The Lakeside Stormwater Reduction Project (LSRP):

Evaluating the Impacts of a Paired Watershed Study on Local Residents

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Abstract

Scientists, city utilities staff, and local environmental engineers teamed up with homeowners to determine the best ways to reduce stormwater runoff from the Lakeside residential neighborhood in Duluth. The Lakeside Stormwater Reduction Project (LSRP) used a paired-watershed approach to assess the results of diverse stormwater treatments in the Lakeside neighborhood of Duluth on stormwater runoff into Amity Creek. The project investigated various installations that reduce runoff and can be easily maintained by homeowners. The goal was to identify effective methods to reduce runoff contributing to problems in Amity Creek and the Lester River. To complement extensive biophysical monitoring, a knowledge, attitudes and practices (KAP) study was done in April 2008. The purpose was to obtain baseline human dimensions data; assess residents' willingness to participate in the project; and to identify possible barriers to adoption. Baseline information and residents' views about stormwater issues were obtained in April 2008. The first-round KAP data was used to refine project design, and to identify possible barriers to participation. The study was repeated with the same sample in September 2010 to evaluate outcomes and impacts. Comparison of the pre and post KAP data shows a significant increase in respondent knowledge about stormwater, a positive shift in attitudes, and strong evidence of adoption of stormwater practices as a result of project efforts. The project successfully increased awareness among residents about the impacts of stormwater on Amity Creek and the Lester River, and fostered adoption of stormwater management practices by homeowners, even in the control sample.

Acronyms

BMPs	Best management practices
CCM	Conservation Corps of Minnesota
DNR	Minnesota Department of Natural Resources
KAP	Knowledge, attitudes and practices
LSRP	Lakeside Stormwater Reduction Project
MCC	Minnesota Conservation Corps
MPCA	Minnesota Pollution Control Agency
NRRI	Natural Resources Research Institute
SIDMA	Social indicators data management and analysis
SIPES	Social indicators planning and evaluation system
SSLSWCD	South St. Louis Soil and Water Conservation District
UMD	University of Minnesota Duluth
USEPA	United States Environmental Protection Agency
WLSSD	Western Lake Superior Sanitary District
WRC	University of Minnesota Water Resources Center

I. Introduction

A team of University of Minnesota researchers, educators and local agency partners have been collaborating since 2002 to address stormwater pollution issues in western Lake Superior watersheds. The Website *www.lakesuperiorstreams.org* provides extensive information on this collaboration and stormwater impacts to area streams. The group also created the Regional Stormwater Protection Team (*www.duluthstreams.org/stormwater/rspt/html*) to provide science-based information to the public, agencies and businesses. Ron Weber, a former Duluth resident, provided initial seed money to fund an initiative to "fix" problems in Lake Superior trout streams. The City of Duluth and the University of Minnesota Duluth (NRRI and Minnesota Sea Grant) and other partners received funding from the United States Environmental Protection Agency 319 Program. The Minnesota Pollution Control Agency provided additional funds to support this inter-agency effort.

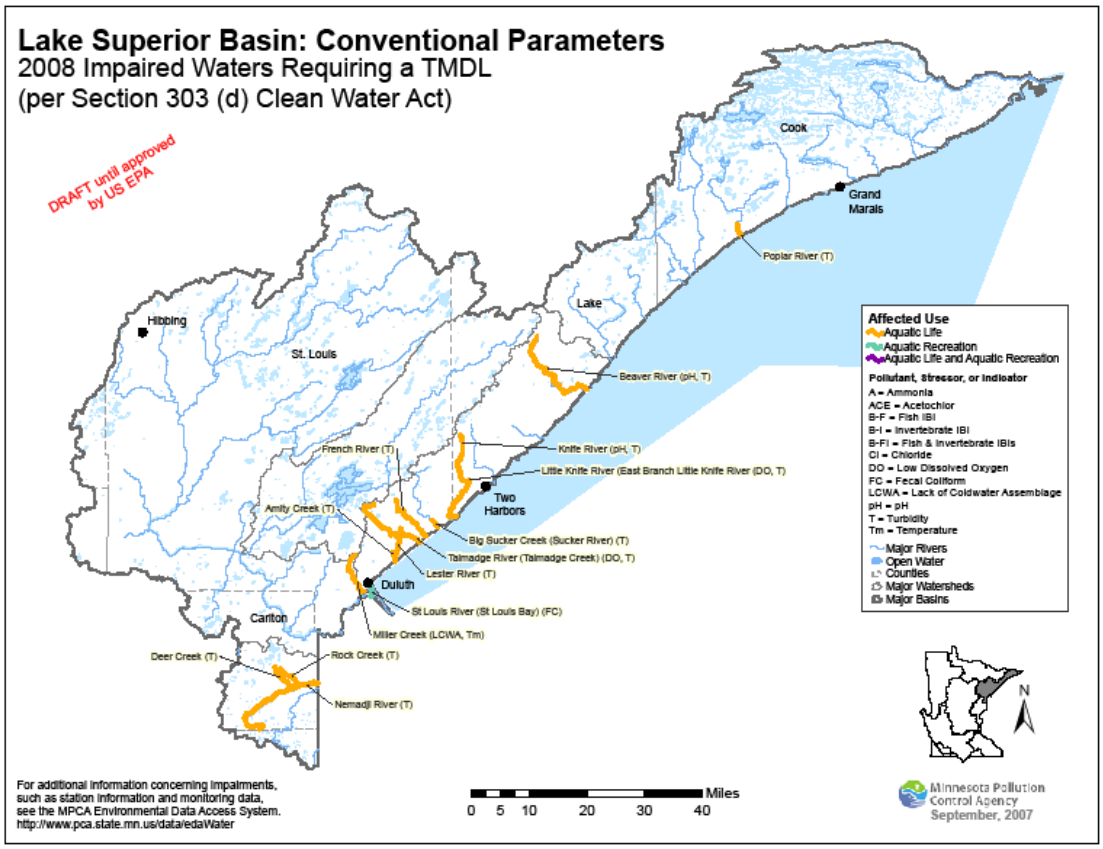

Figure 1: Impaired Streams on Minnesota's North Shore of Lake Superior (Courtesy of the Minnesota Pollution Control Agency)

The Lester River/Amity Creek system was chosen to be a demonstration project because it was designated as impaired due to excessive turbidity from sediment (*http://www.duluthstreams.org/weber*). High volumes of water running off residential lots

during storms that wash sediment into the streams and increase erosion of stream banks is thought to be a significant contributor to the problem.

