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Evaluation of the Burnt Mill Creek Outreach and Demonstration Project

Final Report

Prepared for the City of Wilmington, NC by

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Executive Summary

The goal of the Burnt Mill Creek Outreach and Demonstration Project was *to increase awareness about watershed issues and motivate residents and businesses in selected areas of the watershed to adopt responsible watershed practices on individual properties*. In order to achieve this goal, the three-year project used a proximity-based approach to environmental education and outreach. A proximity-based approach involves an intensive outreach and education effort focused on a specific target audience located in close proximity to a stormwater demonstration site containing best management practices (BMPs) representing behaviors desired by watershed residents.

The theory underlying the proximity-based approach is that targeting public outreach and education on residents located in close proximity to stormwater improvement projects will not only improve the efficacy of the education effort but will increase the motivation to install BMPs designed to address NPS pollution. Accordingly, if the BMC Outreach and Demonstration Project were effective, the target audience should have a higher level of awareness of watershed and NPS pollution issues, a higher rate of BMP adoption by property owners, and a higher level of message retention from outreach and mass media campaigns than nonresidents.

This report evaluates the effectiveness of the proximity-based approach employed by the BMC Outreach and Demonstration Project. The evaluation used a standard quasi-experimental research design – a pretest-posttest nonequivalent control group design. The pretest surveyed a random sample of residents located in single- and multi-family residents in both the target area and the surrounding BMC watershed. A random sample of residents in the City of Wilmington was also surveyed. The posttest involved randomly sampling the same five groups of residents and administering the same set of survey questions. The BMC watershed and City samples served as comparison groups. If the BMC Outreach and Demonstration Project were effective, changes should generally be observed between the pretest and posttest samples for the target area but not for the comparison samples.

Project impacts were measured by comparing responses to a series of survey questions that served as indicators of awareness about NPS pollution, attitudes about the quality of local waterways, changes in behavior concerning structural and nonstructural BMPs, and the effectiveness of the outreach efforts employed by the project. A Pearson Chi-Square statistic was computed for each indicator. This statistic takes into account the variation in sampling error and the different sample sizes in the two survey periods. A probability level of $p < .05$ was used to determine whether the results indicated a statistically significant change in the hypothesized direction.

The results of the evaluation were generally disappointing. On the positive side, the BMC Outreach and Demonstration Project appears to have been successful in delivering messages to single-family homeowners in the target area. There were statistically significant changes in the percentages who reported receiving direct mail as well as those who reported reading

brochures, fact sheets, and newsletters. The absence of any corresponding change in the multi-family sample is most likely explained by the transitory nature of this population and the difficulty in obtaining an accurate list of phone numbers for sampling purposes. Evidence of the success of the mass media component is less clear as there were no statistically significant changes.

While the BMC Outreach and Demonstration Project appears to have been effective in delivering messages by direct mail using such techniques as brochures, fact sheets, and newsletters, it was less effective in changing watershed awareness, attitudes about local water quality problems, and behaviors concerning BMP adoption. There were no statistically significant changes in knowledge about the value of the structural BMPs. There were positive changes in two indicators of knowledge about water quality; however, similar changes in the comparison samples suggest that some other educational mechanism might be the cause.

The BMC Outreach and Demonstration Project also had little impact on changing attitudes about the water quality in the Cape Fear River, Greenfield Lake, BMC, or the Intracoastal Waterway. This was made more disappointing by the fact that there were statistically significant changes in attitudes about Greenfield Lake in the three comparison samples and changes in attitudes about the health of BMC in the single- and multi-family samples of watershed residents.

There was also a lack of evidence of behavioral change when it came to BMP adoption. No statistically significant changes in the adoption of structural BMPs were observed. A few positive changes in behavior of single- and multi-family residents in the target area were observed for nonstructural BMPs. These include a positive change in the disposal of grass clippings. There were also small percentage changes in those reporting "bad" behaviors such as dumping used motor oil, paint, or garbage into storm drains. Unfortunately, since almost no one reported engaging in the behavior during the pretest, there was little substantive change in behavior. What changed was a positive shift in those who reported that they would never engage in the behavior without being prompted by the surveyor. This suggests that educational messages reached their target even if there was little undesirable behavior to change. However, these positive results were tempered by the fact that positive changes were also observed for many of the same indicators in the three comparison samples. Moreover the samples for the single-family residents in the BMC watershed and the City experienced changes in more indicators than did the target area. These findings raise serious questions about whether the changes in behavior observed in the target area samples can be fully attributed to the BMC Outreach and Demonstration Project.

Based on these results, we were left to conclude that the proximity-based approach as employed by the BMC Outreach and Demonstration Project was not an effective strategy for changing watershed awareness, attitudes about local water quality problems, and behaviors concerning the adoption. The report concludes by discussing some of the broader public policy implications associated with the findings and identifying areas where future research is warranted.

Introduction

The goal of the Burnt Mill Creek Outreach and Demonstration Project was *to increase awareness about watershed issues and motivate residents and businesses in selected areas of the watershed to adopt responsible watershed practices on individual properties*. Burnt Mill Creek (BMC) is a water body degraded by urban nonpoint source (NPS) pollution and is on North Carolina's Section 303(d) list. According to the state's water quality monitoring data, the primary pollutants are fecal coliform bacteria, nutrients, and low dissolved oxygen. The major sources of these NPS pollutants are roadways, parking lots, and residential and commercial property.

The three-year Burnt Mill Creek Outreach and Demonstration Project used a proximity-based approach to environmental education and outreach to address these water quality problems. A proximity-based approach is characterized by an intensive outreach and education effort focused on a specific target audience located in close proximity to a stormwater demonstration site that contains best management practices (BMPs) representing the behavioral changes desired by watershed residents. The project relied on a wide range of education and outreach techniques including direct mail, workshops, the internet, and mass media. It also included the installation of a stormwater demonstration site featuring signage and a range of best management practices (BMPs) that could be adopted by watershed residents. The objective of these activities was to increase awareness of watershed issues and stimulate the adoption of structural and nonstructural BMPs including:

- Habitat gardens;
- Pervious pavement;
- Rain barrels;
- Bioretention areas;
- Rain gardens;
- Shoreline buffers;
- Native plants;
- Grassy swales;
- Improved maintenance of storm ditches;
- Picking up after pets;
- Improved car washing practices; and,
- Proper disposal of motor oil and other household hazardous waste.

The theory underlying the proximity-based approach is that targeting public outreach and education on residents located in close proximity to watershed restoration and stormwater improvement projects will not only improve the efficacy of the education efforts but it will also increase their motivation to install BMPs designed to address NPS pollution. Accordingly, if a proximity-based approach is effective, the target audience should have a higher level of awareness of watershed and NPS pollution issues, a higher rate of BMP adoption, and a higher level of message retention from outreach and mass media campaigns than residents in the BMC watershed or the City of Wilmington.

Research Design

This report evaluates the effectiveness of the proximity-based approach employed by the BMC Outreach and Demonstration Project. The evaluation relied on a standard quasi-experimental research design – a pretest-posttest nonequivalent control group design. This research design is often used when legal, ethical, or practical considerations make it impossible to employ a true experimental design. In this case, an experimental treatment was administered to an intact group of residents making the random assignment of individual subjects to separate treatment and control groups impossible.

The research design required a group of subjects to be measured (i.e., the pretest), introduced a treatment (i.e., BMC Outreach and Demonstration Project), and then observed the subjects again (i.e., the posttest). The treatment was introduced in a target area within the larger BMC watershed [Figure 1 and 2]. Residents elsewhere in the BMC watershed and in the City of Wilmington served as similar but nonequivalent control (i.e., comparison) groups. The comparison groups did not receive the information provided by direct mail (e.g., fact sheets, newsletters, invitations to public workshops). However, they were exposed to elements of the mass media campaign as well as unrelated sources of information on NPS pollution and BMP installation provided by other organizations.

The pretest involved surveying a random sample of residents located in single- and multi-family residents in both the target area and the BMC watershed. A random sample of residents in the City of Wilmington was also surveyed. The posttest randomly sampled the same five groups of residents and administered the same qiestionnaire. A pretest and posttest survey of the businesses located in the target area was also conducted.

This type of quasi-experimental design is powerful because it can detect changes due to the introduction of a treatment. Essentially, the approach involves comparing the results of the pretest and posttest surveys and identifying statistically significant changes in the responses. The availability of comparison groups in the larger BMC watershed and the City of Wilmington allowed the research team to determine whether the statistically significant changes were limited to the target area or were part of a broader scale change in watershed awareness or a higher rate of BMP adoption unrelated to the implementation of the BMC Outreach and Demonstration Project. If the proximity-based approach was effective, changes in the target area samples should be observed but not in the comparison samples. If a mass media campaign (either the one associated with this or some other project) of some other phenomena was having an effect, then similar changes should be observed in all three samples.

