecal coliform levels in the mainstem and tributaries in the non-tidal lower basin of the Ipswich River. Domestic animal wastes have been well documented as a significant source of nonpoint source pollution in the lower basin, as shown by the Ipswich Coastal Pollution Control Committee's Study. The full "How Animal Wastes Pollute Water, and What You Can Do About It" grant included the following work:

1. An inventory of town records determined where animal farms, parks, golf courses, and other sources of animal fecal coliform contamination exist near the mainstem or a tributary.
2. Water samples were collected and analyzed for fecal coliform and optical brighteners during both dry weather and wet weather events.
3. Educational materials for all grade levels were developed that centered around a "hands on, seeing is believing" approach to learning promoted awareness of how activities throughout the watershed impact the coastal zone.

Task 2 contained a data collection portion, and herein are the results.

SAMPLING METHODOLOGY

In order to determine the quantitative effect of domestic animal wastes on the health of the Ipswich River and its tributaries in the lower basin, a sampling protocol was developed and carried out during October through December of 1997. A total of twelve sites on four different streams were sampled for fecal coliform and optical brighteners. All sampling was completed in accordance with an approved Quality Assurance Project Plan, attached as Appendix A.

The goals of this sampling project included:

- To quantitatively determine the difference, if any, between dry weather and wet weather fecal coliform levels.
- To determine if fecal coliform contamination in these samples was of human or animal origin.

In order to achieve these goals, fecal samples were taken on three different dry weather occasions. In addition, one wet weather fecal sampling was completed, with samples taken on the day of the storm, and for the next two days. Samples were collected from 12 different monitoring sites, selected because of proximity to known animal farms and based on data from the 1995 Ipswich Coastal Pollution Control Committee report. A map showing the locations of all of the monitoring sites can be found on the next page. Analysis of the fecal coliform data can be found following the map.

In order to determine if the fecal contamination was of human or animal origin, cotton pads were placed in the river to check for the presence of optical brighteners. Optical brighteners are dyes in laundry detergents that cause your whites to “be whiter than white” and to fluoresce under ultraviolet light. There are no known natural sources of optical brighteners. The cotton was secured in specially made wire cages, and placed in the stream bed for one week surrounding the sampling date. After the pads were removed and dried, they were analyzed at the Department of Marine Fisheries to see if they fluoresce under UV light. In all six of our monitoring dates, which encompassed only four separate optical brightener samplings because there was only one during the three days of the wet weather sampling, there were no positive reactions on the cotton pads.

