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Nutrient Reduction PIC: Murden Cove/Fletcher Bay
National Estuary
Program (NEP): Toxics and Nutrients Prevention, Reduction and Control
Grant #G1300087
1/1/2013 – 12/31/2015



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Acknowledgement

The author would like to thank Kitsap Public Health District Pollution Identification and Correction program staff, the United States Environmental Protection Agency, the Washington State Department of Ecology, the City of Bainbridge Island, the Bainbridge Island Watershed Council, the Sakai Middle School and Kitsap Conservation District for their assistance and support in completing the National Estuary project.

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EXECUTIVE SUMMARY

Kitsap Public Health District was awarded a National Estuary Program “Toxics and Nutrients: Reducing Nutrients in a Watershed” grant (NEP) from the Washington State Department of Ecology in January of 2013. The purpose for the project was to reduce nutrient loading and fecal bacteria to improve water quality in the Murden Cove watershed to protect public health, shellfish and aquatic habitat. The goals for this project were to:

- Assess land use practices related to onsite septic systems, management of pet and/or livestock waste, use of fertilizers and yard maintenance
- Conduct routine and investigative water quality monitoring
- Educate residents about the project through public meetings, news releases and during door to door property inspections.
- Coordinate education/outreach and water quality monitoring with partners
- Assess, identify and correct residential nutrient non-point pollution sources

In November 2014, the project was expanded to include, Fletcher Bay in response to a possible downgrade in shellfish classification at the northwestern edge of the mouth of the Bay. The goal was to reduce fecal bacteria by:

- Conducting a concentrated door-to door survey of homes with septic systems that were 25 years or older and within 200 feet of either the shoreline or four major creeks that flow into the Bay.

Kitsap Public Health successfully completed the project by meeting the goals and objectives set forth in the grant contract and work plan. Surveys were conducted in both the Murden and Fletcher Bay watersheds as shown in Figure 1.

Kitsap Public Health completed 193 property inspections in the Murden Cove watershed and 82 in Fletcher Bay. This exceeded our project goals of 175 inspections in Murden and 80 in Fletcher. Four septic system failures were confirmed, two in each of the watersheds. These septic system failures have been corrected. During property inspections nine agricultural properties were identified in the Murden Cove watershed and twelve in Fletcher Bay. Of the twenty-one identified agricultural properties, one was required to address manure management.

Kitsap Public Health has been conducting pollution identification and correction (PIC) projects since 1996. On average there has been an onsite septic system failure rate of 7% (found during property inspections, public complaints and shoreline investigations). During this project, the septic system failure rate was lower at 1% for Murden Cove and 2% for Fletcher Bay.

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Data from monthly monitoring of fecal bacteria showed that all stations failed to meet Part 1 and Part 2 of Washington State's Extraordinary Primary water quality standard during water year 2013, but met Part 1 standards during water years 2014 and 2015. MUR1 (near shore station) met both Parts of the water quality standards in water year 2015. There are currently no standards for nutrients so differences in concentration levels within the creek and seasonal variability were noted. Nutrient levels were similar along all reaches of Murden Creek, except for spikes during high flow events when levels of nitrogen were elevated. In addition, physical parameters including temperature, conductivity, dissolved oxygen and salinity were collected. Temperature, conductivity and salinity were higher at MUR1 than upland stations, which can be related to tidal impacts. Dissolved oxygen levels were similar across all stations.

We also worked with the City of Bainbridge Island (COBI) who conducted monthly monitoring at three additional upstream locations along Murden Creek. Volunteers from the Bainbridge Island Watershed Council helped with monthly monitoring as well as conducted a stream walk with Health District staff to identify additional flows into the Creek.

All reporting, including monthly progress reports, payment requests and semi-annual FEATS reports were submitted on time. All project records were maintained in hard copy and database formats.