This quasi-experimental research design is subject to potential threats to validity that can confound analysis. These include attrition, maturation, history, and testing. Attrition is a potential problem if residents move in and out of the target area while the treatment is administered. This problem is most pronounced for the multi-family residents who rent in the target area. As a result, they may not be present for the whole treatment. They may also

Figure 1: Map of the Study Area

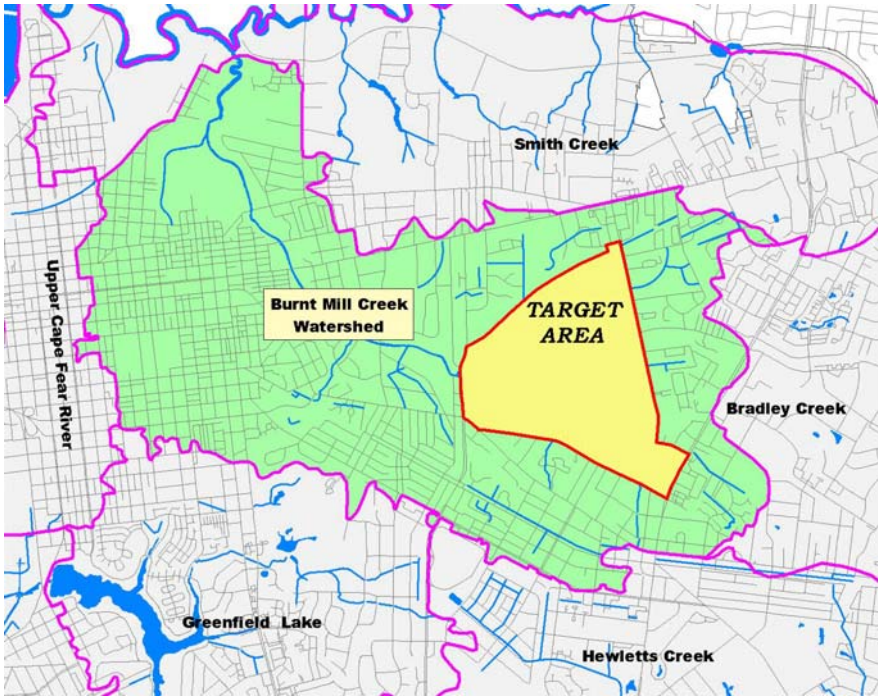
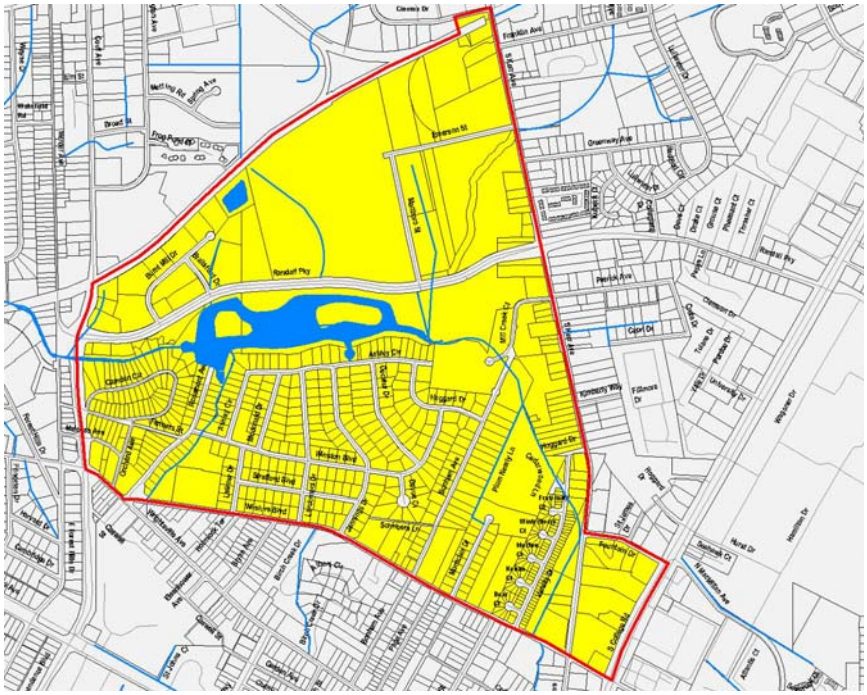


Figure 2: Map of the Target Area



identify less with their surrounding neighborhood (e.g., subwatershed) and be less susceptible to education and outreach messages with a place-based component. This could complicate efforts to identify significant changes in this subgroup of respondents.

Maturation and history can also be a threat to validity when long time periods elapse between the pretest and posttest. In this case, approximately 25 months elapsed between the pretest and posttest. Accordingly, events and educational efforts by other public and nonprofit organizations could confound the findings making it more difficult to observe statistically significant changes in the target group as compared to the various control groups. However, this problem is largely controlled for because the residents in the target area and comparison groups should experience similar effects due to history and maturation. Similarly, the administration of similar survey instruments to the target and comparison groups should minimize any validity threats due to testing.

Another potential validity threat are the survey questions asking about behaviors such as dumping used motor oil into a storm drain where the respondent might be unwilling to admit to a surveyor that they engaged in the behavior. Accordingly, it is possible that respondents may lie to the surveyor. Normally, this is cause for concern and the results should be viewed with some skepticism since at least some small percentage of respondents may be lying. However, if respondents are lying, then one can reasonably assume that they know that the behavior is wrong and inappropriate. This implies that they know what the correct behavior is. Since the objective of the project was to educate residents about the proper behavior, to the extent that the reported changes in behavior are in the desirable direction they should still be viewed as a positive indicator of the effectiveness of the project.

Survey Instruments

The pretest and posttest used a telephone survey administered randomly to five groups of residents:

- Single-family residents in the target area;
- Multi-family residents in the target area;
- Single-family residents outside of the target area but in the BMC watershed;
- Multi-family residents outside of the target area but in the BMC watershed; and,
- Residents in the City of Wilmington.

We used a telephone survey for several reasons. Given the large number of questionnaires that had to be administered to five different groups of residents, a telephone survey offered substantial savings in terms of time and cost than collecting data using face-to-face interviews or self-administered questionnaires. It also allowed the research team to use a questionnaire with a complicated skip pattern based on responses to a wide range of educational, attitudinal, and behavioral questions that were closed- and open-ended in nature. The use of a telephone survey also had the added advantage of standardizing data entry.

However, the use of a telephone survey did have some disadvantages. It limited the overall length of the survey. Questions also had to be simple enough to be understood and retained by respondents while they formulated answers. This created some limitations in terms of asking questions about complicated problems such as the causes of NPS pollution and certain BMPs.

The questionnaire used for the surveys was designed to collect five types of data from the respondents. It collected information on:

- ***Watershed awareness*** related to stormwater, NPS pollution, watersheds, and BMPs;
- ***Attitudes*** about the quality of local waterways;
- ***Behavioral changes*** associated with the adoption of structural and nonstructural BMPs;
- ***Outreach effectiveness*** to see where residents get information about watersheds, NPS pollution, and BMPs; and,
- ***Demographics*** pertaining to housing type, income, race, education, and sex to facilitate data analysis.

The questions were developed by the research team in conjunction with staff from the City of Wilmington's Stormwater Services. After a draft questionnaire was developed, it was pretested with a small group of people to ensure that the questions were understandable to the general public and that it could be completed within the target timeframe (i.e., approximately fifteen minutes). The basic questionnaire was then slightly modified given the fundamental differences in each group of respondents. For example, people living in apartments lack the property to install some types of BMPs.

Four different versions of the questionnaire were used for the pretest. The first was used for residents of single-family homes in the target area and outside the target area but inside the BMC watershed. The second was used for residents of multi-family homes in the target area and outside the target area but inside the BMC watershed. The third was used for city residents. The fourth was used for businesses. The posttest used similar versions of each questionnaire. A few minor changes to the pretest questionnaires were made to better reflect the treatment as it was actually implemented over the previous 25 months. The posttest versions of all four questionnaires are contained in Appendix A.

Survey Administration

The questionnaires were administered by the University of North Carolina Wilmington's (UNCW's) Survey Research Laboratory (SRL). The pretest was administered during October and November in 2002. The posttest was administered during January, February, and March in 2005. The total responses to each survey are listed in Table 1. In order to standardize data input and the administration of the survey, each version of the questionnaire was coded using software codenamed DATA, a variant of computer assisted telephone interviewing (CATI) software commonly used for telephone interviewing. The interviewer

Table 1: Total Number of Survey Responses for Pretest and Posttest Surveys

	2002 Pretest	2005 Posttest
Single-family – Target Area	63	62
Multi-family – Target Area	44	27
Single-family – BMC Watershed	301	318
Multi-family – BMC Watershed	155	314
City of Wilmington	395	1293
Total	**958**	**2014**

sits with a telephone headset in front of a computer. The program prompts the interviewer with the phone number to dial and what to say when a respondent answers the telephone. The computer then prompts the interviewer to ask a series of questions and provides a range of possible responses. These include both closed- and open-ended questions. The interviewer records the responses with the keyboard, writing it directly to the computer disk. The software helps validate the accuracy of the recorded data by comparing each item with a range of acceptable alternative responses. Any invalid data entry must be resolved before the interviewer can proceed to enter the response for the next question. This helps avoid the entry of spurious or invalid data. When the respondent's answer leads to specific follow-up questions, the software automatically prompts the data enterer for the relevant questions.

Interviewers consisted primarily of undergraduate and graduate students from UNCW. Each interviewer underwent a training session where they were informed of the purpose of the survey and the importance of clearly reading questions as written on the computer screen. The surveyors were also instructed on how to read the informed consent statement, and they were instructed not to interview anyone under the age of 18. The interviewers also practiced reading through the questionnaire and learned how to use the computer assisted telephone interviewing (CATI) software during the training sessions. The telephone survey was typically administered from 6:00 – 9:00 PM during the week from Monday to Thursday and on Sunday evenings. A supervisor was present to ensure quality control as were members of the research team.

Sampling Design

Telephone surveys for the pretest and posttests were administered to a random sample of residents of single- and multi-family homes inside the target area and outside the target area but inside the BMC watershed as well as the City of Wilmington. The preparation of the phone numbers for the four samples within the BMC watershed was a complicated process and differed for the pretest and posttest.