The LSRP is designed as an adaptive, paired watershed research project that centers on three adjoining streets in the Lakeside neighborhood of Duluth. The project objective is to determine if working with homeowners to install stormwater retention features has the potential to produce a cost-effective improvement that could be applied throughout the Great Lakes Basin. The study compares a "retrofitted" neighborhood to one left "as is." In addition, the study evaluates the effect of various educational and awareness approaches on changing people's understanding and actions as related to water quality issues

The LSRP demonstrates the effectiveness of residential Best Management Practices (BMPs) at reducing stormwater runoff problems for Lake Superior tributaries. The project installed residential BMPs in a subwatershed in an older residential neighborhood in order to compare the runoff to that of similar control subwatersheds without stormwater BMPs. The neighborhoods identified for the program are located in the Lester-Amity stream system that is on the Minnesota 303(d) list for excessive turbidity. Tributaries receiving the runoff from the targeted neighborhood are being severely eroded by high peak flows and deliver highly turbid water to the stream. Water flow, temperature, and turbidity measurements were taken within storm sewers in both subwatersheds before and after BMP installation, requiring three full field seasons of work. Real-time flow, temperature and turbidity data from storm sewer flow are posted on the Lake Superior Streams website (*www.lakesuperiorstreams.org*). Residents' knowledge of runoff issues, solutions and responsibilities were measured at the beginning and end of the project. Results of this demonstration project should be applicable throughout the Great Lakes.

One component of the LSRP included a baseline socio-economic KAP (knowledge, attitudes and practices) study of the target audience in the project area. The findings of the first-round study, completed in April 2008, were summarized in Eckman and Walker (2008). The first KAP study was carried out prior to intensive education and outreach efforts, and before stormwater retention devices were installed on properties in the treatment area. Results were used to inform project planning, identify potential participants, and to design education and outreach activities. The KAP study was repeated with the same respondents in September 2010. This report compares the pre and post project KAP study data sets, and assesses the results of the LSRP education and outreach efforts with local audiences. The LSRP began in February 2008 and closes in June 2011.

Stormwater Issues in Duluth

In the Lakeside neighborhood, stormwater drains into Amity Creek, a DNR-designated trout stream which is on the MPCA impaired streams list for turbidity. Amity Creek flows into the Lester River, and then into Lake Superior. In Duluth Minnesota and Superior, Wisconsin, the ultimate receiving bodies of urban stormwater are the St. Louis River Estuary and Lake Superior. In addition to impacts on waterbodies, stormwater creates problems for homeowners in Duluth, and especially for those living below properties that channel stormwater downstream.

Like much of Minnesota's north shore of Lake Superior, the Lakeside neighborhood rests on clayey soils perched on bedrock where water cannot easily percolate. Before these residential properties were developed this water would mostly have soaked into the ground and very slowly seeped into a local stream or wetland. If it all runs off the property, it can cause problems as it combines with runoff from other properties. The greater the percentage of impervious surface in the watershed, the greater are the impacts on downstream water bodies, and the more expensive it is to fix the problems.

Many Lakeside residents report that stormwater runoff causes flooded basements and other problems that are costly to deal with. City staff report many complaints from residents about wet yards and winter icing from sump pump activity. The City is seeking an effective program to address nuisance ponding at the source, as well as reducing flows to the stormwater system and winter icing problems. Besides problems such runoff causes on residential properties, increased runoff due to urban development is creating problems for area streams. Runoff from driveways, roofs and streets enters storm sewers and flows directly into streams and lakes untreated, carrying trash or pollutants with it. Consequently, it is a problem both with the amount of flow, and with the salt, nutrients, and pollutants carried in stormwater to neighboring waterbodies.

The Amity Creek tributary near Graves Road runs turbid during storm events, and has severely eroding banks and gullying due to excessive runoff received from adjoining neighborhood storm sewers. Excessive runoff, and the associated sediment caused by the increased erosion, often carries greater loads of nutrients and chloride into streams (Anderson *et al* 2003). Runoff from residential neighborhoods helps to create these high peak flows, leading to the erosion that creates turbidity in Amity Creek.

Photo 1: Graves Road tributary to Amity Creek, 2008. This tributary receives stormwater flow from the study neighborhood and experiences high amounts of erosion during storm events.

The LSRP paired watershed project area includes a treatment street, a control street, and an intervening street in the Lakeside neighborhood of Duluth. The portions of each street are three blocks long, and include large newer homes uphill, and modest older homes downhill. The three city streets (Ivanhoe, Idlewild and Kingston) have separate underground stormsewer pipes that can be individually monitored for water quality using automated sensors. The storm sewers for all three streets drain toward the Graves Road tributary and Amity Creek, which flows into the Lester River and eventually into Lake Superior.

Photo 2: Erosion and sedimentation in the Graves Road tributary, 2008.

Photo 3: Confluence of the Graves Road tributary and Amity Creek.