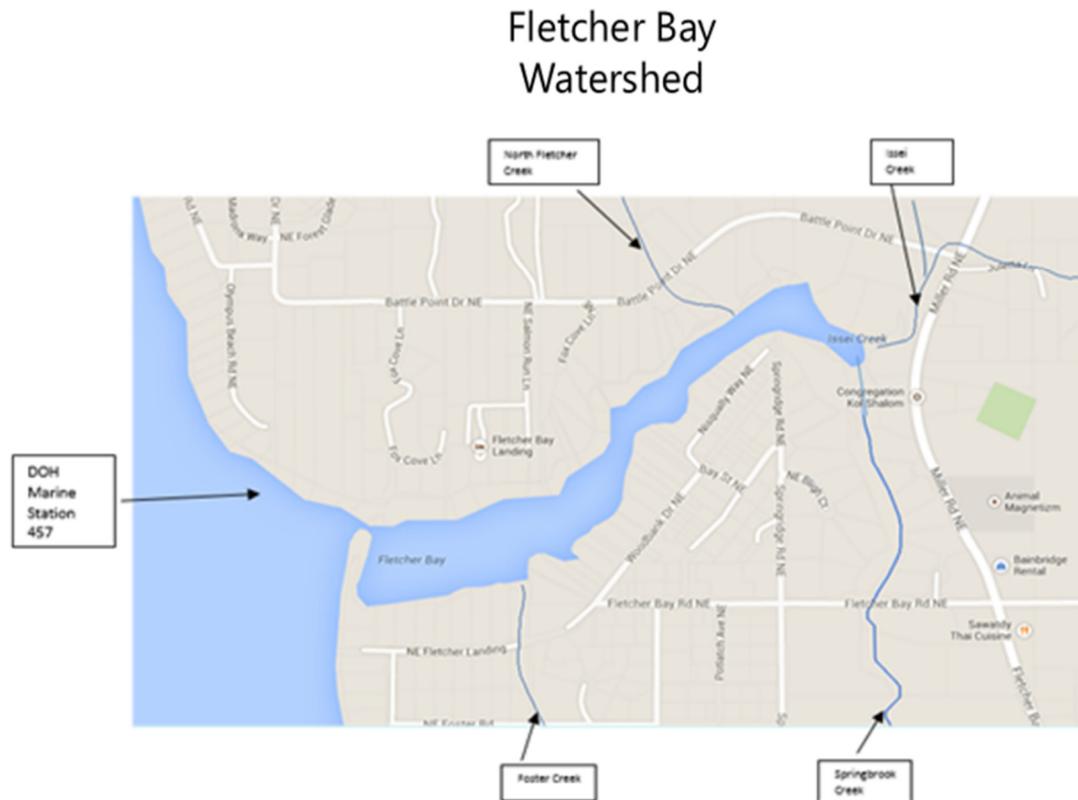
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Figure 1. Project Areas



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I. SUMMARY OF FINAL NUMBERS FOR NINE METRICS ESTABLISHED IN GRANT WORK PLAN

The following nine metrics were used to track inspections during the “Toxics and Nutrients: Reducing Nutrients in a Watershed” project;

Metric #1: To conduct 175 Murden Cove and 80 Fletcher Bay door-to-door property inspections

Metric #2: To track the number of on-site septic (OSS) system failures

Metric #3: To track the number of OSS system failures that were repaired

Metric #4: To identify the number of livestock pollution problems

Metric #5: To track the number of livestock pollution problems successfully resolved

Metric #6: To identify any residential fertilizer use problems

Metric #7: To track the number of residential fertilizer use problems successfully resolved

Metric #8: To identify any other problematic land use practices

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Metric #9: *To track the number of other problematic land use practices successfully resolved*

There were 275 door-to-door property inspections completed for the project; 193 in Murden Cove and 82 in Fletcher Bay. These inspections included on-site septic system OSS records and Geographical Information System (GIS) research to evaluate the property. Inspections included review of OSS systems, livestock pollution, pet waste, drainage and natural yard care. Table 1 categorizes the property inspections by OSS ratings.

Of the 275 properties inspected, 200 OSS systems were functioning to design standards and received a rating of No Apparent Problem. Seventy-one OSS systems were rated as either Suspect, Concern or No Records and four systems were found to be failing (~1.5% failure rate), two in each watershed. The Murden Cove and Fletcher Bay failures were found in February 2014, March 2014, May 2015 and June 2015, respectively. All four failing systems have been repaired.