The list of phone numbers used for the 2002 pretest surveys was developed by the City of Wilmington's Stormwater Services using New Hanover County tax parcel data and City of Wilmington Utility Account information. A geographic boundary of the target audience area

was created using the City's geographic information system (GIS). This resulted in the selection of 745 lots or tracts of land from NHC parcel data. The parcel identification numbers were used to link these data to the City's Utility Account information, which included a phone number. However, if the parcel identification number in either database was incorrect then they could not be linked. Land use data from the NHC parcel data was then used to assign the parcel to the list of phone numbers for single- or multi-family homes and businesses. While these data were outdated, they were thought to be the most accurate source of information at the time. A similar procedure was used to generate the list of phone numbers for the BMC watershed with the numbers for the target area removed. The phone numbers for the random sample of residents for the City of Wilmington came from a bank of phone numbers compiled for other surveys of City residents conducted by UNCW's SRL.

The pretest list of phone numbers had some inaccuracies as evidenced by the large number of returned and undeliverable mailings. In an attempt to generate a more accurate list of phone numbers, City of Wilmington's Stormwater Services purchased a digital version of *Cross+Search Plus* from Hill Donnelly/City Publishing, which was published in November 2004. This database contained records for both citizens and commercial entities within Wilmington and New Hanover County. The records include a range of information including names, mailing addresses, telephone numbers, and information that could be used to categorize the property as a single- or multi-family residence or a business. A process called *geocoding* was then used to combine the data from *Cross+Search Plus* with the City's GIS system. The resulting dataset was a file that included both the contact information and a spatial representation. These data were then queried using the boundaries for the target area, BMC watershed minus the target area, and the City of Wilmington to generate the list of phone numbers that were randomly sampled during the posttest survey.

These procedures generated a slightly larger list of numbers from which to randomly sample in the target area, 974 compared to 745 records [Table 2]. This increase was due in part to factors such as population growth, increased occupancy rates in apartment complexes, and new economic development. It was also hoped that the posttest procedures would generate a more accurate list of phone numbers due to the procedures used, improvements in information technology, and the databases used to generate the information. However, as indicated in Table 1, the larger pool of phone numbers did not help to increase the sample size of single-family residents in the target area. The sample size of multi-family residents actually declined even though there was a larger pool of phone numbers to sample from [Table 2]. There was a slight increase in the sample size of single-family residents in the BMC watershed while the sample size for multi-family residents more than doubled [Table 1]. Based on these results, it was unclear to what extent the revised procedures actually produced a more accurate list of phone numbers.

While the problems with the 2002 database may have hindered the implementation of the treatment in some ways, the differences in procedures are of minimal concern to the analysis of the pretest and posttest data. Staff in the City of Wilmington's Stormwater Services were unable to discover any systematic errors indicating that some particular subset of potential respondents was ignored during the pretest. Moreover, the lack of any significant increase in the response rates suggests both procedures produced inaccuracies and it is

Table 2: Differences in the Pretest and Posttest Phone Sample for the Target Area

Land Use	Phone Numbers for the Pretest Sample	Phone Numbers for the Posttest Sample
Single-Family	473	396
Multi-family	205	429
Business	67	149
Total	**745**	**974**

reasonable to assume that these errors occurred randomly within each sample. Accordingly, there is reason to believe that that the population surveyed during the pretest and posttests was representative of the overall population in the respective geographic areas.

In an attempt to further investigate potential differences between the pretest and posttest samples, the demographic characteristics of the 2002 pretest and 2005 posttest samples were compared using statistical techniques. Table 3 presents the results of a Pearson Chi Square analysis (see the following section for a discussion of this procedure) comparing the five pretest and posttest samples for the target area, watershed, and city. The only significant difference for the single-family residents in the target area was that the posttest sample had a large number of property owners living on or adjacent to creeks, streams, or marshy areas. We can think of no reason why this difference would confound our findings because all of the more important socioeconomic variables had no statistically significant changes.

In terms of the multi-family residents, two comparisons were statistically significant. The home ownership variable in the posttest sample experienced a significant increase in those who rented, 51.2 percent in the pretest compared to 96.2 percent in the posttest. This suggests that the procedures used to develop the database may have generated a more reliable set of phone numbers for those who rented apartments, duplexes, and town homes than was used for the pretest. However, with the exception of dog ownership, which declined from 36.4 percent to 14.8 %, all of the important socioeconomic variables remained unchanged. While there are no important demographic differences between the samples that serve to confound the analysis, the inclusion of a larger number of renters who are transitory in nature opens up a potential threat to validity in attrition between the samples. As a result, some of the renters will not have experienced the full treatment. This bias will also produce a more conservative set of findings in that it is likely to underreport potential effects rather than over report them.

Comparison of the demographics for the pretest and posttest samples of single- and multi-family residents in the BMC watershed also produced statistically significant differences in home ownership. In the single-family resident samples for the BMC watershed, home ownership increased from 74.2 percent to 82.6 percent. However, none of the important socioeconomic variables changed in any significant way. In the multi-family home samples, the proportion of renters increased from 37.2 to 81 percent. The only other statistically significant change was in household incomes where there was a general increase in the lower

Table 3: Significant Demographic Changes Between the Pretest and Posttest Surveys

Changes in Demographic Characteristics	Target Area		BMC Watershed		City
	Single Family	Multi Family	Single Family	Multi Family	
▪ Have a dog	N	**	N	N	N
▪ There is a creek, stream, or marshy area on or next to their property	***		N		N
▪ Home ownership	N	***	**	***	N
▪ Education level	N	N	N	N	**
▪ Spanish or Hispanic origin	N	N	N	N	N
▪ Racial or ethnic group	N	N	N	*	**
▪ Household Income	N	N	N	**	N
▪ Gender	N	N	N	N	N

* Change would be statistically significant at $p < .1$
** change was statistically significant ($p < .05$) in the desired direction
*** change was statistically significant ($p < .01$) in the desired direction
(-) change was statistically significant but not in the desired direction
N indicates that there was no statistically significant change between the pretest and posttest samples
A shaded cell indicates that the question was not relevant to the sample

incomes and a decrease in the upper incomes. Collectively, these findings suggest that the revised procedures did a better job of identifying phone numbers for residents who rented and that the individuals excluded from the pretest sample were located in relatively less affluent households. It is unclear how this might bias the analysis. However, "environmentalism" is often associated with the affluent and better educated segments of society. Accordingly, these differences could bias the results in a conservative fashion by making it harder to identify statistically significant changes between the pretest and posttest samples. However, it is unclear to what extent this may or may not be the case.

Comparisons of the demographics for the pretest and posttest samples of City residents produced two statistically significant differences. The posttest sample was better educated with slight increases in the percentages of respondents with college and post graduate degrees and fewer individuals with high school, some college, or community college educations. The posttest sample was also more racially diverse with an increase in people identifying themselves as black from 3.8 percent to 8 percent. It is unclear how these sample differences might confound the analysis.

Procedures for Analyzing the Pretest and Posttest Data

Since many of the people interested in this evaluation might be unfamiliar with nonparametric statistical techniques, it is useful to briefly explain the methods used to analyze the data presented in the following sections. To simplify our analysis, we chose a Pearson Chi Square analysis because it is often recommended when the objective is to assess

Table 4: Results of the Cross Tabulation of Single-Family Residents' Collection of Dog Waste in the Target Area

Crosstab

% within Measurement period

		Measurement period		
		pre target single	post target single	Total
COLLECTS DOG WASTE	All the time	34.5%	25.0%	31.1%
	most of the time	24.1%	43.8%	31.1%
	Somtimes	3.4%	6.3%	4.4%
	Never	37.9%	25.0%	33.3%
Total		100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.272[a]	3	.518
Likelihood Ratio	2.244	3	.523
Linear-by-Linear Association	.122	1	.727
N of Valid Cases	45		

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is .71.

the impact of a treatment on a study population. In this case, we have two independent samples collected at the beginning and end of the project, the pretest and posttest, respectively. The response frequencies from the pretest are compared with those from the posttest. Differences between the two are presumed to be attributed to the treatment, in this case the Burnt Mill Creek Outreach & Demonstration Project. If there are no differences, then presumably the project had no impact. The comparison samples from the BMC watershed and the City of Wilmington are used to help verify that any statistically significant differences are due to the project and not to some other underlying change in attitudes and behaviors that occurred during the project period.

For example, consider Table 4. Does this table present evidence that the project had an impact on respondents' collection of dog waste when they walk them? Those who "never" collect pet waste dropped from 37.9 to 25 percent (a 12.9 percent decrease). Those who collect pet waste "most of the time" increased from 24.1 percent to 43.8 percent. Each indicates a positive effect desired as a result of the project. However those who collected "all of the time" dropped from 34.5 to 25 percent, a 9.5 percent decrease that was not desired.

Another complication is in the "sometimes" category. In percentage terms, there is almost a doubling people who "sometimes" collect waste, 3.4 to 6.3 percent. While this is a small

Figure 3: Pet Waste Collection is a Nonstructural Best Management Practice (BMP)

percentage, it is a substantial percentage increase. Is this good information for asserting the project had an impact since it is only about a 3 percent difference?

In order to understand if these changes are significant, it is important to recognize that these results are based on samples of a larger population. Random sampling was used to select households for participation. This sampling method means that some households were part of the survey while others did not participate, even though they had the same probability of participation as did the respondent. Consequently, the results could vary based on which households were included and which were not. To compensate for this variation we must consider sampling error.

Sampling error is an estimate of how much a sample can vary from other samples that might have otherwise been selected. It requires us to adjust what we assert about our results such that we can take into account sampling variability if other households had participated. Sampling error is largely determined by the number of observations. To see why the "sometimes" category presents a complication, assume there was a 4 percent sampling error. We apply this plus or minus 4 percent sampling adjustment to the number we observe, 6.3 percent, and determine that the percent of respondents who sometimes collect their waste lies between 1.3 and 11.3 percent. Now when we compare this range to the pretest number, we cannot determine if the people who sometimes collect their dog's waste went up or went down.