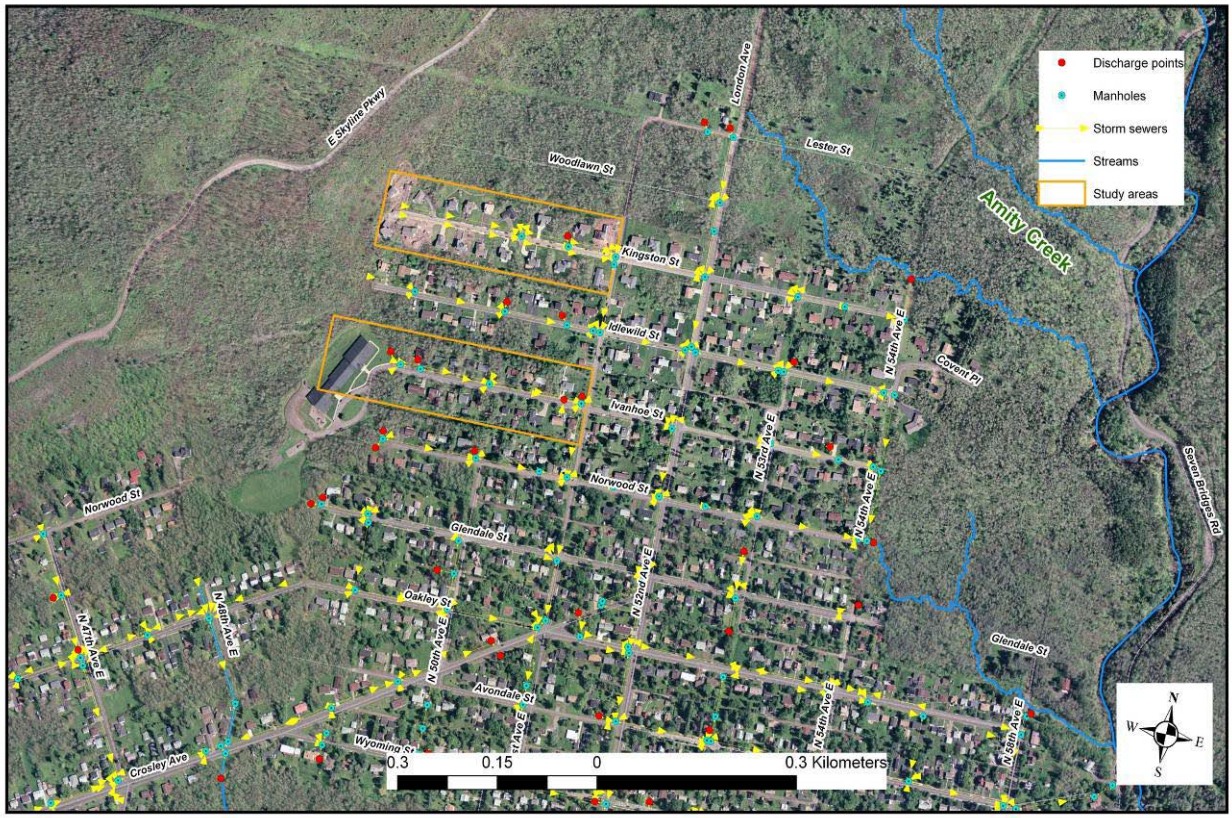

Photo 4: Aerial view of the project neighborhood.
Source: Jesse Schomberg

II. Methodology

The LSRP team needed to determine existing knowledge, behaviors and practices related to residential stormwater management in the project area in order to plan and carry out the paired watershed project. Initially the team intended to use the SIPES (Social Indicators Planning and Evaluation System) and SIDMA (Social Indicators Data Management and Analysis) framework developed through the USEPA Region 5 social indicators effort. It was determined, however, that the standardized SIDMA questionnaire for urban residents did not include the specific questions needed to plan the LSRP. It was therefore decided to carry out an experimental KAP study to help plan the LSRP and to evaluate outcomes and impacts on local residents. KAP studies have been widely used in international water quality and sanitation programs, especially in developing countries, but are relatively unknown in the United States. The KAP methodology used in this project was based upon a literature review done in 2007 by WRC (Eckman 2011),[2]

[2] Since the first LSRP KAP study in April 2008, the Water Resources Center has conducted about twenty additional KAP studies in Minnesota on a variety of water resources projects. A meta-analysis of the KAP study method is forthcoming by Eckman et al.

which identified the key elements and protocols for conducting a KAP study. This is thought to be one of the first times that a KAP study has been tested in a water quality project in Minnesota.

To prepare the LSRP KAP study a "gap exercise" was organized and facilitated by WRC staff, whereby project team members considered what they would need to know about local homeowners in the treatment and control areas. Specifically, the team focused on *"what don't we know about our audience, but should*?" A list of gaps was compiled as the project partners discussed the specific issues and questions that would need to be answered before planning the project activities and identifying participating households. Some of the gaps identified could be addressed using existing data (such as St. Louis County databases, GIS layers, or US Census information). The list of gaps was refined and ranked, and formed the basis for the survey questionnaire. Draft questions were developed by the team, refined, and finally incorporated into a draft Survey Monkey questionnaire. The draft questionnaire was circulated among team members and revised again until consensus was reached on content and wording. The final Survey Monkey questionnaire was then pretested, printed and administered during a house-to-house survey from May 5-10, 2008.

The survey sample included all households within the paired watershed area as defined by project researchers. The treatment and control samples corresponded to the underground storm sewer structure, separated by a "buffer" or intervening street. The total number of households in the paired watershed area was 83, of which 63 were sampled in both 2008 and 2010 for a response rate of 76%. While this population is of course too small for random probability sampling, it did offer an opportunity for a purposive sample and qualitative research methods (descriptive statistics, direct/participant observation, and key informant interviews).

The survey enumerators were five Minnesota Conservation Corps crew members who were trained by WRC in interviewing and data entry. A second MCC crew was trained for the second-round (repeat) survey in 2010. The WRC team (Karlyn Eckman and Rachel Walker) supervised the 2008 field work with the support of Valerie Brady and other staff from NRRI and Minnesota Sea Grant. WRC supervised the second-round field survey in 2010 as well. Fifty-seven households were interviewed in-person during the week of May 5-10 2008. Six households that could not be reached in person later completed and returned a mailed questionnaire, for a total of 63 households. Three of the returned mailed questionnaires did not include an address, could not be positively identified and were therefore eliminated from the survey. All households on the treatment street were surveyed except one, which could not be contacted. Twelve of nineteen households on the control street were surveyed (six households were unreachable; one homeowner refused). In 2010, the same 63 households were re-contacted and interviewed, for a 73% response rate.

Questionnaire data for both surveys was entered into Survey Monkey by MCC crew members, who cross-checked each other's data entry for accuracy. The Survey Monkey software automatically calculated descriptive statistics. In addition, a WRC research assistant (Lilao

Bouapao) conducted a content analysis on the many open-ended comments provided by respondents. Findings from the content analysis are incorporated into the following sections.