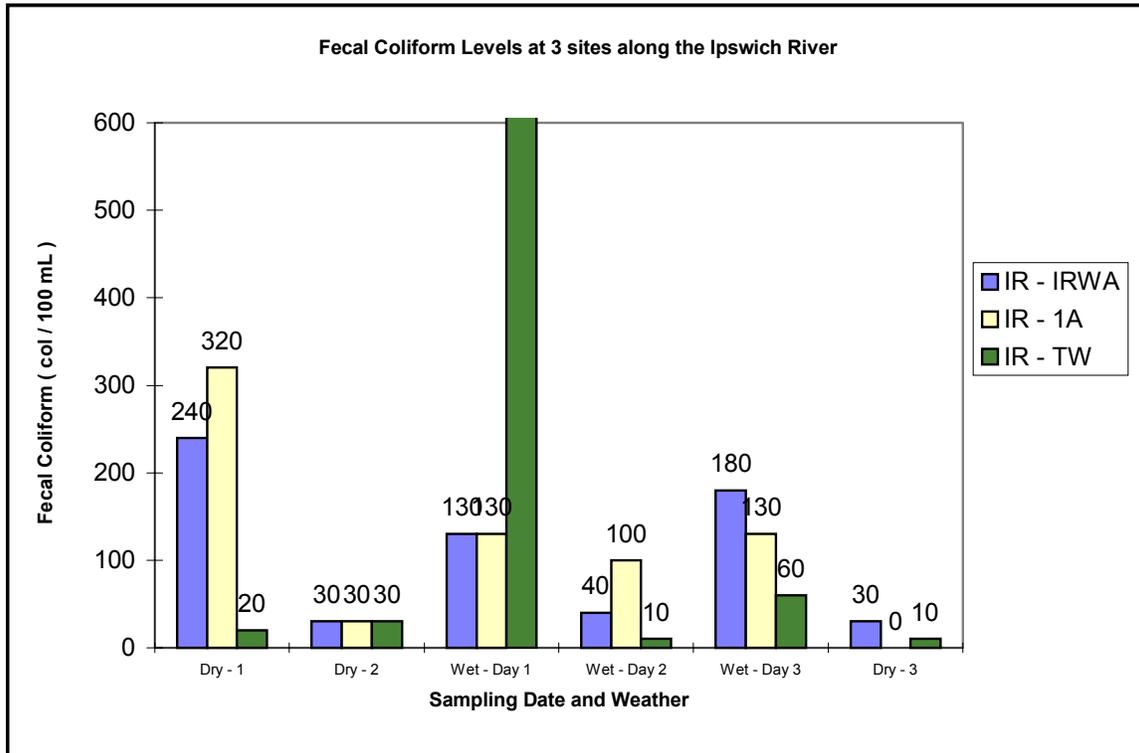
To ensure that our methodology was not at fault because no positive reactions were seen, cotton pads were then placed in the effluent at the Ipswich Wastewater Treatment Plant. These pads, when analyzed, showed an extreme positive response, showing that when optical brighteners were present in force, the pads responded by fluorescing very strongly.

The lack of response of the optical brighteners in the monitoring sites is not absolute proof that the fecal coliform present in the rivers and streams does not come from human

sources. However, it is a good indicator that the fecal coliform present is from animal, rather than human, sources.

SAMPLING LOCATION MAP

FECAL COLIFORM DATA AND ANALYSIS



Samples were collected at three tidal locations along the Ipswich River: **IR-IRWA** was just downstream of the Sylvania Dam, behind the old IRWA office at 51 S. Main Street. Fecal samples were taken in well mixed water from the shoreline. **IR-1A** was downstream from the IRWA site. Fecal samples were collected with a bucket from the upstream side of the Choate Bridge on Route 1A. **IR-TW** was downstream from the 1A site, and samples were taken from the public access dock at the Ipswich Outboard Club, until the dock was removed, and then fecal samples were collected from a well-mixed area on the shoreline. Optical Brightener samplers were placed in the rocks at both IR-IRWA and IR-1A. No OB samplers were placed at IR-TW because of the concrete nature of the stream bottom. No OB samples were positive at either IRWA or 1A.

As can be seen from the graph above, fecal coliform varied from 10 - 30 col / 100 mL on both Dry - 2 and Dry - 3 sampling dates at all three sites. On both of these dates, fecal was sampled at low tide during dry weather. On Dry - 1, however, sampling occurred at high tide, and fecal levels were eight to over ten times higher at IR-IRWA and IR-1A than at the low tide samplings. The fecal count at IR-TW remained similar, however. At Sylvania Dam, slightly upstream and all freshwater, the ICPCC reported fecal levels in dry weather ranging from 8 - 35 col / 100 mL. At IR-TW, however, the ICPCC reported dry weather counts ranging from 24 - 790. Here the ICPCC data and the IRWA data are not consistent. The small number of sampling dates accounts for that inconsistency.

One possible explanation of the aberrant counts at IR-1A and IR-IRWA is the local duck population that is fed off of the Chippers dock near Route 1A. Their waste may account for a dry weather rise in fecal in the local area around 1A.