Thus, when we consider the whole table, two categories went in the desired direction, one category went in an undesirable direction, but we do not know what one category did. The Pearson Chi-Square statistical test is a means of resolving most of these complications. It

provides a summary statistic that takes into account both sample error and the consistency of comparisons across categories. For Table 4, the Pearson Chi-Square statistic is 2.272 with 3 degrees of freedom (df). This equates to a probability (p) of $p = .518$. To interpret the statistic we ask how likely this value would have occurred by chance, that is could it have been due to sampling variability? The interpretation, based on probability theory, is that it would have occurred by chance about 52 out of 100 times. However, we have selected to use a conventional standard for assessing outcomes of 5 or less times out of 100 (i.e. the $p < .05$ probability standard). The $p < .05$ standard is widely recommended when performing social science research. In other words, the results are considered to be statically significant unless the outcome is likely to occur 5 percent of the time or less. Since $p = .518$ exceeds the desired likelihood (i.e., a 51.8 percent chance), we conclude that there is insufficient evidence from the pretest and posttest results to assert that the reports of dog waste collection were different in the posttest sample when compared to the pretest sample. Thus, there is no evidence that the BMC Outreach and Demonstration Project had a significant effect on this behavior.

In the sections and tables that follow, we use the $p < .05$ probability standard as the basis for determining whether there is sufficient evidence to suggest that the changes observed were statistically significant. The tables also indicate when the Pearson Chi-Square statistic was $p < .01$. These results offer stronger evidence that the changes observed between the pretest and posttest samples are statistically significant (i.e., 1 or less times out of 100). Since several results were close to the $p < .05$ standard, the tables also report when the statistical analysis produced a Pearson Chi-Square statistic of $p < .1$. While not to be interpreted as statistically significant, these results do offer some evidence of a possible effect.

Summary of the Evaluation Findings

If using a proximity-based approach to environmental outreach and education is effective, changes in the frequencies of responses from the pretest and posttest surveys should be readily observed. In particular, we would expect to observe changes in the hypothesized direction for one or more indicators (i.e., survey questions) used to measure watershed awareness, attitudes, and behavioral changes due to the implementation of the BMC Outreach and Demonstration Project. The indicators constructed to measure outreach effectiveness are designed to determine the nature of the messages received by residents and whether they changed during the study period. Presumably, these changes would be attributable to the BMC Outreach and Demonstration Project.

Project impacts were measured by comparing the indicators of awareness, attitudes, behavior changes, and outreach effectiveness using the pretest and posttest samples of: (1) single-family residents in the target area; (2) multi-family residents in the target area; (3) single-family residents outside of the target area but in the BMC watershed; (4) multi-family residents outside of the target area but in the BMC watershed; and, (5) residents in the City of Wilmington. A Pearson Chi-Square statistic was computed for each indicator. This statistic takes into account the variation in sampling error and the different sample sizes in the two survey periods. A probability level of $p < .05$ was used to determine whether the results

indicated a statistically significant change in the hypothesized direction (e.g., the outreach effort increased rather than decreased BMP adoption or environmental awareness). There were several instances when a less conservative standard (i.e., $p < .01$) might have produced statistically significant findings.

The following sections summarize the results of these comparisons and draw conclusions about the implications of these findings. Appendices B, C, D, E, and F contain the frequencies and Pearson Chi-Square statistics for each indicator analyzed in this evaluation.

Changes in Watershed Awareness

The survey contained a series of questions to determine whether the BMC Outreach and Demonstration Project had any discernable impact on the residents' watershed awareness. The questions were of two general types. The first examined the knowledge about the value of selected best management practices (BMPs). The second examined the respondents' knowledge about watersheds and the fact the nonpoint source (NPS) runoff is an important water quality problem [See Appendix B for Statistical Analysis].

Knowledge about the Value of Selected BMPs

When respondents were asked about their behaviors (described below), they were also asked if they knew of any water quality benefits associated with selected BMPs to determine their knowledge about the value of engaging in these practices [Table 5]:

- Planting native plants;
- Using pervious materials for paths, walkways, or driveways;
- Installing rain gardens;
- Using rain barrels; and,
- Installing habitat gardens.

The results of the comparisons of residents of single-family homes in the target area produced no statistically significant differences between the pretest and post test surveys. Since the residents in the multi-family homes would be unable to install these BMPs, residents in the target area and BMC watershed were not asked this subset of questions.

The findings for the comparisons of the pretest and posttest samples for the single-family residents in the BMC watershed were equally disappointing. None of the indicators was statically significant in the desired direction. Moreover, while knowledge about the value of rain gardens was statistically significant, it was not it the desired direction. The percentage of individuals acknowledging that there were benefits associated with rain gardens was 19.9 percent in the pretest but declined to 11.4 percent in the posttest. Thus, knowledge about the value of rain gardens appears to have declined. There were no statistically significant changes in the five indicators for the sample of City residents.

Table 5: Evidence of Change in Watershed Awareness Based on the Pretest and Posttest Surveys

Indicators of a Change in Watershed Awareness	Target Area		BMC Watershed		City
	Single Family	Multi Family	Single Family	Multi Family	
Knowledge about the value of selected BMPs					
▪ Planting native plants	N		N		N
▪ Pervious materials	N				*
▪ Rain gardens	N		***(-)		N
▪ Rain barrels	N		N		N
▪ Habitat gardens	N		N		*(-)
Knowledge about water quality					
▪ All rain water is not absorbed by the ground before it gets to streams	N	N	N	**(-)	N
▪ Rain falling on roads picks up pollutants from automobiles	N	N	N	N	N
▪ Water from storm drains is carried to local waterways	N	N	***	N	*
▪ Major source of poor water quality is NPS runoff	**	N	***	N	***
▪ Recall hearing the term watershed	N	N	**	N	***
▪ They recall the name of the watershed they live in	**	*	N	N	N

* Change would be statistically significant at $p < .1$
** change was statistically significant ($p < .05$) in the desired direction
*** change was statistically significant ($p < .01$) in the desired direction
(-) change was statistically significant but not in the desired direction
N indicates that there was no statistically significant change between the pretest and posttest samples
A shaded cell indicates that the question was not relevant to the sample

Based on these findings, it does not appear that the BMC Outreach and Demonstration Project had a significant impact on residents of the target area when it comes to their knowledge of the value of best management practices (BMPs) such as planting native plants, pervious materials, rain gardens, rain barrels, and habitat gardens.

Knowledge about Water Quality

The respondent's knowledge of water quality and NPS pollution problems affecting the BMC watershed were examined using six indicators that asked questions such as whether rain falling on roads picks up pollutants and whether they recalled hearing the word watershed and knew the name of the watershed they lived in. The results of the comparisons of the pretest and posttest samples for the residents in single-family homes in the target area produced mixed results [Table 5]. Two indicators produced statistically significant results. There was a change in the percentage of respondents who knew that the major source of poor water quality in local waterways was runoff from yards, streets, and parking lots (i.e., NPS pollution). The percentage of respondents increased from 68.6 to 88 percent. The

percentage of respondents who knew the name of the watershed they lived in also changed from 20.9 to 44.4 percent. There were no statistically significant changes in the other four indictors. The results for residents of multi-family homes in the target area were more disappointing with no statistically significant changes [Table 5].

In the single-family home samples for the BMC watershed, three indicators were statistically significant. The percentage of respondents who correctly answered that water from storm drains is carried directly to local creeks, streams, lakes, and waterways increased from 70.1 to 79.6 percent. The percentage of respondents who correctly knew that the major source of poor water quality in local waterways was NPS pollution increased from 66.9 to 81.7 percent. The percentage of respondents who said they had heard the term watershed also increased from 68.7 to 76.6 percent in the posttest. Only one indicator for the multi-family home sample had a statistically significant result. However, the results were not in the desired direction. The number of respondents who correctly knew that all rainwater is *not* absorbed into the ground before it gets to local streams, creeks, and rivers declined from 84.2 to 73.8 percent.

The results of the comparisons of the pretest and posttest samples of City residents also produced two indicators with statistically significant changes. The percentage of respondents recognizing that NPS pollution was the major source of poor water quality in local waterways increased from 74.5 to 82 percent. The percentage of residents who had heard the term watershed also increased from 75.6 to 83.7 percent.

These results suggest that the BMC Outreach and Demonstration Project may have had some small impact on the residents of single-family homes due to the change in the two of the six indicators. However, the findings for the analysis of the comparison samples for the BMC watershed and the City produced a similar set of results. This casts doubt on whether the BMC Outreach and Demonstration Project was solely responsible for the changes observed in the two indicators. Since similar changes were observed not only in the BMC watershed but in the City sample, it is possible that the changes observed in the single-family home sample for the target area were part of some broader change in knowledge about the importance of NPS to local waterways caused by some other mechanism. To the extent that the BMC Outreach and Demonstration Project was the cause of the observed changes, it would most likely be its mass media component rather than the educational messages delivered by direct mail, the internet, or public workshops.

Changes in Attitudes about Water Quality

The survey contained four questions used to determine whether the BMC Outreach and Demonstration Project resulted in any changes in attitudes about water quality in the Cape Fear River, Greenfield Lake, Burnt Mill Creek (BMC), or the Intracoastal Waterway (ICW) [See Appendix C for Statistical Analysis]. Primarily, we were concerned with whether the respondents became more knowledgeable about water quality problems in BMC. However, it was possible that if the project was effective in providing information about water quality

Table 6: Evidence of Change in Attitudes Based on the Pretest and Posttest Surveys

Indicators of a Change in Attitudes about Water Quality	Target Area		BMC Watershed		City
	Single Family	Multi Family	Single Family	Multi Family	
▪ Water quality in Cape Fear River	N	N	*	N	N
▪ Water quality in Greenfield Lake	*	N	***	***	***
▪ Water quality in Burnt Mill Creek	N	N	**	**	N
▪ Water quality in Intracoastal Waterway	N	N	N	N	N

* Change would be statistically significant at $p < .1$
** change was statistically significant ($p < .05$) in the desired direction
*** change was statistically significant ($p < .01$) in the desired direction
(-) change was statistically significant but not in the desired direction
N indicates that there was no statistically significant change between the pretest and posttest samples

problems to the residents in the target area, then they might learn more about water quality problems in other local waterways as well.