III. Results of the First-Round KAP Study (April 2008)

Findings are presented first as a summary with averages for all three streets. This section also summarizes findings by block for respondent knowledge, attitudes and practices, where findings are broken down by block for treatment, intervening and control streets.

Summary of 2008 KAP Study Results

A larger number of respondents in the first KAP study believed that stormwater causes greater problems on their neighbors' property (40%) in comparison to their own property (27%). Thirty-two percent said that stormwater is not a problem on their lot. Some respondents said that stormwater affects a neighbor's retaining wall or their neighbors' basements. One respondent said s/he believed that "Hawk Ridge Estate [an uphill development] should not have been built." Another said, "He who has the lowest house loses." Yet many also contradicted some of their earlier claims that stormwater is not a problem on their property. Many respondents said that their basements had flooded several times in the last decade. Some said that basement flooding is a "big problem in East Duluth," reporting an average accumulation of four inches in their homes. Many discussed problems with failed sump pumps and two property owners acknowledged spending $10,000 the previous year on excavation around their foundation as a result of basement flooding. One of these homeowners said, "You don't know the importance of [stormwater management] until it happens to you."

Sixty-five percent of respondents said that they manage stormwater on their property with a sump pump and 32% managed stormwater with landscaping. Some discussed adjusting the gradient on their property, adding trees, installing gutters to channel water to the center of their yard, and putting rocks into a small creek bed ("Penny Creek") or a ditch behind their home. Several respondents said that they manage stormwater with drain tile or French drains, in some cases channeling water from their property onto the street. Some mentioned the value of having or wanting city curbs. Some were aware of a "class about rain barrels," but had no time to attend, and others were aware that street leaf litter cleanup might help to improve water quality. The MCC survey crew observed respondents' landscaping efforts, but they did not find widespread use of rain gardens, rain barrels, or native plants.

While a majority of respondents said they learned about stormwater issues from TV news or weather (62%), 21% said they were not aware of any helpful information to manage stormwater, and 25% were unsure how to manage stormwater on their property. Some respondents had heard of "Rex, the watershed dog," or had learned about stormwater issues from print media. One respondent said s/he had visited *www.lakesuperiorstreams.org*.

While 38% thought that stormwater might cause problems in Lake Superior, 84% were unaware that Amity Creek is listed by the MPCA as impaired due to erosion from stormwater. One respondent discussed that stormwater "picks up wrong materials that are bad for the environment and deposits them in adjacent streams/ the lake." Another said he grew up in the neighborhood and knew that "rivers are worse" than when he was a child.

Photo 5: Amity Creek
Photo credit: Kimberly Nuckles, MPCA

Seventy-nine percent answered positively that they would like to learn more about the results of this study and the LSRP. If the costs and effort were mostly covered, 64% were willing to implement something (such as a rain garden or barrel) to manage stormwater on their property. These individuals, along with others volunteering at the September 2008 community workshop, were contacted by project staff. Seventeen of these households eventually were enrolled in the program and became "treatment" respondents.

The 2008 data for all questions can be found in the following section, where both 2008 and 2010 data sets are compared.

Discussion and Conclusions of First-Round Survey

Key findings

Many respondents appeared to understand that development uphill results in greater stormwater flow downhill. Many appeared to be reasonably aware of links between rain events and certain problems, including impaired water quality and property damage associated with too much stormwater flow. Half of the treatment street residents felt that stormwater is not a problem on

their properties. Very few of the uphill residents seemed aware that drainage from their properties impacts downhill properties, streams and rivers. The City and LSRP partners could better inform households in Lakeside about how residential stormwater affects Amity Creek and the Lester River, particularly in terms of water quality and impacts on aquatic habitat. This is especially important for recent residential developments, where newer owners and even some developers may be unfamiliar with local streams and lakeshore issues. This is an area that could be further explored, for example, with the Hawk Ridge development higher uphill and upstream.

The great majority of residents did not make the connection between excess residential stormwater and its effects on Amity Creek; indeed very few could name Amity Creek or the Lester River. Residents do, however, understand the "big picture" about how excess stormwater runoff can harm Lake Superior, which is a very positive finding. Such local knowledge could be a starting point upon which to build a residential information and education outreach effort.

Photo 6: Lake Superior from the beach at Gitchee Gumee Park in Duluth, near the mouth of the Lester River.

Most residents did know that the septic and storm sewer systems are different and that the water in them is treated differently. This represents a "success story" in that the City and its partners have been able to positively inform local residents about previous municipal infrastructure works.

The majority (59%) of respondents are unaware of how stormwater fees are used, but a few thought they were used to maintain the WLSSD or sanitary sewer infrastructure. Several respondents discussed that "city pipes are not well maintained," recalling the failure of water mains near their homes. Most of these comments came from residents on the intervening street.

A significant majority said they were open to cost-share initiatives to mitigate stormwater flow. A striking difference of opinion existed, however, from street to street regarding interest and ability to participate in cost-share strategies. Only one resident on the treatment or intervening streets stated that cost could be a constraint to managing stormwater on their property. However, 42% of residents on the control street stated that cost would be a constraint. Cost was also the mostly highly ranked constraint for intervening street residents.

The majority of homeowners in the study were willing to learn more about the project and to consider residential stormwater and runoff retention practices. In general, there was positive interest and willingness to learn more about the LSRP, as well as to participate in the LSRP. The study concluded that there was very good potential for the LSRP team to work with local residents to better understand and adopt stormwater management BMPs such as rain gardens or landscaping. Many households (especially on control and intervening streets) were interested in measures to mitigate flooded basements, waterlogged yards, and in some cases, eroded landscaping and property damage. While this is especially relevant for downstream residents who receive stormwater runoff from uphill, many are avid gardeners and interested in rain gardens and landscaping with native plants. Again, this would be a good entry point upon which to build an I & E effort.

The study found that there was both a significant need and considerable opportunity for more public education on both stormwater and sanitary sewer issues. This presented a very good opportunity to inform residents of the *www.lakesuperiorstreams.org*. website, as it did not appear to be widely known in the neighborhood. There was also very good potential for fostering the adoption of residential best management practices through the LSRP. Providing an opportunity for residents to actually view properly installed and maintained BMPs would help to improve local knowledge and possibly to encourage adoption of such practices.