During property inspections nine potential livestock pollution properties were identified in the Murden Cove watershed and 12 in Fletcher Bay. Of the 21 properties, one livestock manure management problem was identified and successfully resolved. Property inspections also included information regarding natural yard care and pet waste management. No residential fertilizer, pet waste or other problematic land use practices were identified.

Table 1. OSS Ratings for Completed Property Inspections

| Project Area | Total Inspections | # of Failures | OSS failure rate | Suspect | No Apparent Problems | Concern | No Records | Denied Access |
|---------------------|--------------------------|----------------------|-------------------------|----------------|-----------------------------|----------------|-------------------|----------------------|
| Murden Cove | 193 | 2 | 1% | 0 | 141 | 17 | 33 | 12 |
| Fletcher Bay | 82 | 2 | 2% | 0 | 59 | 8 | 13 | 1 |
| Grand Totals | 275 | 4 | 1.5% | 0 | 200 | 25 | 46 | 13 |

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The following definitions for onsite septic system ratings include:

SUSPECT. When one or more of the following conditions apply: drain field is saturated; water sample results from bulkhead drains, curtain drains or other pipes or seeps at or above 500 FC/100 ml or 406 EC/100 ml and a positive non-visual dye test confirmed by Ozark underground laboratories; water sample results are less than 500 FC/100 ml or 406 EC/ml and positive visual dye test. A follow up wet season dye trace will be conducted and a suspect letter will be mailed to the owner.

CONCERN. This includes; system with no records and drainfield less than 50 ft. from surface waters or wells, improper use of designated reserve area, vehicular traffic and/or pavement on OSS components, roof drains or other drainage impacting OSS, unpermitted expansion or modification that affects OSS, unpermitted work conducted on the OSS, excavation or excess fill within OSS area, or a cut, down slope of the OSS that has potential to impact performance. In cases where there are unpermitted alterations, expansions, repairs etc., PIC staff consult with the Program Manager regarding enforcement options.

II. FECAL MONITORING DATA

All water quality sampling was performed according to an Approved Quality Assurance Project Plan. Water pollution source identification and correction was completed according to our approved Pollution Identification and Correction Protocol Manual 2012.