The results of the comparison of the single- and multi-family samples in the target area found no statistically significant changes in the four indicators [Table 6]. The results of the comparisons of the pretest and posttest samples in the BMC watershed produced more positive results. The single- and multi-family samples experienced statistically significant changes in the response pattern for the questions asking about water quality in Greenfield Lake and Burnt Mill Creek (BMC). With respect to Greenfield Lake, the percentage of single-family respondents who thought that the water quality was "extremely good" or "good" remained essentially the same. The percentage who thought that water quality was "bad" also declined from 51.4 to 36.4 percent, however, the percentage who thought that the water quality was "extremely bad" increased from 37.4 to 52.9 percent. There was also a small increase in the percentage of single-family respondents who thought that the water quality in BMC was "good" (31.8 to 34.4 percent) and there was a decease in the percentage that thought it was "bad" (53.8 to 38.8 percent). At the same time, the percentage of respondents who thought that water quality in BMC is "extremely bad" increased from 14.5 to 26.3 percent.

In the multi-family sample, the percentage of respondents characterizing Greenfield Lake's water quality as "good" declined (14.2 to 10.2 percent). The percentage who thought it was "bad" also declined (54.2 to 41.1 percent). Conversely, the percentage of multi-family respondents identifying Greenfield Lake's water quality as "extremely bad" increased from 31.7 to 48.7 percent. There were also changes in how respondents viewed BMC's water quality. No one in the posttest thought that water quality was "extremely good", a decline of 1.5 percent. There was a slight increase in the percentage who thought that BMC's water quality was "good" (34.3 to 36.7 percent). There was a large increase in the percentage who viewed water quality as "bad" (44.8 to 57.8 percent) while the percentage who categorized it

as "extremely bad" declined from 19.4 to 5.5 percent. There were no statistically significant changes in the attitudes about water quality in the Cape Fear River or Intracoastal Waterway for either the single- or multi-family samples.

The comparisons of the pretest and posttest samples of City residents also revealed a statistically significant change in the attitudes about water quality in Greenfield Lake. The percentage of respondents identifying Greenfield Lake's water quality as good declined from 11.6 to 6.4 percent. Conversely, the percentage identifying its water quality as extremely bad increased from 34.9 to 49.1 percent. There were no statistically significant changes in the other three indicators.

While changes in attitudes about water quality in Greenfield Lake and BMC are encouraging, it is unclear to what extent they were due to the implementation of the BMC Outreach and Demonstration Project. If the project were responsible for changes in attitudes, one would expect to find statistically significant changes in the single- and multi-family home samples in the target area. The absence of these changes suggests that another mechanism could be responsible. For example, the water quality problems in Greenfield Lake are readily observable to anyone who passes by. Greenfield Lake's water quality problems have also received considerable media attention over the last few years. It is unclear why the changes in attitudes about BMC's water quality would be observed in the single- and multi-family samples for the BMC watershed but not in the single- and multi-family samples for the target area or the City sample.

Changes in Behavior

One of the primary objectives of the BMC Outreach and Demonstration Project was to change the behavior of residents in the target area. To measure these behavioral changes, the pretest and post test surveys contained a wide range of questions asking about whether the respondent had installed structural BMPs (e.g., installing pervious materials, rain gardens, habitat gardens, etc.) or utilized nonstructural BMPs (e.g., proper disposal of grease, collecting pet waste, getting soil tests, etc.) to minimize NPS runoff and improve water quality [See Appendix D for Statistical Analysis].

Use of Structural BMPs

The surveys of single-family residents in the target area, BMC watershed, and City asked respondents whether they installed any of the following structural BMPs:

- Planted native plants;
- Installed pervious materials;
- Planted trees for shade;
- Installed a rain garden;
- Installed a rain barrel;
- Have a habitat garden; or,
- Planted a buffer or vegetation next to a waterway.

Figure 4: Habitat Gardens are an Example of a Structural BMP

These seven indicators were used to examine the extent to which the proximity-based approach employed by the BMC Outreach and Demonstration Project changed behavior in terms of implementing structural BMPs.

Comparisons of the pretest and posttest samples for single-family residents in the target area produced disappointing findings. There were no statistically significant changes in behavior [Table 7]. The results of the comparisons of the pretest and posttest samples for single-family residents in the BMC watershed were also disappointing. Only one indicator produced statistically significant changes. The individuals who installed paths, walkways, or driveways and used pervious materials increased from 32.7 to 53.6 percent.

The comparisons of pretest and posttest samples of City residents produced three statistically significant changes, although two were in the opposite direction from that desired. On the positive side, of those who planted plants in the last year, the percentage of respondents who said they planted native plants increased from 64.6 to 77 percent. However, respondents were less likely to install rain gardens or plant buffers next to local waterways. In the pretest, 11.1 percent of respondents said they installed a rain garden compared to only 5.5 percent in the posttest sample. While 36.8 percent of respondents reported that they planted a buffer in the pretest, only 22.1 percent acknowledged doing so in the posttest.

The lack of statistically significant changes in the single-family home sample for the target area suggest that the BMC Outreach and Demonstration Project had little discernable impact on behavior when it comes to installing structural BMPs. There is also no reason to suspect that the BMC Outreach and Demonstration Project caused the positive or negative changes observed in the BMC watershed or in the City. The lack of statistically significant findings should not be surprising. Installing many of the structural BMPs requires knowledge of a

Table 7: Evidence of Behavior Change Based on the Pretest and Posttest Surveys

Indicators of Behavioral Change	Target Area		BMC Watershed		City
	Single Family	Multi Family	Single Family	Multi Family	
Structural BMPs					
▪ Planted native plants	N		N		***
▪ Installed paths with pervious materials	N		**		N
▪ Planted trees for shade	N		N		N
▪ Installed a rain garden	N		N		***(-)
▪ Installed a rain barrel	N		N		N
▪ Have a habitat garden	N		N		N
▪ Planted a buffer or vegetation next to waterway	N		N		***(-)
Nonstructural BMPs					
▪ Collect your dog's waste	N	N	*	N	**
▪ Wash your car in proper location	N	N	**	N	N
▪ Properly dispose of grass clippings	**	**	*	***	N
▪ Properly dispose of leaves or pine needles	N	N	N	***	**
▪ Properly dispose of cooking grease	N	N	**	N	N
▪ Did something to improve water quality	N	N	N	N	N
▪ Planted grass to eliminate brown spots	N		N		*(-)
▪ Got a soil test for their lawn	N		***		N
▪ Proper application of fertilizer	N		N		N
▪ Put grass clippings and leaves into a storm drain or drainage ditch	N	N	***	N	***
▪ Poured old or used engine oil or antifreeze into a storm drain or drainage ditch	**	N	N	N	*
▪ Emptied paint into a storm drain or drainage ditch	**	N	N	N	N
▪ Hosed down a driveway, sidewalk, or parking lot into a storm drain or drainage ditch	N	***	**	N	***
▪ Put garbage or litter into a storm drain or drainage ditch	**	*	**	N	**

* Change would be statistically significant at $p < .1$
** change was statistically significant ($p < .05$) in the desired direction
*** change was statistically significant ($p < .01$) in the desired direction
(-) change was statistically significant but not in the desired direction
N indicates that there was no statistically significant change between the pretest and posttest samples
A shaded cell indicates that the question was not relevant to the sample

Figure 5: Example of a Rain Garden BMP

practice, a behavioral change, and a commitment of resources such as time, money, and energy. Thus, it is reasonable to expect that these behavioral changes will be harder to achieve than getting residents to adopt the nonstructural BMPs described in the following section.

Use of Nonstructural BMPs

The survey also asked a wide range of questions that served as indicators to determine whether the BMC Outreach and Demonstration Project was effective in changing behavior associated with adopting nonstructural BMPs. The questions ranged from whether residents properly disposed of grass clippings and cooking grease to whether they engaged in destructive activities such as pouring engine oil or antifreeze into storm drains or drainage ditches.

Comparisons of the pretest and posttest samples for single-family residents in the target area produced mixed findings [Table 7]. The analysis revealed several positive changes that were determined to be statistically significant. Fewer people reported that they:

- Improperly disposed of grass clippings;
- Poured old or used engine oil or antifreeze into a storm drain or drainage ditch;
- Emptied paint into a storm drain or drainage ditch; and,
- Put garbage or litter into a storm drain or drainage ditch.

The response pattern to the question on where grass clippings are disposed reveals a decrease in leaving lawn clippings on the lawn (65.1 to 40 percent) and an increase in clippings going into the waste stream (14.3 to 23.3 percent), presumably for a legal yard waste pick up. There was also a slight increase in composting (17.5 to 21.7 percent).