IV. Project Implementation in the Treatment and Control Areas

A public workshop launched the LSRP project in September 2008, five months after the first-round KAP study. All residents in the three-street study area were invited, including residents in the control and treatment areas, as well as an intervening street (Idlewild) that was intended to be a buffer between the two. Interestingly, residents in the downslope control street (Ivanhoe) were experiencing significant issues with stormwater flooding, and were receiving stormwater from larger new homes with large impervious footprints that had been built above them. Downslope residents in older, smaller homes requested that the LSRP team also assist them to deal with runoff issues.

Meanwhile, several residents in the upslope treatment street (Kingston) were uninterested in participating. It became clear that various residents were either inclined or disinclined to participate in the LSRP, and that willingness to participate did not correspond neatly with the experimental design (which was based on the underground storm sewer infrastructure). This situation caused the project designers to rethink the experimental design and control/treatment outreach strategy. The team ultimately decided to work with homeowners on Kingston and Idlewild Streets who were not part of the initial treatment group, but were strongly interested in adopting stormwater treatments.

Q17 asked "Where can stormwater cause problems?" The first-round KAP study provided data on which specific properties had experienced stormwater problems. While only 17 respondents answered "on my property" in Q17, thirty-three reported a variety of specific problems on their property in response to other questions. Numerous anecdotal comments captured by enumerators documented additional reports of stormwater problems. Problems reported included flooded basements, iced driveways and garages, failed sump pumps, soggy yards and other issues. Only 4 individuals reported that they did not previously have stormwater problems. Altogether 57 of 63 respondents (90%) noted some issue with stormwater. Households reporting stormwater issues are identified on the map in Figure 2 below.

Figure 2: Houses reporting stormwater problems in 2008

Figure 3: Houses receiving stormwater installations through the LSRP (2008-2009)

During the period between the two KAP studies the LSRP team initiated an outreach campaign aimed at households in the treatment area. Two LSRP team members (Brady and Schomberg) worked with homeowners, stormwater specialists and MMC crews in 2008 and 2009 to assess stormwater drainage issues and to install a variety of stormwater retention devices at participating homes. These included:

- Twenty-two rain barrels installed at seventeen homes.
- Five rain gardens created and planted; several with extra storage via rock sumps.
- 250 trees and shrubs planted & protected.
- Five stormwater ditch checks.
- Other treatments: twelve rock sumps and two swales

Photo 7: Treatment installation by the Conservation Corps of Minnesota, 2009.
Photo credit: Valerie Brady

Photo 8: Completed rain garden installation in control area, 2010
Photo credit: Karlyn Eckman

Photo 9: Stormwater ditch check installation, 2009.
Photo credit: Valerie Brady

V. The Second-Round KAP Study (April 2010)

The second-round KAP study utilized the same sample, methodology and protocols as the first study to ensure that data sets were directly comparable. Several efficacy questions were added to the end of the second-round questionnaire to better understand the reasons for adoption or non-adoption of recommended practices. A different Minnesota Conservation Corps crew was trained to administer the questionnaires and to enter data into Survey Monkey. The second KAP study was administered during the week of September 12 2010, twenty-nine months after the first-round survey.

Findings: Comparing the first and second data sets

If a project is successful in inducing the adoption of recommended practices, one would expect to see that audience knowledge has increased, attitudes will have shifted in a positive direction, and that recommended practices have been adopted and maintained. All of these KAP values should shift in a positive direction. In comparing the first and second round data sets for the LSRP, most of these values did indeed change in the expected directions. A narrative summary for each question follows.

Knowledge questions

The first knowledge question (Q1) was intended to test respondent knowledge and awareness of the Graves Road Tributary and Amity Creek. As can be seen in Photo 4 (above), the Graves Road tributary to Amity Creek is approximately three blocks from the study area. Comparative pre/post project results are summarized in Table 1 below:

Table 1: Do you know if a stream runs near your neighborhood?

	2008 baseline survey (all respondents) *n* = 63	**2010 (control respondents)** *n = 46*	**2010 (treatment respondents)** *n* = 17
Yes	48%	69%	82%
No	38%	13%	18%
Not sure	11%	13%	0%
Other	3%	5%	0%

In 2008, less than half of all residents were aware of Amity Creek. By 2010 this number had jumped to 69% in the control area, and 83% among treatment households.

The second knowledge question (Q2) asked whether respondents could name the stream in their neighborhood. In 2008, only 30 of 63 respondents said they were aware of a stream in their neighborhood (see Table 1), and of those, only 13 (21%) could correctly name the stream (Amity). Many incorrectly identified that creek as the Lester River. Overall, a combined total of thirty (48%) of all respondents in the project area were able to name the Amity, Lester or both.

Table 2: "What is the name of the stream in your neighborhood?"

	2008 baseline survey (all respondents) ***n* = 63**	**2010 (control respondents)** ***n* = 46**	**2010 (treatment respondents)** ***n = 17***
Able to name Amity Creek	13 (21%)	14 (30%)	6 (40%)
Able to name the Lester River	15 (24%)	4 (9%)	3 (20%)
Able to name both Amity and Lester	2 (3%)	7 (15%)	3 (20%)
Not sure	7 (11%)	6 (13%)	2 (13%)
Unable to name any stream or river	25 (40%)	12 (19%)	0
Other	1 (2%)	3 (6%)	1 (6%)

In 2010, 54% of control residents were able to correctly name the Amity, Lester or both. In the treatment area, 80% of those responding were able to name the Amity, Lester or both. This represents a slight increase in the control area, and a significant increase among treatment households.

Interestingly, in 2010, five respondents reported that there is an underground stream or river, and several people reported springs in the area (these are apparently new perceptions since 2008).

The next knowledge question (Q3) asked the respondent to describe what the term "stormwater" means to them. As the following results show (Table 3), understanding of the term "stormwater" was very high in both surveys.

Table 3: Can you describe the meaning of stormwater?