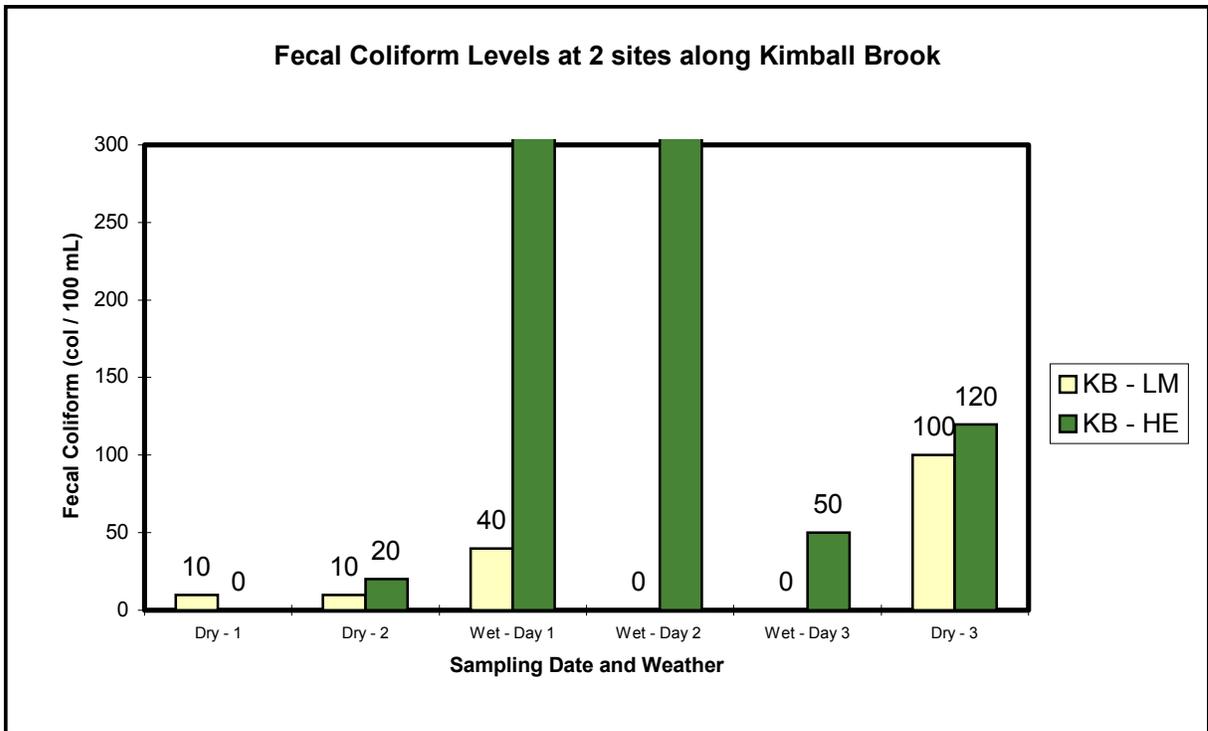
During the wet weather sampling, fecal counts jumped significantly at IR-TW to 730 col / 100 mL. This result is more than 24 times the amount seen at IR-TW at any other time. After the first day of sampling, however, counts at IR-TW dropped back down to well within the dry weather range at 10 and 60 col / 100 mL. At IRWA and 1A the trend we saw was different. At both sites fecal counts were high compared to the low tide dry weather samplings on the day of rain, and then they dropped lower on the second day. On the third day, however, the fecal counts rose to above or at the first day's high counts.

Summary of fecal data for the Ipswich River:

- Dry weather sampling shows low counts at all three sites, except for the high tide sampling where the upstream sites were higher by a factor of eight as compared to the low tide samplings.
- During the wet weather sampling, the downstream site jumped significantly (24 times greater than the dry weather), then dropped back down to dry weather levels on day two, and raised slightly on day 3.
- During the wet weather sampling, the two upstream sites were higher than the low tide samplings in dry weather, but only by a factor of about 4. Both dropped off on the second day of sampling, but then jumped back up to the same or higher level as the first day on the third day after the rainstorm.
- The ICPCC report lists 15 horses, 21 cows, 10+ sheep, 3 ponies, 10 goats, and over 50 miscellaneous animals living within the Ipswich River Watershed in 1992.

Summary of results for the Ipswich River.