Figure 6: Example of a Rain Barrel BMP

There was a decrease in the percentage who reported that they poured old or used engine oil or antifreeze into a storm drain or drainage ditch. While 1.7 percent acknowledged this behavior in the pretest, no one reported engaging in the behavior in the posttest. Moreover, 10.3 percent volunteered without being prompted that they "would never do it." No one volunteered this response in the pretest. Similarly, no one reported emptying paint into a storm drain or drainage ditch in the pretest and the same was true for the posttest. However, 10.3 percent volunteered without being prompted that they would never do this behavior. The same pattern was evident for the question asking whether they put garbage or litter into a storm drain or ditch. Accordingly, while the percentage change in behavior for these three indicators was actually quite small, the respondents were generally more emphatic during the posttest that they would not engage in this behavior. This suggests that the educational component may have reached its target even if there was little undesirable behavior to modify.

However, for most indicators we were unable to identify any statistically significant behavioral changes. Indicators where no statistically significant change in behavior occurred include:

- Proper collection of dog waste;
- Washing a car in the proper location;
- Properly disposing of grass clippings;
- Properly disposing of leaves and pine needles;
- Properly disposing of cooking grease;
- Taking actions to improve water quality;
- Planting grass to eliminate brown spots;
- Getting a soil test;
- Proper application of fertilizer to lawns;
- Not putting grass clippings and leaves into a storm drain or ditch; and,

- Hosing down a driveway, sidewalk, or parking lot into a storm drain or drainage ditch.

The comparisons of the pretest and posttest samples for the multi-family home samples in the target area produced disappointing results [Table 7]. Positive changes were observed for only two indicators:

- Properly disposing of grass clippings; and,
- Fewer reports of hosing down a driveway, sidewalk, or parking lot into a storm drain or drainage ditch.

On the positive side, changes in the response pattern for the question asking about the frequency of hosing down a driveway, sidewalk, or parking lot into a storm drain or drainage ditch were encouraging. Whereas 24 percent of pretest residents reported doing so less than once a month, 100 percent of the posttest sample reported that they never engaged in this behavior. However, it proved to be more difficult to determine how to interpret the changes for the grass clippings indicator. The percentage of respondents who reported leaving their grass clippings on the lawn decreased from 36.1 to 4.3 percent from the pretest to the posttest. However, there was a decrease in the number who reported composting (13.9 to 4.3 percent) and there were small increases in the percentages who reported putting them in the trash (22.2 to 30.4 percent) and on the street (8.3 to 13 percent). There was also a large change in the "don't know" response category (19.4 to 47.8 percent).

The results of the comparisons of the pretest and posttest samples for single-family residents in the BMC watershed produced a much broader range of statistically significant changes. This was somewhat unexpected and to some extent contradicts the assumptions of the proximity-based approach because the BMC Outreach and Demonstration Project appears to have had a stronger effect on the behavior of single-family residents outside of the target area than inside it. The comparison of the pretest and posttest samples revealed statistically significant changes in the following indicators:

- Using the proper car washing location;
- Properly disposing of cooking grease;
- Getting a soil test for their lawn;
- Fewer reports of putting grass clippings and leaves into a storm drain or ditch;
- Fewer reports of hosing down a driveway, sidewalk, or parking lot into a storm drain or drainage ditch; and,
- Fewer reports of putting garbage or litter into a storm drain or drainage ditch.

The changes in the response pattern for using the proper car washing location were mixed. The percentage who reported washing their car in a driveway declined from 70.8 to 47.1 but the percentage washing their car on the street increased from 7.7 to 20 percent. On a positive note, the percentage washing their car on the grass increased from 21.5 to 32.9 percent.

Disposal of cooking grease also experienced a mixed set of changes. There were small declines in those who disposed of grease in the sink (15.8 to 7.6 percent). Conversely, there

was an increase in those who disposed of grease in the trash (74.1 to 82.1 percent). There were only minor fluctuations in the percentages who reported disposing of grease in the toilet, on the ground, or in a storm drain or ditch.

There was also a significant change in the percentage of single-family residents in the BMC watershed who reported getting a soil test. While only 8.3 percent of the pretest reported getting a soil test, 17.2 percent of the posttest reported getting one.

There were fewer reports of putting grass clippings and leaves into a storm drain or ditch for the posttest than the pretest for single-family residents in the BMC watershed. The percentages who reported that they engage in this behavior "more than once a month" declined from 1 to .3 percent. The percentage practicing this behavior "less than once a month" also declined (5.2 to 2 percent). While the percentage who reported "never" declined from 91.3 to 88.6, the percentage who volunteered without being prompted that they "would never do" this behavior increased from 2.4 to 9.1 percent.

There were slightly fewer reports of hosing down a driveway, sidewalk, or parking lot into a storm drain or drainage ditch. There were small declines in the percentage of respondents who reported that they engage in this behavior "more than once a month" (2.8 to 2.4 percent), "less than once a month" (14.6 to 13.6 percent), and "never" (80.1 to 76.6 percent). However, the percentage who volunteered without being prompted that they "would never do" this behavior increased from 2.4 to 7.5 percent.

Similarly, there were fewer reports of putting garbage or litter into a storm drain or drainage ditch. The percentage of residents who reported engaging in this behavior declined slightly from 2.8 to 2 percent. There was also a small decrease in the percentage who reported "never" engaging in this behavior (93.4 to 87.5 percent) but this was offset by an increase in those who volunteered without being prompted to do so that they "would never do" this behavior (3.8 to 10.5 percent).

The results of the comparisons of the pretest and posttest samples for the multi-family residents in the BMC watershed revealed statistically significant changes in only two indicators:

- Properly disposing of grass clippings; and,
- Properly disposing of leaves and pine needles;

However, changes in the response pattern for both indicators were mixed. In terms of grass clippings, the percentage who reported leaving them on the lawn declined substantially from 43 to 21.2 percent while there was a large increase in the "don't know" response category (24.2 to 47.6 percent). There was a slight increase in putting the clippings in the trash (12.5 to 15.4 percent) and on the street (7.8 to 9.5 percent) while the percentage who reported burning (1.6 to .4 percent) and composting (10.9 to 5.9 percent) declined. The response pattern for the question asking respondents how they disposed of leaves and pine needles was also difficult to interpret. The percentage that left them on the lawn declined from 22.6 percent to 14.5 percent. There was a slight increase in the percentage who reported burning

them (1.6 to 2.6 percent). The percentage who reported putting them in the trash (20.2 to 16.4 percent), composting (19.4 to 8.6 percent), and putting them in the street (10.5 to 7.4 percent) declined while there was a large increase in the "don't know" responses (25.8 to 50.6 percent).

The results for the comparisons of the pretest and posttest samples of City residents revealed statistically significant changes in five indicators:

- Proper collection of dog waste;
- Properly disposing of leaves and pine needles;
- Fewer reports of putting grass clippings and leaves into a storm drain or ditch;
- Fewer reports of hosing down a driveway, sidewalk, or parking lot into a storm drain or drainage ditch; and,
- Fewer reports of putting garbage or litter into a storm drain or drainage ditch.

However, it is unclear how to interpret some of the observed changes. Others represent minor shifts in behavioral patterns that are statistically significant but are not necessarily substantively significant.

The results for the indicator examining the collection of dog waste reveal changes in all of the desired directions. The percentage of respondents who reported that they collect dog waste "all of the time" or "most of the time" increased from 43.5 to 55.8 percent and from 16 to 18.9 percent, respectively. Conversely, the percentage of respondents who reported that they "sometimes" collect dog waste declined from 15.3 to 9.8 percent while those who "never" collect waste declined from 25.2 to 15.5 percent. It is unlikely that these changes were due to the BMC Outreach and Demonstration Project. If that were the case, changes should be observed in the target area as well. It is also unclear why the City sample had a significant finding that was not observed in the other four samples. Accordingly, it is unclear how to interpret this positive finding.

The change in the response pattern for the disposal of leaves and pine needles was also hard to interpret. The percentage who reported leaving them on the lawn declined slightly (27.5 to 22.6 percent) as did the percentages who reported burning (1.7 to.9 percent), composting (24.6 to 21.3 percent), and "don't know" (16.2 to 14.8 percent). Conversely, there was an increase when it came to putting them on the street (2.8 to 5.2 percent) or in the trash (27.2 to 35.2 percent).

There were fewer reports of putting grass clippings and leaves into a storm drain or ditch in the posttest compared to the pretest. However, while statistically significant they do not appear to be substantively significant. The percentage who reported engaging in this negative behavior "more than once a month" and "less than once a month" declined from 1.1 to .2 percent and from 4 to 1.3 percent, respectively. Conversely, the percentage who reported "never" doing it increased from 93.6 to 94.6 percent. The percentage who volunteered without being prompted that they "would never do" this behavior also increased from 1.3 to 3.5 percent.

When asked about hosing down a driveway, sidewalk, or parking lot into a storm drain or drainage ditch, the changes in the response pattern were mixed and relatively small. The percentage who reported doing so "more than once a month" declined from 3.7 to 1.4 percent while there was an increase from 13.4 to 17 percent in those reporting that they did so "less than once a month." Similarly, while the percentage who reported "never" engaging in this behavior declined from 82.4 to 79.3 percent, there was an increase in the percentage who volunteered without being prompted that they "would never do" this behavior (.5 to 2.3 percent).

A similar response pattern emerged for the indicator asking respondents whether they put garbage or litter into a storm drain or ditch. The percentage who reported doing so "more than once a month" declined slightly from .5 to .1 percent while there was a small increase in those reporting that they did so "less than once a month" (.3 to 1.1 percent). The percentage who "never" engage in this behavior declined slightly from 96.8 to 94.4 percent, however, the percentage who volunteered without being prompted that they "would never do" this behavior increased from 2.4 to 4.4 percent. Once again, while statistically significant, the percentage changes were relatively small.

These results suggest that the proximity-based approach embodied by the BMC Outreach and Demonstration Project had only a limited impact on changing behaviors associated with various nonstructural BMPs. The strongest statistical impacts appear to have been in educating single-family homeowners about the importance of properly disposing of products such as paint, used engine oil, and antifreeze. However, the actual changes in behavior in percentage terms were actually quite small.