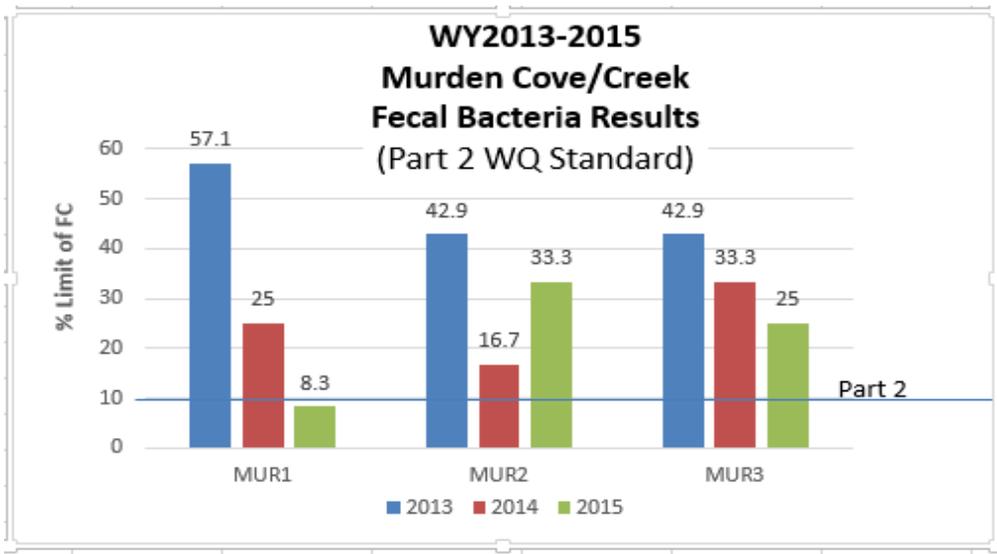
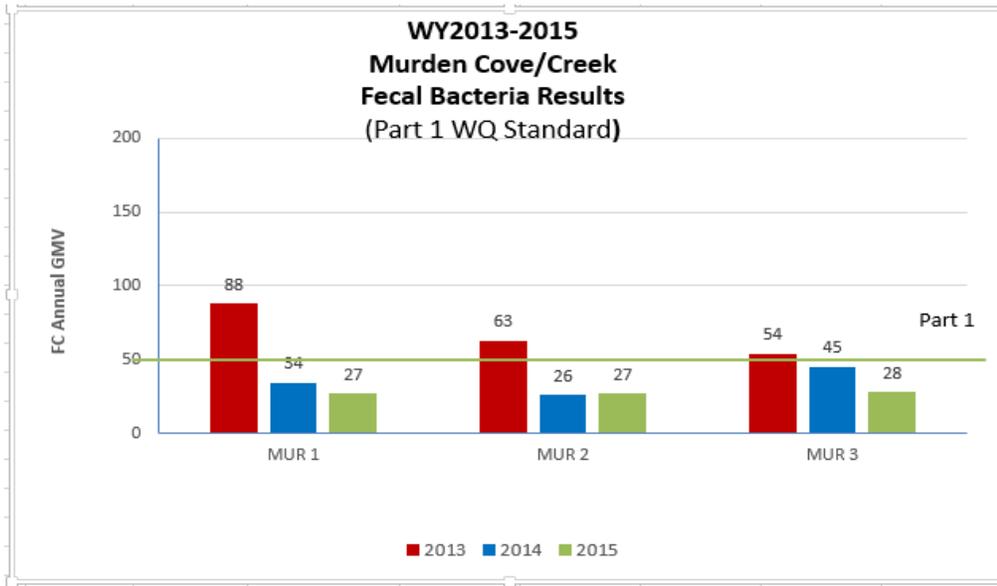
There were 32 monthly monitoring events along Murden Creek and its' tributary, Meigs Creek, which included three storm events during this project. Two of these storm events were conducted during wet-weather months (between October-April), and one was completed in a dry-weather month (May-Sept). MUR1 (nearshore station), MUR2 (mainstem Murden Creek) and MUR3 (Murden tributary, Meigs Creek) are indicated as KPHD sampling locations on the Murden Cove map in Figure 1. In addition, the City of Bainbridge Island and its' volunteers sampled three other locations and added a fourth in May of 2014 during the monthly monitoring events, also indicated on the map in Figure 1. All creek monitoring was completed during the 2013-2015 timeline identified in the work plan.

Monthly monitoring data included; fecal bacteria (FC), nutrients and physio-chemistry parameters. Fecal bacteria data, as shown in Figure 2, for Water Years 2013-2015 indicates that all three stations had improving trends. In Water Year 2013 all three stations failed to meet Part 1 (geometric mean less than or equal to 50 FC/100 ml) and Part 2 (not more than 10% of all samples obtained for calculating a geometric mean greater than 100FC/100ml) of the Water Quality Standards. These standards are shown in Figure 2 as the freshwater standard for extraordinary primary contact. In Water Years 2014, all stations met Part 1 and failed Part 2 and