	2008 baseline survey (all respondents) *n* = 63	2010 (control respondents) *n = 46*	2010 (treatment respondents) *n = 17*
Able to correctly describe stormwater	54 (86%)	44 (96%)	17 (100%)
Unable to correctly describe stormwater	4 (6%)	0	0
Don't know	1 (2%)	1 (2%)	0
Other	4% (6%)	1 (2%)	0

The fourth knowledge question (Table 4 below) was intended to test respondent knowledge and awareness about the movement of stormwater on residential properties. This was a check-all-that-apply question.

Table 4: "When stormwater runs off people's lots, where does it go?"

	2008 baseline survey (all respondents) *n = 63*	2010 (control respondents) *n = 46*	2010 (treatment respondents) *n = 17*
Other people's properties	25 (40%)	18 (39%)	11 (65%)
The street	34 (54%)	26 (57%)	10 (59%)
Storm drains	42 (67%)	31 (67%)	12 (71%)
Not sure	2 (3%)	1 (2%)	0
Other	33 (52%)	30 (65%)	0

In 2008, the majority of survey respondents (67%) understood that stormwater from their property enters storm drains that drain into Lake Superior. They understood that heavy rains

running downhill results in potential problems for "downhill" home-owners and, ultimately, for Lake Superior. One respondent said, "stormwater comes off the hill and runs from one property to the next." Comparing the 2008 and 2010 responses shows that the largest shift is greater awareness that stormwater can flow onto other people's property, although there was a slight positive shift in awareness for the other categories as well.

A follow-up check-all-that-apply question asked about the disposition of stormwater that enters stormdrains (Table 5).

Table 5:"What do you think happens to stormwater that runs into the storm drain on your street?"

	2008 baseline survey (all respondents) ***n = 63***	**2010 (control respondents)** ***n = 46***	**2010 (treatment respondents)** ***n = 17***
It goes to the creek	14 (22%)	15 (33%)	10 (59%)
It goes to Lake Superior	48 (76%)	32 (70%)	14 (82%)
It goes to a wastewater treatment plant	12 (19%)	10 (22%)	2 (12%)
Not sure	7 (11%)	6 (13%)	0
Other	25 (40%)	22 (48%)	2 (12%)

Of the 2008 comments received for the "Other" category, seven respondents thought that stormwater goes to a catchment or basin on 52nd Avenue and Superior Street. Most other comments generally referred to downhill movement of water towards Lake Superior. Several comments were made that stormwater carries sand or dirt into the lake, and one respondent said that stormwater is "hot," meaning that it brings heated water into Lake Superior. Of the twenty-two 2010 control respondent comments, seven thought that stormwater goes to holding tanks or basins either on 52nd and Superior, or to basins near the lake. Two of the 2010 treatment respondents also thought that stormwater is treated in a wastewater treatment plant. These findings should that there continues to be confusion about the difference between stormwater and sanitary sewer water, and the disposition of each.

The next knowledge question (Q #7) asked whether respondents had noticed too much rainwater in the streets after a heavy storm.

Table 6: "Where do you think too much stormwater can cause problems?"

	2008 baseline survey (all respondents) *n = 63*	2010 (control respondents) *n = 46*	2010 (treatment respondents) *n = 17*
On my property	17 (27%)	15 (33%)	4 (24%)
On neighbor's property	25 (40%)	15 (33%)	9 (53%)
In Amity Creek	17 (27%)	13 28%)	11 (65%)
In Lake Superior	24 (28%)	15 (33%)	11 (65%)
All of the above	14 (22%)	18 (39%)	5 (29%)
Not sure	7 (11%)	1 (2%)	0
I don't think it causes a problem	4 (6%)	2 (4%)	0
Other	0	24 (52%)	5 (29%)

For 2010 control respondents mentioning "Other," numerous residential problems were mentioned including broken sump pumps, flooding and ponding on lawns, icing of garages and driveways, erosion and slumping, and flooded basements. Several respondents also mentioned that dirt and road salts could be washed into Amity Creek and Lake Superior. For 2010 treatment respondents, icing and erosion of roads was noted and one respondent said that stormwater "takes everything with it into the lake including pollutants… (stormwater) affects fish, and changes temperature of the lake."

Question 9 was an open-ended question that tested respondent knowledge about sanitary sewer water. Comparative results are found in Table 7 below.

Table 7: "Can you describe sanitary sewer water?"

	2008 baseline survey (all respondents) *n = 63*	2010 (control respondents) *n = 46*	2010 (treatment respondents) *n = 17*
Able to describe correctly	38 (60%)	40 (87%)	15 (88%)
Unable to describe correctly/Don't know	11 (17%)	4 (9%)	2 (12%)
Skipped	4 (6%)	2 (4%)	0

There was an improvement in the ability of all respondents to describe the difference between stormwater and sanitary sewer water over the 2 ½ year period, although enumerators captured a number of comments that indicate a certain level of uncertainty.

Question 10 was a follow-up question that tested respondent knowledge about treatment of stormwater and sanitary sewer water. Results are summarized in Table 8 below.

Table 8: "Do you think stormwater and sanitary sewer water go through the SAME treatment process or are they treated differently?"

	2008 baseline survey (all respondents) *n = 63*	2010 (control respondents) *n = 46*	2010 (treatment respondents) *n = 17*
Same	7 (11%)	4 (9%)	1 (6%)
Different	48 (76%)	31 (67%)	10 (59%)
Not sure	7 (11%)	10 (22%)	5 (29%)
Other	9 (14%)	13 (28%)	3 (18%)

Results show that there is still confusion among many residents about the differences between sanitary sewer water and stormwater. This is most noticeable in the comments captured by the enumerators. Many respondents thought that stormwater is treated in a holding tank on Superior Avenue. There appears to be a need and opportunity to clarify the differences for the general public, possibly with educational messages from the City.

Question #11 focused on determining the preferred sources of information about stormwater by neighborhood residents. This was a check-all-that-apply question.

Table 9: "Where have you heard about local stormwater issues?"