- The downstream TW site seems to flush very quickly, and / or to mix with a quantity of non-polluted waters enough to dilute contamination quickly. This is evidenced by the low fecal level on the high tide sampling date, as well as the quick recovery from the high levels of coliform seen on the first day of the rainstorm.
- There is a significant difference between the dry weather and wet weather fecal data. This leads to the conclusion that stormwater run-off, rather than non-compliant septic systems or other non-weather dependent pollution sources, is the leading cause of the elevated fecal coliform levels.
- There were no positive tests for Optical Brighteners, and there are no wastewater treatment plant discharges in the sampled area of the Ipswich. This, in conjunction with the numbers of animals living within the watershed as listed by the ICPCC leads to the conclusion that the elevated counts are at least partly a result of animal waste run-off.



Kimball Brook was sampled at two locations. The first was at the upstream end of the brook, off Longmeadow Drive, behind the Courtland Way cul-de-sac of houses. With landowner permission, we walked behind their house and took samples from the outlet of their small pond that forms the beginning of Kimball Brook. This site was **KB-LM** and geese and ducks were often sited in the small pond. The second site was 5' downstream of the outlet pipe on the downstream side of the Heard Drive culvert and was **KB-HE**. These sites were chosen because of the known animal farms on Pine Swamp and Bush Hill Roads.

As can be seen from the graph above, the fecal levels are approximately the same at both sites at all three dry weather samples. On Dry-1, fecal levels were 10 and <10 col / 100 mL, on Dry-2 they were 10 and 20 col / 100 mL, and on Dry-3 they were 100 and 120 col / 100 mL. Thus, on none of the dry weather sampling dates was there more of a difference than 20 col / 100 mL of fecal between the two sites.

In the wet weather samplings, fecal remains low at KB-LM (40 on Day 1, <10 on Day 2, and <10 on Day 3), showing a slight jump on Day 1, but nothing significant. At KB-HE, however, fecal jumps significantly higher than any of the dry weather samples: 990 on Day 1, 400 on Day 2, and 50 on Day 3. The disparity between the wet weather samples on these two sites clearly shows that there is a wet weather source of fecal coliform between these two sites. Given the information about the animals present in this area, and the negative optical brightener response, it is likely that run-off from animal wastes are the cause of the higher fecal coliform levels.

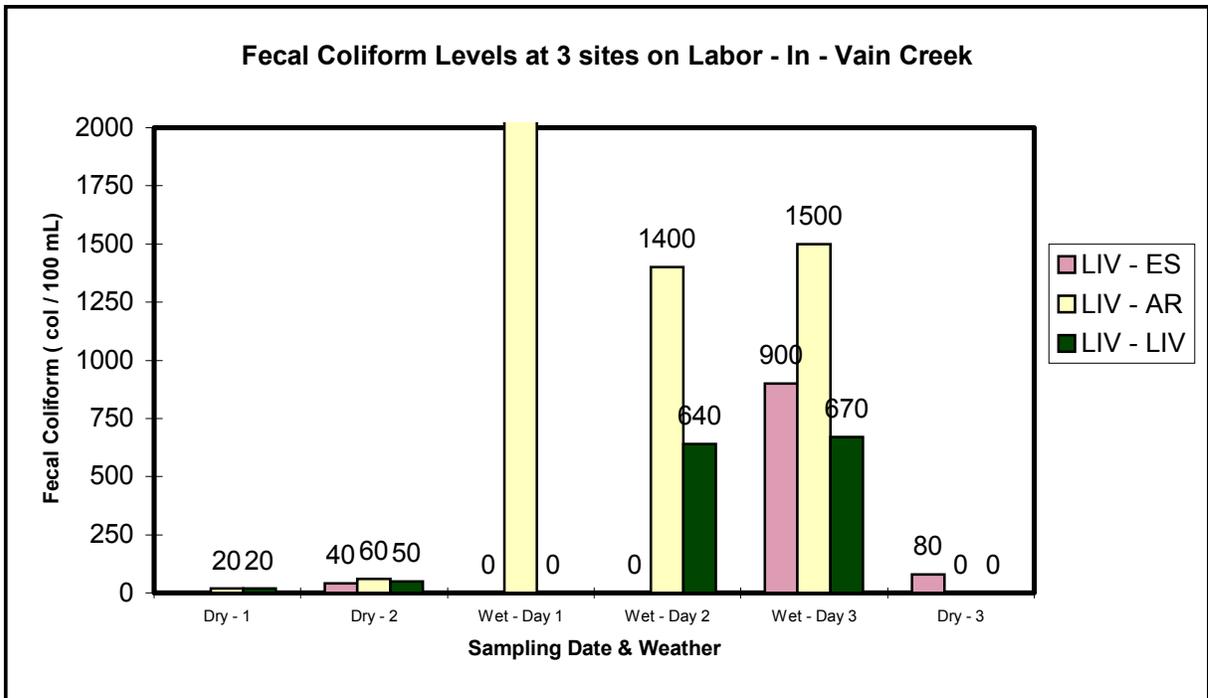
The Ipswich Coastal Pollution Control Committee only tested Kimball Brook at the KB-He site. Their data for this site matches ours quite well. On their five dry weather samples here, fecal ranged from 7 - 79 col / 100 mL. On their 2 wet weather samples though, fecal on the day of rain was >24,000 and 5,400. Thus, the ICPC shows the same spike that we do, but of a much greater magnitude.