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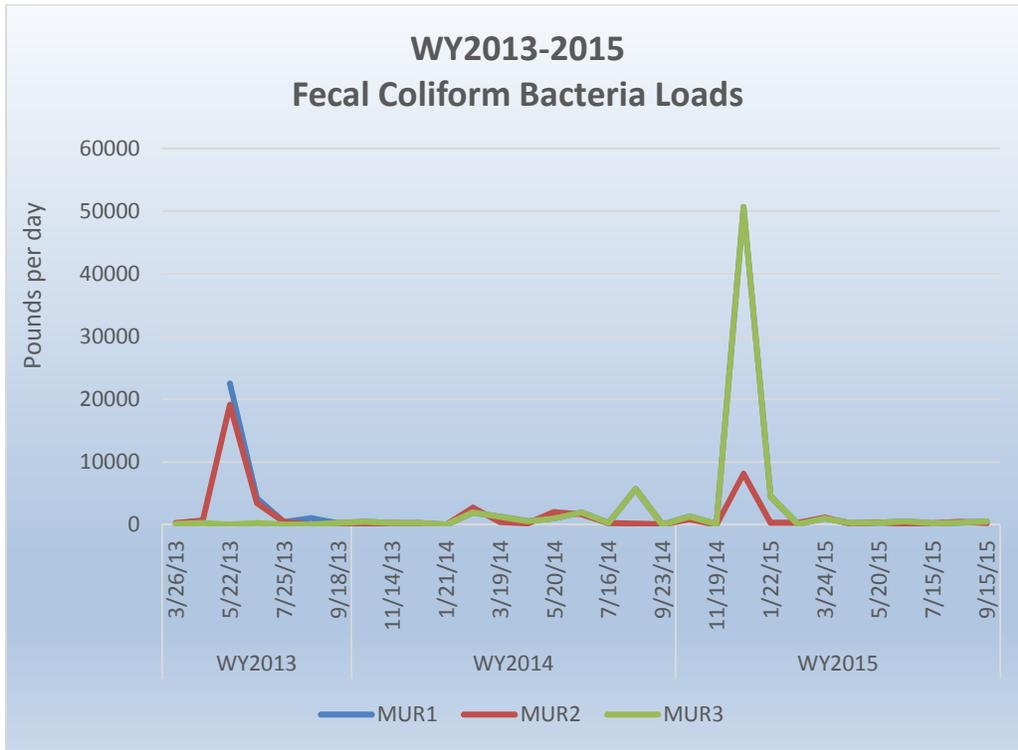
in Water Year 2015 all stations met Part 1 and MUR1 showed continued improvement by meeting Part 2 Standards as well.

Figure 2. Fecal Bacteria Results and Water Quality Standards



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| | Freshwater Standard | | Marine Water Standard | |
|------------------------------|---|--|--|---|
| Parameters | Extraordinary Primary Contact | Primary Contact | Extraordinary Aquatic, Primary Contact | Excellent Aquatic, Primary Contact |
| Fecal Coliform Bacteria (FC) | <p>Part 1: ≤50 FC/100 ml (geometric mean)</p> <p>Part 2: Not more than 10% of all samples obtained for calculating a geomean</p> <p>>100 FC/100 ml</p> | <p>Part 1: ≤100 FC/100 ml (geometric mean)</p> <p>Part 2: Not more than 10% of all samples obtained for calculating a geomean</p> <p>>200 FC/100 ml</p> | <p>Part 1: ≤14 FC/100 ml (geomean)</p> <p>Part 2: Not more than 10% of all samples obtained for calculating a geomean >43 FC/100 ml</p> | <p>Same as Extraordinary Aquatic - Primary Contact waters</p> |

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Sampling on 6/25/2013, 12/11/2104 and 10/26/2013 was considered storm events. Table 2 below shows the FC and rain data;

Table 2. Murden Creek Storm Event Results

| Murden Storm events | (FC/100ml) | | | | | |
|----------------------------|-------------------|--------------------|-------------------|--------------------|-------------------|--------------------|
| Station | 6/25/2013 | Rain Totals | 12/11/2014 | Rain Totals | 10/26/2015 | Rain Totals |
| MUR 1 | 270 | 6/24= 0.1" | 110 | 12/10=1.39" | 110 | 10/25=0.33" |
| MUR 2 | 360 | 6/25=0.74" | 4 | 12/11=0.76" | 110 | 10/26=0.11" |
| MUR 3 | 150 | | 50 | | 260 | |

As can be seen from this data, the storm events didn't create significant differences in FC levels.

In addition, Figure 2 Fecal Bacteria Loads show that MUR3, the tributary to Murden Creek had a few peaks in bacterial load which may be attributable to the beaver dam located above the sampling location.

Kitsap Public Health District staff and Bainbridge Island Watershed Council volunteers completed a stream walk of the lower and upper segment of Murden Creek. No additional non-point source flows were found in the upper segment and flows found in the lower segment yielded FC levels of 10 and 4, and were deemed to be non-contributing factors.