	2008 baseline survey (all respondents) *n = 63*	2010 (control respondents) *n = 46*	2010 (treatment respondents) *n = 17*
PSAs	10 (16%)	17 (37%)	7 (41%)
TV news or weather	39 (62%)	24 (52%)	16 (94%)
Streamline	1 (2%)	6 (13%)	8 (47%)
Internet or website	3 (5%)	5 (11%)	2 (12%)
Newspaper	29 (46%)	25 (54%)	14 (82%)
Flier in utility bill	12 (19%)	16 (35%)	5 (29%)
Sign or billboard	1 (2%)	3 (7%)	1 (6%)
Rex the Watershed Dog	3 (5%)	1 (2%)	3 (18%)
Other	34 (54%)	33 (72%)	13 (76%)
Not sure that I have heard about stormwater	6 (10%)	6 (13%)	0

Standard media formats (TV, newspapers, PSAs) ranked higher across the board than did the Internet. The most noted source of information was the "Other" category. The comments recorded by enumerators showed that the most important "Other" source were members of the LSRP project team, three of whom were consistently mentioned by name. The LSRP team had a consistent presence in the study area with significant interaction among local residents. This "high-touch" approach was apparently effective in transferring information about stormwater to local residents.

Question #12 tested respondent knowledge about stormwater utility fees, and comparative results are presented in Table 10 below.

Table 10: Do you know how your stormwater utility fees are used?

	2008 baseline survey (all respondents) *n = 63*	2010 (control respondents) *n = 46*	2010 (treatment respondents) *n = 17*
Yes	7 (11%)	7 (15%)	4 (24%)
No	37 (59%)	32 (70%)	11 (65%)
Not sure	12 (19%)	6 (13%)	2 (18%)
Other	12 (19%)	0	0

Results show that there is still considerable uncertainty about stormwater fees, with 70% of control residents and 65% of treatment residents stating that they do not know how the fees are used.

Question #13 was intended to test respondent knowledge about stormwater impairments in Amity Creek (see Table 11 below).

Table 11: "Are you aware that muddiness and erosion in Amity Creek have caused it to be placed on a list of "impaired" streams?"

	2008 baseline survey (all respondents) *n = 63*	2010 (control respondents) *n = 46*	2010 (treatment respondents) *n = 17*
Yes	8 (13%)	14 (30%)	13 (76%)
No	52 (83%)	32 (70%)	4 (24%)
Not sure	1 (2%)	0	0
Other	5 (8%)	11 (24%)	1 (6%)

Over time, respondents increased their knowledge about the Amity Creek impairment, even among control group respondents. Of the comments received, most indicated that the respondents had received information about Amity Creek from LSRP team members.

Regarding **attitudes**, many residents shifted their attitude about who is responsible for managing stormwater from the City to shared responsibility (both City and homeowner). Table 12 below illustrates the change in attitudes over time.

Table 12: "Whose job is it to manage stormwater flowing onto and off of your property?"

	2008 baseline survey (all respondents) *n = 63*	2010 (control respondents) *n = 46*	2010 (treatment respondents) *n = 17*
The City	22 (35%)	9 (20%)	3 (18%)
The property owner	20 (32%)	12 (27%)	3 (18%)
Both	21 (33%)	22 (49%)	11 (65%)
Not sure	3 (5%)	2 (4%)	0
Other	11 (18%)	14 (30%)	0

In 2008, residents were almost evenly split between the City, property owner, or both. By September 2010 there was a significant shift in attitude, with the majority of respondents in both treatment and control groups stating that stormwater management is a shared responsibility. Of the comments received in the pre and post surveys, most noted that responsibility on a private lot rests with the homeowner, while the City is responsible for maintaining storm drains once stormwater leaves homeowners' lots. Two respondents suggested that the City provide more information and education to homeowners about stormwater.

Question #16 asked all respondents whether they would be interested in learning more about the LSRP. Fifty (79%) responded positively; ten (16%) said "No;" three (5%) were not sure; and four (6%) had "Other" comments. Of these, one was interested in obtaining help; one was interested in the study findings; and one said that they were moving.

Question #17 was intended to determine whether the respondent was inclined or disinclined to participate in the LSRP. This was a one-time question and was not repeated in the 2010 KAP study. Results are summarized in Table 13 below.

Table 13: If the costs and effort were mostly covered, would you be willing to try something to manage stormwater (such as a rain garden or rain barrel) on your property?

	2008 baseline survey (all respondents) *n = 63*	2010 (control respondents) *n = 46*	2010 (treatment respondents) *n = 17*
Yes	40 (64%)	-	-
Maybe, but I'd like to learn more about it	13 (21%)	-	-
No	8 (13%)	-	-
Not sure	1 (2%)	-	-
Other	12 (19%)	-	-

The **practices** questions showed an increase over time in the adoption and maintenance of recommended practices. In 2010, more people were trying things to manage stormwater (yet more were reporting that stormwater isn't an issue for them). Some non-treatment households adopted stormwater treatments without help from the project.

Table 14: "Have you ever done anything to manage stormwater on your property?"

	2008 baseline survey (all respondents) *n = 63*	2010 (control respondents) *n = 46*	2010 (treatment respondents) *n = 17*
Sump Pump	41 (65%)	27 (59%)	-
Rain barrel	7 (11%)	7 (15%)	-
Rain garden	3 (5%)	3 (7%)	-
Landscaping	20 (32%)	13 (28%)	-
Native plants	9 (14%)	8 (17%)	-
Other	37 (59%)	37 (80%)	-
No	15 (24%)	8 (17%)	-

Of the thirty-seven "Other" comments in 2008, six respondents had dug trenches or ditches to re-route water, and five had installed gutters and downspouts to redirect stormwater. Four respondents had created rock basins or catchments. Two respondents had planted trees, and two others reporting clearing debris from curbside stormdrains. One respondent had adjusted the lot gradient, and another had planted Marsh Marigolds in their diversion trench. Although seven

respondents reported having rain barrels in 2008, only a few were actually seen by the enumerators. Of note, several respondents reported that their sump pumps had failed and had been replaced, in some cases with a different basement draining system.