Summary of fecal data for Kimball Brook:

- On the three dry weather sampling dates, fecal levels were within 20 col / 100 mL of one another at both of the sampling sites.
- Fecal levels on two of the dry weather dates were quite low. On the third levels were higher, but remained very similar to one another. The date the dry weather sites in Kimball Brook were higher than the other dry weather dates is not the same date that the dry weather results were higher than the other dates in the Ipswich River.
- There was a very sharp increase in fecal coliform levels (7 - 99 times greater) at the downstream site KB-HE on the first day of the wet weather sampling. There was no corresponding increase at the upstream site.
- The downstream site recovered within the three day sampling period to within range of the dry weather sampling results.
- The ICPC lists 30 pigs, 19 cows, 12 sheep, 6 horses, 2 goats, and 1 pony as living within the Kimball Brook watershed in 1992.

Summary of results for Kimball Brook:

- The increase in the downstream sites fecal levels in wet weather, with no corresponding upstream increase, clearly indicates a wet-weather source of fecal between the two areas.
- The lack of positive responses on the optical brighteners at both sites indicates that this source is animal rather than human in nature.



Labor-In-Vain Creek (or Gould’s Creek as it is known locally) was sampled at three locations: Upstream at the upstream side of the Essex Road (Rt. 133) crossing (**LIV-ES**), Mid-Stream on the downstream side of the Argilla Road crossing (**LIV-AR**), and Downstream on the downstream side of the Labor-In-Vain Road crossing (**LIV-LIV**). These sites were selected because of the animal population along Argilla and Essex Roads. Of these three sites, only LIV-ES is not tidal.

As can be seen from the graph above, all three of the dry weather dates showed fairly low and consistent between the sites fecal results. Dry-2 and Dry-3 both occurred at low tide, while Dry-1 sampling occurred at high tide. The non-tidal upstream site of LIV-ES was not sampled on Dry-1, however, due to time constraints. The greatest difference we saw in the fecal results as the river flows downstream was on Dry-3, when there was a count of 80 at LIV-ES, and <10 at both of the tidal downstream sites. This can easily be explained because of the mixing that goes on as the creek changes from a very small brook to a large tidal inlet as it goes downstream.

The wet weather results for these three sites are not as consistent, however. On the first day of wet weather sampling the mid-stream site, LIV-AR, rose dramatically to 8,300 col / 100 mL fecal count. That was the highest count seen in any sample in this study, and was 130 - 830 times higher than the dry weather counts seen in dry weather at this site. The fecal contamination tapered off the next day to 1,400, but remained near there at 1,500 on the third day of wet weather sampling.