There also appears to be some evidence that the project had an impact on behaviors when it comes to the proper disposal of grass clippings. However, the results were mixed and the fact that there was evidence of a change at the watershed level suggests that these changes could be due to some other phenomenon. The same pattern held for the multi-family sample.

Similarly, there appears to be evidence that the project had an impact on keeping garbage out of ditches. However, the fact that significant changes were observed at the watershed and City levels suggests that some other cause may better explain these changes. Moreover, the changes, while statistically significant were substantively insignificant since very small changes in behavior were actually reported.

The most important change in reported behavior is actually in the multi-family sample where the frequency of hosing down a driveway, sidewalk, or parking lot into a storm drain or drainage ditch dropped from 24 percent doings so less than once a month to 100 percent reporting that they never engaged in this behavior. Unfortunately, the fact that the change was not observed in the single-family residents and that it was observed in two of the three comparison groups suggests that something other than the BMC Outreach and Demonstration Project might be the cause of this change.

The statistically significant changes in the comparison groups, while interesting, are unlikely to have been caused by the BMC Outreach and Demonstration Project. To the extent that

they were attributable to the BMC Outreach and Demonstration Project, they would most likely be due to its mass media component. Although, they could just as easily be explained by other NPS education efforts underway in the region.

Evidence of Outreach Effectiveness

The pretest and posttest surveys also contained questions designed to examine where residents received information about water quality and steps that could be taken to address NPS pollution. Two sets of indicators were used [Table 8]. The first used a series of questions examining whether residents in the target area received and acted upon outreach messages delivered by the BMC Outreach and Demonstration Project. Residents were also asked whether they were more likely to look for information on water quality. The second set of indicators examined whether residents in the five samples received messages sent by various forms of mass media [See Appendix E for Statistical Analysis].

Message Delivery and Action

This set of indicators asked about the methods used to convey information to residents over the course of the BMC Outreach and Demonstration Project (e.g., workshops, fact sheets, direct mail, etc.). Comparisons of the pretest and posttest samples within the target area provide some insight on whether these messages were received and acted upon. Residents in the target area received numerous direct mailings of fact sheets, brochures, and newsletters with information and an internet address where people could find more information. They also received post cards announcing dates and topics of neighborhood workshops and other educational events. While relatively easy albeit costly to conduct mass mailings, it is unclear whether residents read and respond to these materials. If they do, then some changes in the response patterns should be observed when comparing the pretest and posttest samples for the target area.

The results of the comparisons of the pretest and posttest samples for single-family residents in the target area produced three statistically significant changes [Table 8]. However, one of the changes was in the opposite direction from the one hypothesized by the project. There were no statistically significant changes in the multi-family sample. The most important finding was that there was a significant increase in the percentage of respondents who reported receiving direct mail, 29.3 percent to 75.4 percent. Since all residents in the target area received direct mail as a result of the BMC Outreach and Demonstration Project, we expected to have a positive, statistically significant finding for both the single- and multi-family samples for this indicator. The lack of a positive result for the multi-family home sample could be due in part to the problems with the initial mailing list and the transitory nature of the population living in this type of housing. It could also explain why this sample generally experienced fewer statistically significant changes than the single-family home sample.

It was also encouraging to find that there was a statistically significant increase in the residents reporting that they read a brochure, fact sheet, or newsletter with information about

Table 8: Evidence of Outreach Effectiveness Based on the Pretest and Posttest Surveys

Indicators of Outreach Effectiveness	Target Area		BMC Watershed		City
	Single Family	Multi Family	Single Family	Multi Family	
Message Delivery and Action					
▪ Recalled receiving direct mail about water quality	***	N	N	N	**
▪ Recalled seeing a local watershed sign	N	N	**	N	N
▪ Looked on the internet for information about local water quality and things to do to improve it	N	N	N	N	N
▪ Read a brochure, fact sheet, or newsletter with information about local water quality	***	*	*	*	N
▪ Attended a workshop on local water quality	*	N	N	N	N
▪ Are likely to read stories about local water quality in the newspaper	**(-)	N	**	N	N
Mass Media Campaign					
▪ Recalled seeing PSAs about water quality on TV	N	N	N	N	***
▪ Recalled seeing news stories about water quality on local television	N	N	N	N	**
▪ Recalled seeing news stories about water quality in the Star News	N	N	N	N	N
▪ Recalled hearing news stories or PSAs about water quality on the local radio	N	N	***(-)	N	N

* Change would be statistically significant at $p < .1$
** change was statistically significant ($p < .05$) in the desired direction
*** change was statistically significant ($p < .01$) in the desired direction
(-) change was statistically significant but not in the desired direction
N indicates that there was no statistically significant change between the pretest and posttest samples
A shaded cell indicates that the question was not relevant to the sample

water quality (i.e., 44.8 percent compared with 74.1 percent in the posttest). This suggests that a sizable percentage of people who received direct mail remembered reading some aspect of it. However, the mailings did not appear to increase the likelihood that they looked on the internet, attended workshops on local water quality, made them more likely to read stories about local water quality in the newspaper, or that they noticed local watershed signs. Interestingly, there was also a negative change in the percentage reporting that they would be more likely to read stories about local water quality in the newspaper. While there was an increase in those who reported that they would be "very likely" to read stories (44.8 to 54 percent) and a decline in those "unlikely" (8.6 to 3.5 percent), there was a major drop in those that would be "somewhat likely" (44.8 to 29.8 percent) and an increase in those that reported they "would not read" (1.7 to 12.3 percent). While further research on the effectiveness of direct mail as a method of providing information about water quality is still

needed, the results do suggest that direct mail can be an effective strategy to provide information on NPS pollution to residents.

Comparisons across the other three samples, the single- and multi-family residents in the BMC watershed and the City also reveal a few statistically significant changes. However, since no direct mail from the project was sent to the people living in these areas, it is unclear what the cause of these changes was. City residents reported a statistically significant change in receiving direct mail (26.1 to 32.5 percent). This change could possibly be due to other factors such as the annual newsletter the City sends out which contains information on drinking water quality or direct mail associated with other water quality projects sponsored by the City or nonprofit organizations.

Single-family residents in the BMC watershed did experience an increase in seeing watershed signs (41.3 to 52.5 percent). There was also a change in the responses when asked about how likely they were to read stories about local water quality in the newspaper. There was an increase in those who reported that they were "very likely" (48.3 to 58.1 percent) but a decrease in those "somewhat likely" (39.7 to 28.2 percent). There were also small increases in those who reported that they were "unlikely" (4.9 to 5.4 percent) or "would not read" (7.1 to 8.3 percent). It is unclear what caused these changes. It is possible that activities associated with the BMC Outreach and Demonstration Project may have triggered these changes. Single-family residents living in the watershed area might have an increased awareness of the watershed signs as a result of mass media associated with the project and may have been more likely to notice the signs associated with the stormwater demonstration site. This could also explain why they reported being more likely to read newspaper stories. The lack of similar findings in the multi-family sample could be due to the more transitory nature of these residents and the fact that they might not identify with the neighborhood they live in.

Mass Media Campaign

The second set of indicators examined whether residents received information from the mass media (e.g., radio, television, and newspapers). Since the BMC Outreach and Demonstration Project generated a number of mass media activities such as public service announcements (PSAs), comparisons across all five geographic areas can determine if these messages were noticed. Presumably, if a particular technique were truly effective, then positive changes should be observed across all five geographic areas. Moreover, if the proximity-based approach was effective, we would expect the residents in this geographic area to be particularly receptive to these messages.

Unfortunately, these comparisons produced only three statistically significant changes, none of which was in the target area. City residents experienced two statistically significant changes. The percentage of residents who saw a PSA about water quality on TV increased from 46.7 to 56.7. There was also a small increase in the percentage of residents that recalled seeing news stories about local water quality on local television from 53.3 to 59.4 percent. However, one change was in the opposite direction from the one desired. The percentage who reported hearing news stories or PSAs on the radio declined from 31.9 to 22.1 percent.

These statistical results cast further doubt on the efficacy of the proximity-based approach to environmental outreach. Residents in the target area were no more receptive to residents located in the comparison groups. The results also suggest that the mass media campaign associated with the BMC Outreach and Education Project, or for that matter any other mass media campaign during the study period, were generally ineffective as there were few changes between the pretest and posttest. While it is possible that PSAs on such things as stormwater management and picking up dog waste were not associated with "water quality" as asked in the survey questions, we believe that this is an unlikely explanation for the failure to observe changes. Moreover, the results of the analysis reveal few changes across all three geographic areas that might be explained by some sort of mass media campaign. The possible exceptions might be some of the identified changes in watershed awareness associated with the importance of NPS pollution and behavior changes associated with putting things in storm drains and ditches.

Business Survey

We also attempted to do pretest and posttest surveys of businesses in the target area in order to determine whether there were any changes in watershed awareness, attitudes, and behavioral changes due to the implementation of the BMC Outreach and Demonstration Project. However, sampling businesses proved to be a complicated endeavor.

First, the procedures used did not produce a good list of phone numbers for businesses. As indicated by Table 2, the list of phone numbers used in the posttest was over twice as large. During the pretest the surveyors encountered many wrong numbers, contacted businesses that were not located in the target area, and phoned numbers that turned out to be residences rather than businesses. Second, it proved to be difficult to develop a survey instrument that would be applicable to the diverse range of businesses located in the target area. Third, it was difficult to determine who to sample at a business. Some phone numbers went to the owner's answering machine that were never answered after repeated attempts. Others were answered by staff working in a store that refused to participate because they did not have the authority or were not knowledgeable enough to fill out the survey. Fourth, unlike the residential surveys, there was more suspicion by potential respondents. As a result, they were more hesitant to participate in the survey. Finally, many business people reported that they were simply too busy to answer the survey.