By 2010, control respondents reported renewed efforts to manage stormwater. Some of the anecdotal comments suggested that control households were aware of the LSRP treatments. Many were planning to try new installations on their own, or had already taken action. Four respondents had created new ditches, French drains or swales; two had added gutters; and two had changed the lot gradient. One respondent reported installing a 500 gallon cistern to hold stormwater. Several respondents were planning to install rain barrels or rain gardens, or were in the process of doing so. Of note, one respondent commented "NO rain barrel--doesn't like appearance. Is unhappy that neighbors got treatments."

With regard to **barriers,** the 2008 survey explored the reasons that residents might not adopt or maintain stormwater installations. Results are summarized in Table 15 below.

Table 15: "What prevents you from managing stormwater on your property?"

	2008 baseline survey (all respondents) *n = 63*	**2010 (control respondents)** *n = 46*	**2010 (treatment respondents)** *n = 17*
Stormwater is not a problem	18 (29%)	23 (50%)	-
Not aware of information that could help me	12 (19%)	4 (9%)	-
Not sure what to do	14 (22%)	6 (13%)	-
There's a cost involved	12 (19%)	11 (24%)	-
My physical ability limits me	1 (.5%)	3 (7%)	-
Don't know	5 (8%)	2 (4%)	-
Other	23 (37%)	27 (59%)	-

Of the twenty-three 2008 "Other" comments, several mentioned that they were not aware that stormwater should be managed by property owners. Five respondents had just moved into the neighborhood, or were about to move elsewhere. A few felt that stormwater is not a priority for them, and two others noted the relative costs of managing (or not managing) stormwater. One

suggested that “more people should get involved…there should be monthly neighborhood /group projects.” Others indicated an interest in learning more and trying different things.

Of the twenty-seven comments received in the second-round survey, four people said that nothing prevents them from managing stormwater. Two suggested that money was an issue; two said that they would manage stormwater but didn’t know what to do; and another had no time (caregiver to a disabled daughter). One person said that the amount of work needing to be done would take many people. Several people expressed disappointment that their properties were not chosen as “treatment” houses, and there appeared to be some confusion over the LSRP selection process:

> “(Respondent is) frustrated that his property wasn't in work area; very interested in managing stormwater and the project.”
>
> “I wanted to put in a rain garden, but I'm in the control area so they told me not to; wants to know why there are houses on 52nd have sump pumps that drain into the road”
>
> “Rich and Dana said they would recommend him for the project, but nothing ever came of it.”
>
> “She didn't really want to participate, she expressed feelings of exclusion from the project because neighbors got plants and they did not.”
>
> “Owner would be more than willing to have work done, is interested in the positive effects it would have on her neighbors and general environment. She thought she was on the list to get work done, but when the project came around, her house was skipped.”

Photo 8: Rain barrel installation in control area, 2010

Outcome questions

Several questions were added to the second-round KAP study for treatment households. The purpose of the additional questions was to determine the acceptability of the stormwater installations that had been recommended and installed by the LSRP. As a caveat, it is too soon to determine the longer-term acceptability of the installations, as most were installed within a year or even a few months prior to the second-round KAP study. Nevertheless, some useful information has been obtained and is summarized in Table 15 below.

Table 15: Summary of Outcome Questions
(2010 Treatment Respondents Only)

	Yes	No	Don't know
Did you have water problems on your property before this project started?	10 (59%)	7 (41%)	0
Did you think those treatments have helped to reduce stormwater runoff ?	10 (59%)	1 (7%)	4 (23%)
Have you spent any time maintaining the things you received from the project?	15 (88%)	2 (12%)	0
Was this maintenance difficult?	1 (6%)	16 (94%)	0
Do you plan to maintain these things in the coming year?	16 (94%)	0	0
Would you recommend any of these to your friends?	16 (94%)	1 (6%)	0
Is there anything you wish would have been done differently?	3 (18%)	12 (71%)	2 (12%)
Did the project make it easier for you to manage stormwater than before?	6 (38%)	6 (38%)	4 (25%)
Did other residents become interested in the changes on your lot?	11 (65%)	6 (35%)	0

Most of the treatment households felt that the installations have helped to solve stormwater problems on their properties, although some said that it's too soon to tell. Most residents in the treatment group liked their BMPs, but they were split 50:50 on whether or not the BMPs helped them manage stormwater. Further research would be useful (e.g. pair the Y/N on this question with the treatments they got to determine whether it is location on the topography or type of treatment that matters more in whether they think the BMPs helped them manage stormwater).

88% have done some maintenance on the treatments, and 96% report that the maintenance isn't difficult. All will maintain the installation in the coming year. 96% would recommend the installations to their friends.

VI. Summing Up

A comparison of the 2008 and 2010 KAP data sets shows that respondents in general did show an increase in knowledge, a positive shift in attitudes, and an increase in practices. Concerning knowledge questions overall, both control and treatment sample respondents increased their knowledge about stormwater runoff and resulting problems. Respondents also increased their knowledge about where stormwater goes, and subsequent impacts on neighbors and water bodies. Respondents in both control and treatment samples also increased their knowledge about the nearest creek (Amity), and impacts of stormwater on Amity Creek. There was a significant increase in awareness about stormwater overall, and about sources of stormwater information. For treatment households, there was a major shift in knowledge on all counts except awareness of sanitary sewer water. In addition to the seventeen treatment households volunteering to install stormwater devices, the control households also increased their stormwater management. Treatment households appeared to believe that the treatments would help to reduce stormwater runoff, but many noted that it was too soon to tell.

Certain gaps in respondent knowledge persisted from the baseline to the second-round surveys. First, respondents remain confused about how their City stormwater utility fees are used. Second, there is uncertainty among many residents about the difference between stormwater and sanitary sewer water. There was also some confusion about what happens to sanitary sewer water. These gaps represent an opportunity for the City and LSRP team to educate residents about stormwater fees, and the purpose of these separate underground water conveyance systems.

Opinions about responsibility for managing stormwater runoff shifted over time from primarily the City of Duluth to a shared responsibility of the City and residents.

The primary barriers to managing stormwater were cost and uncertainty about what to do.

Finally, there is a consensus by the LSRP team and WRC researchers that the KAP study methodology proved useful, cost-effective, and yielded valuable information for both planning and evaluation purposes.

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