This sharp peak on the first day of wet weather was not seen at the other two sites. The downstream site, LIV-LIV, showed virtually no fecal on the first day, with a count of <10. On the second day, however, it rose to 640, and remained near there at 670 for the third day. This jump on the second day could be a result of upstream contamination making its way downstream over time.

The upstream site, LIV-ES, showed no response to wet weather until the third day, with counts of <10 on both the first and second day of the wet weather sampling, and then a spike to 900 on the third day. This delayed spike could be a result of the extremely low flow, slightly iced over conditions of the small brook in that non-tidal upstream area. It could have taken time for fecal contamination to get through the wetlands to the Essex Road culvert.

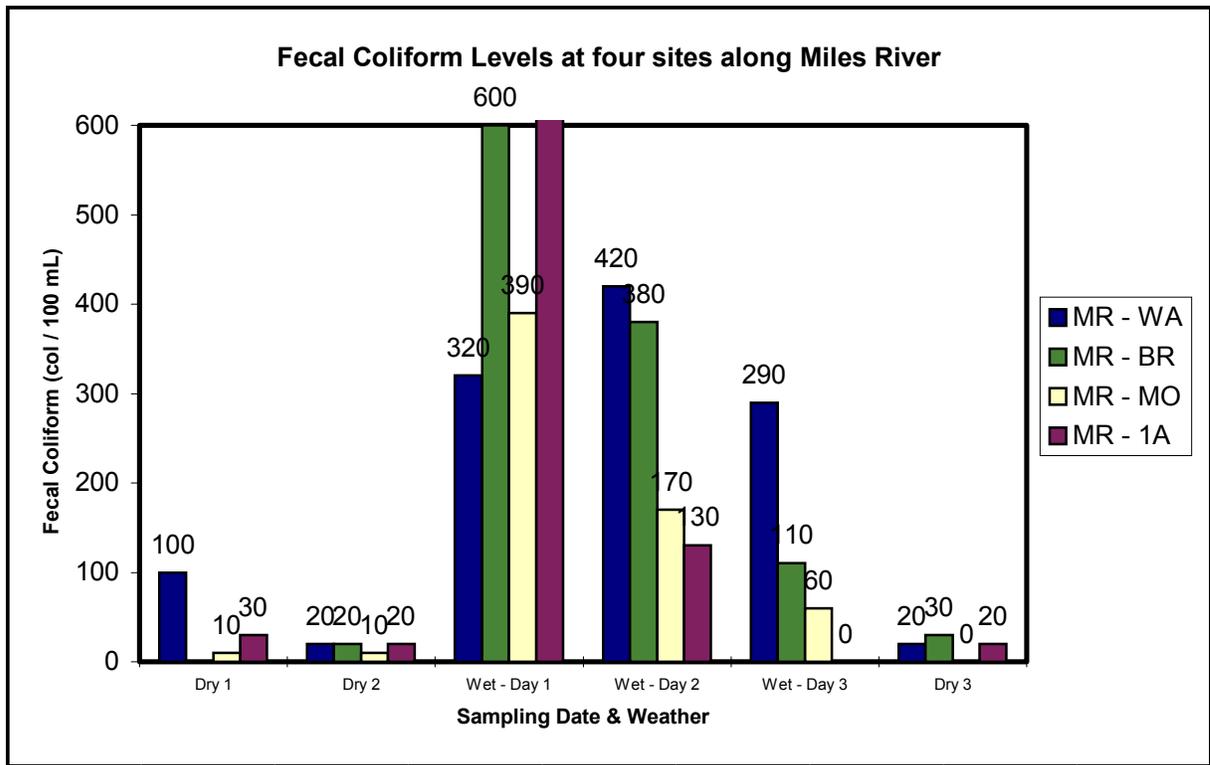
The ICPCC sampled LIV-ES once, at dry weather. Their result of 20 col / 100 mL correlates well with what we saw at LIV-ES in dry weather. The ICPCC's dry weather samplings of LIV-AR are slightly higher than what we saw, with six samples ranging from 12 - 223 col / 100 mL. Their wet weather samplings at LIV-AR showed a small spike on the day of rain (4 samples from 110 - 2,400) but nothing like the large spike to 8,300 that we saw. At LIV-LIV the ICPCC saw higher dry weather counts than us as well, with six samples ranging from 80 - 1700. They saw a small spike on the day of rain as well, with six samples ranging from 170 - 2700. Thus the ICPCC data does not correlate especially well with ours on this creek, but both sets of data show a spike after wet weather.