Consequently, we had no confidence in either the generalizability or usefulness of the initial survey results. During the posttest, we hoped that an improved set of phone numbers might eliminate some of these problems. We also redesigned the questionnaire and had a trained surveyor dedicated to sampling businesses. However, we experienced the same set of problems and were able to get only 34 respondents to complete a survey and had a large number of refusals (e.g., too busy and do not call back, wrong numbers, not in the survey area, actually a residence). More troubling, we were unable to contact over half of the total pool of numbers because there was either no answer, only an answering machine, or the person who picked up was too busy to talk at the time. Based on our inability to contact the

vast majority of potential respondents we have little confidence in the accuracy or validity of the completed surveys.

Comparison of the samples would also be problematic. In this case, the differences in the procedures used to generate the phone numbers do appear to have the potential for biasing the sample since the total pool of numbers more than doubled. Different procedures were also used to administer the survey and the survey instrument was modified in an attempt to encourage greater participation. Accordingly, there are no statistical results to report since no comparisons could be made between the pretest and posttest samples.

Conclusions

The BMC Outreach and Demonstration Project hypothesized that if a proximity-based approach to environmental outreach was effective, single- and multi-family residents should experience changes in watershed awareness, attitudes about local water quality problems, and behaviors concerning the adoption of structural and nonstructural BMPs. The analysis of the pretest and posttest samples leads us to several conclusions.

The project was successful in delivering messages to single-family homeowners in the target area. There was a statistically significant change in the percentage of homeowners that reported receiving direct mail. There was also a significant increase in those who reported reading brochures, fact sheets, and newsletters with information about water quality and things that can be done to improve it. While not statistically significant, there was also some indication of a positive change in those that reported attending workshops on local water quality. The absence of any corresponding change in the multi-family sample is most likely explained by the transitory nature of the population and the difficulty in obtaining a good list of phone numbers to use for sampling this population. It is unclear why more residents in the target area reported that they were less likely to read stories about local water quality in the local paper.

Evidence of the effectiveness of the mass media campaign is less clear. If it were effective, one would expect similar changes in both the target area and the control groups since the messages sent (e.g., PSAs on radio and television, newspaper stories, television coverage) could be received by people in all five samples. However, only the City sample experienced statistically significant changes in the percentages who reported seeing PSAs and news stories about water quality on television. Interestingly, there were no changes in those who recalled seeing news stories about water quality in the Star News. There was also no change in the percentage who recalled hearing news stories or PSAs about water quality on the local radio in four of the five samples. In the fifth sample, single-family residents in the BMC watershed, the percentage or residents hearing stories on local radio was statistically significant except it went down. These data suggest two possible conclusions. The first is that the proximity-based approach and its emphasis on direct mail, workshops, and the stormwater detention site did not make residents in the target area more receptive to mass media messages. The second is simply that the mass media campaign was not effective.

While the BMC Outreach and Demonstration Project appears to have been effective in delivering messages by direct mail, it was generally ineffective in changing watershed awareness, attitudes about local water quality problems, and behaviors concerning BMP adoption. There were no statistically significant changes in knowledge about the value of structural BMPs. There were some positive changes in improving knowledge about water quality. Statistical evidence suggests that there was an increase in the percentage that knew that the major source of poor water quality was NPS runoff and there was a positive change in the percentage that knew the name of the watershed they lived in. However, the presence of similar changes in the samples for single-family residents in the BMC watershed and the City suggest that some other educational mechanism might be the cause. The lack of statistically significant changes in the multi-family residents in the target area is likely explained by the transitory nature of this population.

It was also clear that the BMC Outreach and Demonstration Project had little impact on attitudes about the water quality in the Cape Fear River, Greenfield Lake, BMC, or the Intracoastal Waterway. There were no statistically significant changes in attitudes in either the single- or multi-family samples for the target area. However, there were changes in attitudes about Greenfield Lake in the other three samples. There were also changes in attitudes about the quality of BMC in the single- and multi-family samples of watershed residents.

Evidence pertaining to behavioral changes was also disappointing. No statistically significant changes in the adoption of structural BMPs were observed. Although positive changes in behavior some nonstructural BMPs in the target area were observed. Positive changes in the disposal of grass clippings were observed. There were also small percentage changes in those reporting "bad" behaviors such as dumping used motor oil, paint, or garbage into storm drains. Unfortunately, since almost no one reported engaging in the behavior to begin with, there was little substantive change in behavior. What changed was a positive shift in those who reported that they would never engage in the behavior without having to be prompted by the surveyor. This suggests that the educational messages may have reached their target even if there was little undesirable behavior to change.

These positive changes should be tempered by the fact that positive changes were also observed for many of the same indicators in the BMC watershed and City samples. Moreover the samples for the single-family residents in the BMC watershed and the City experienced changes in more indicators than did the target area. These findings raise serious questions about whether the changes in behavior observed in the target area can be attributed to the BMC Outreach and Demonstration Project. In all likelihood, some other educational process was the cause of the changes across all five samples. To the extent that the BMC Outreach and Demonstration Project had some influence, it was most likely its mass media component. Although, these data suggest this is not the case.

Based on these results, it does not appear that the proximity-based approach as employed by the BMC Outreach and Demonstration Project is an effective strategy for changing watershed awareness, attitudes about local water quality problems, or behaviors concerning BMP adoption. While residents of the target area reported receiving information, the evidence

suggests that they did not retain or act on much of it. Changing behavior is difficult and likely requires more than simply reading educational information. Behavior changes such as the installation of structural BMPs requires not only the knowledge about proper behavior but also involves commitments of resources like time and money. It is possible that further analysis of these data will reveal changes among various subgroups. Similarly, only small portions of the samples engaged in some behaviors such as planting trees or installing paths. Thus, only a small subset of each sample was asked about whether they installed a structural BMP. This fact makes it difficult to detect changes in the aggregate. Accordingly, an important area for future investigation is whether there may changes among various subgroups and whether these changes are modified by different socioeconomic factors.

Local officials should also take some consolation in the fact that very few residents reported engaging in "bad" practices like putting grass clippings, leaves, paint, engine oil, antifreeze, or garbage in drainage ditches or storm drains during the pretest. Thus, for many indicators it was going to be very difficult to demonstrate results that were substantively significant. After all, if virtually no one dumps something like used motor oil into a storm drain there is little behavior to modify. Conversely, it is also clear that much work needs to be done to educate homeowners about BMPs such as rain barrels, habitat gardens, planting buffers, and rain gardens because few residents in any of the samples reported knowing the benefits of these practices. Moreover, in the City sample, the percentages who reported installing rain gardens and planting buffers actually declined between the pretest and the posttest.

Implications for Future Research

While more research is clearly needed and the results are limited to one project focused on a target population with a particular set of demographic characteristics, they do suggest some important public policy implications. First, the results suggest that a proximity-based approach with a broad range of outreach methods done in conjunction with a neighborhood stormwater demonstration site has limited ability to change watershed awareness, attitudes about water quality problems, or behaviors concerning the adoption. It is unclear whether the proximity-based approach is based on a flawed theory or whether the target area selected had demographic characteristics that limited its effectiveness. In either case, more research is warranted because it is widely assumed that implementing demonstration projects (e.g., the stormwater demonstration site) in conjunction with education and outreach will influence behavior. In fact, numerous demonstration projects similar to this one have been implemented nationwide. The statistical findings reported here cast doubt on whether this strategy is effective in educating or changing the public's behavior.

Second, the continued mailings of NPS related materials to residents in the target area had little discernable impact on residents in the target area. There are many possible explanations. It could be that the target area had demographic characteristics that limited the likelihood that direct mail would produce the changes desired. It may also be the case that those who are already interested in environmental issues read the materials and those who are not simply dispose of the materials without reading them. Thus, while a small percentage might become interested as a result of receiving materials, little behavior change occurs

overall. This is clearly an important area for future research. If these findings have broader generalizability, there would be profound public policy implications because a substantial investment of time, money, and energy is spent distributing outreach materials not only in Wilmington but in countless cities across the United States.

Third, the results raise important questions about what information needs to be provided to the public about NPS pollution and behaviors related to the adoption of structural and nonstructural BMPs. For example, a great deal of time, money, and energy is spent explaining what NPS pollution is and that dumping things like used oil and garbage in storm drains is bad. However, roughly 80 percent of residents in Wilmington know that water from storm drains is carried directly to local waterways and had heard the term "watershed" while an impressive 97 percent know that rain falling on roads and highways and other paved surfaces picks up pollutants. Moreover, with the exception of hosing down driveways and parking lots to storm drains, virtually no one in any of the samples reported engaging in this behavior. While there was clearly a time when these messages were appropriate, it may not be the case any more. It is also clear that much work remains to be done to educate the public about some BMPs (e.g., habitat gardens, soil tests, the importance of planting vegetation next to local waterways, etc.). Much more needs to be learned about the current state of public knowledge and how it differs along various socioeconomic characteristics in order to design more effective outreach and education campaigns.

Finally, it is clearly very difficult to target a transitory population such as those who live in multi-family housing with a project such as this. Not only do they move before experiencing the full long-term educational effort but they are unlikely to identify with their neighborhood (i.e., subwatershed) as much as a homeowner would. Other socioeconomic differences associated with multi-family housing (e.g., rent subsidized apartments) may also limit a NPS educational effort's ability to effectively change watershed awareness or behavior. Accordingly, an important area for further investigation is to determine whether certain socioeconomic characteristics influence BMP adoption and find out which outreach methods can best be used to educate transitory populations. This could help in designing more effective education and outreach programs.