Summary of fecal results on Labor-In-Vain creek:

- Dry weather results show fecal levels fairly low (all samples below 100) and consistently the same at the three sampling locations.
- The wet weather peaks at the three sites all occurred on different days. The upstream site peaked on Day 3 of sampling, the Mid-stream site peaked on Day 1 of sampling, and the downstream site peaked on Day 2 of sampling. All three sites clearly show a wet weather peak significantly higher than the dry weather data.
- All of the cotton pads placed in these three sites were negative for optical brighteners, indicating the waste is of animal origin. The ICPCC Report lists 75 horses, 54 cows, 35 chickens, 22 sheep, 17 ponies, 5 swans, 1 goat, and unknown miscellaneous animals in the watershed.

Summary of conclusions on Labor-In-Vain creek:

- Dry weather fecal levels are low and show no distinguishable difference between the days or the sites. In wet weather, there are very large peaks that occur on day of rain or in the two days after. These peaks are rainfall related and are probably from animal waste in the Argilla and Essex Road area, as those two sites saw the higher peaks than the downstream site at Labor-In-Vain road.



There were a total of four sites along the Miles River, selected because of their proximity to livestock, as well as their spacing down the Miles River. The sites were (from upstream to downstream): the upstream side of the Walnut Road bridge in Wenham, the upstream side of the Bridge Street bridge in Hamilton, the downstream side of the Moulton Street bridge in Hamilton, and the downstream side of the 1A bridge in Ipswich.

As can be seen from the graph, fecal counts were between 0 and 30 at all sites on all three dry weather days except for one count of 100 at Walnut street (the farthest upstream site). Thus, dry weather data was fairly low and fairly consistent in the Miles River.

In wet weather, there were noticeable spikes in the data. The three downstream sites spiked on the day of rain, and then declined on the next two days, but (except for the farthest downstream site MR-1A) had not reached dry weather levels by the third day. MR-WA, the upstream site, spiked on the day of rain, and then the fecal level rose on the next day, and dropped again on the third day of wet weather sampling.

A very noticeable trend in the wet weather data is that the downstream sites recovered to their dry weather levels significantly faster than the upstream sites. The farthest downstream site, MR-1A, spiked to the highest count recorded in the Miles River in this survey to 2,300. This was 115 times the dry weather counts of 20. But on the second day the count was down to 130, and on the third day to <10. This downstream site spiked quickly, and then recovered.

At the second most downstream site, MR-MO, fecal counts spiked to 39 times the dry weather counts on the day of rain. Then it recovered to 17 times the dry weather counts on the second day and to 6 times the dry weather counts on the third day. Thus, by the third day counts were significantly recovered, but not quite completely.

The third most downstream site, MR-BR, is very similar to the trend in MR-MO. It is the most upstream site, however, that does not peak on the day of rain, but instead peaks the second day, and then begins to recover after that.

This data can be explained by due to the lag time needed for the fecal to get the the sites, and the larger flows that dilute the downstream sites fecal contamination.

Summary of fecal data for the Miles River:

- All three dry weather dates show low and consistent fecal counts.
- There is a significant increase in the wet weather counts at all four of the sampling sites on the day of rain. The most upstream site, however, peaks after the day of rain sampling, as we saw in Labor-In-Vain creek.
- There are 96 horses, 75 cows, 36 chickens, 11 ponies, 3 goats, 3 sheep and 2 ducks listed in the ICPCC report as living in the Miles River Watershed in 1992.

Summary of results for the Miles River:

- It is obvious from the data that there is a significant source of dry weather fecal contamination. Given the proximity of livestock, and the negative response on all of the optical brightener tests, it can be concluded that animal waste plays a large part of the spikes that we saw in the data.

CONCLUSIONS:

All of the four streams looked at within this study showed a significant increase in the levels of fecal coliform in wet weather as opposed to dry weather sampling. Each of the four streams had their own peculiarities as to which sites reflected the greatest coliform loading, yet all streams experienced severe raises in the level of coliform in wet weather.

Of all of the dry weather samples, only 2 samples were above the Class B / Class SA swimming standard of 200 col / 100 mL of fecal coliform. Both of these sites were in the tidal area of the Ipswich River, and the levels occurred on the same sampling day.

In wet weather sampling, only two sites were above the Class B / Class SA boating standard of 1,000 col / 100 mL of fecal coliform. Both the Miles River at 1A on the day of rain, and Labor-In-Vain Creek at Argilla Road on all three days of wet weather sampling were about the 1,000 level. All but three of the twelve sites were above the swimming standard in wet weather.

Of the seventy total samples taken, only 17 were below the Class SA standard of 14 col / 100 mL that allows shellfishing. In the tidal sections of the Ipswich, only 3 of 18 samples were below 14. In the tidal sections of Labor-In-Vain Creek, only 2 of 12 samples were below the standard.

In order to make it safe to reopen the shellfish beds in the Ipswich area, a great deal of work needs to still be done. The education portion of this grant has already sponsored a number of brochures: for the general public, for horse owners, for school children. In addition, a total of 17 school presentations were made to classrooms aged 4th to 12th grade. Education, responsible animal owners, and control of surface run-off of animal waste are the key to reducing the fecal contamination in the Lower Ipswich Basin.

QA/ QC ANALYSIS

On each sampling date, except for 11-22-97 and 11-23-97 which occurred on weekend days and the Ipswich Wastewater Treatment Plant Lab was closed, three different types of quality control samples were taken. First, there was a *lab duplicate*, where two samples were taken and analyzed at the Charles River Watershed Association's (CRWA) Lab and the Ipswich Wastewater Treatment Plant Lab. Second, there was a *duplicate sample*, where two samples were taken and then were both analyzed at the CRWA Lab. Third, there was a *lab split*, where one sample was taken and tested twice at the CRWA Lab.

CRWA has implemented the appropriate procedures for fecal coliform, according to Standard Methods, in their lab. Below you will find an analysis of our 16 total QA/QC samples according to Standard Methods, 19th Edition, 9020, Section 4, page 9-9.

Date	QA/QC Type	Sample 1 Result	Sample 2 Result	Log 1	Log 2	Range	Within 3.27R ?
10-23	LS	10	0	1	-	-	
	DS	20	10	1.30103	1	0.30103	Yes
	LD	20	10	1.30103	1	0.30103	Yes
11-13	LS	30	30	1.47714	1.47714	0	Yes
	DS	30	10	1.47714	1	0.47714	Yes
	LD	10	10	1	1	0	Yes
11-22	DS	990	880	2.99564	2.94448	0.05116	Yes
	LD	390	510	2.59106	2.70757	0.11651	Yes
11-23	LD	380	360	2.70757	2.55630	0.15127	Yes
11-24	LS	50	40	1.69897	1.60205	0.09692	Yes
	DS	10	50	1	1.69897	0.69897	Yes
	DS	130	160	2.11394	2.20412	0.09018	Yes
	LD	50	0	1.69897	-	-	
12-10	LS	10	0	1	-	-	
	DS	30	10	1.47714	1	0.47714	Yes
	LD	20	10	1.30103	1	0.30103	Yes

The summation of the Range of Logs is: 3.06238

$R \text{ hat} = \text{Summation } R \text{ log} / n = 3.06238 / 13 = 0.23557$

Precision criterion = $3.27 * R \text{ hat} = \mathbf{0.77031}$

All data is within precision ranges as specified in Standard Methods.