All data was entered into the PIC water quality database and used for tracking and reporting purposes, as well as shared with COBI.

In the Fletcher Bay watershed, investigative segment sampling was conducted and e.Coli (EC) and FC data is shown in Table 3 below;

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Table 3. Fletcher Bay Bacteria Results

| Fletcher Bay | (EC/100ml) | | | | | | | |
|-------------------------|-----------------|--|------------------|-------------------------|------------------|----------------|---|------------------|
| | Except as noted | | | | | | | |
| Station | 9/2013 | Range or Value for 9/2013-10/2013 or 10/2013 | Range for 5/2014 | Range for 3/2014-6/2014 | Range for 6/2014 | 11/20/2015 | Rain Total for 11/20/2015 | 10/27/14-1/12/16 |
| FB5 shoreline station | | 22.2-1986.3 | | | | | | |
| FB5A | 34.0 | | | | | | | |
| FB5AA | | | 25.3-159.7 | | | 2001 FC/100 ml | 11/18=0.02" 11/19=0.09" 11/20=0.01" | |
| FB9 shoreline station | | 892.9 | | 14.8-228.2 | | | | |
| FB9A | | | 17.3-167.0 | | | | | |
| FB9B | | | | | 67.0-69.7 | | | |
| Marine Station 457/PO05 | | | | | | | | 0.5-5.0 FC/100ml |

FB5 and FB9 were shoreline stations sampled through another funding source. Segment sampling indicated by FB5A, FB5AA, FB9A and FB9B were monitored to help identify areas of concern. The elevated level at FB5AA of 2001 FC/100ml, seems to be an outlier.

In response to the threatened status of Fletcher Bay, Marine Station 457 was added to the Health District's Marine Trend Monitoring program as station PO05, in October of 2014. Data shows that levels from 10/27/2014-1/12/2016 ranged from 0.5-5.0 FC/100ml as shown in Table 3. This would suggest that there is a downward trend in FC values and that the Systematic

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Random Sampling method utilized by the Washington State Department of Health for Annual Growing Area Review should show improvement. The Health District will continue to monitor the marine station as long as it remains in threatened status.

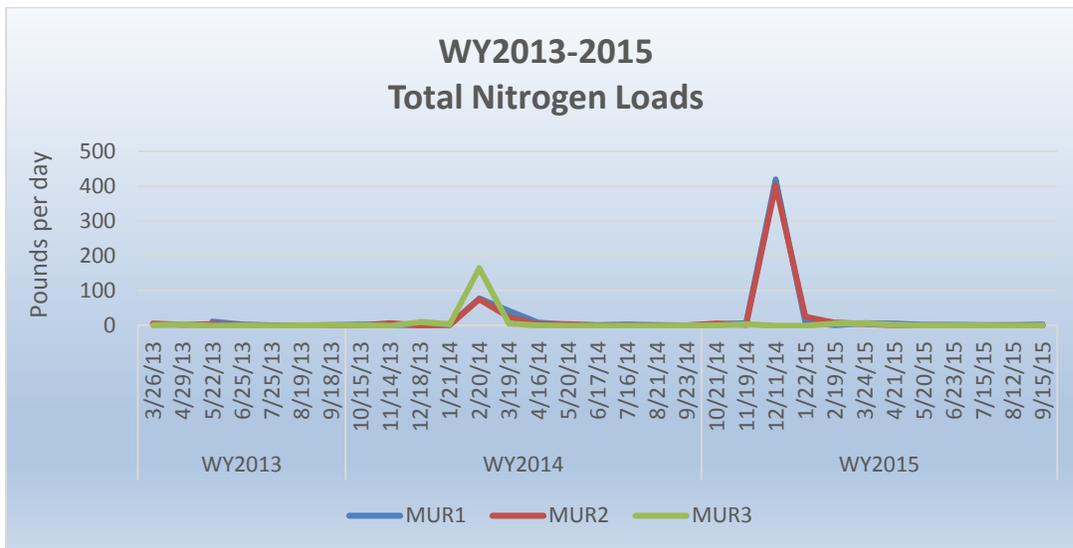
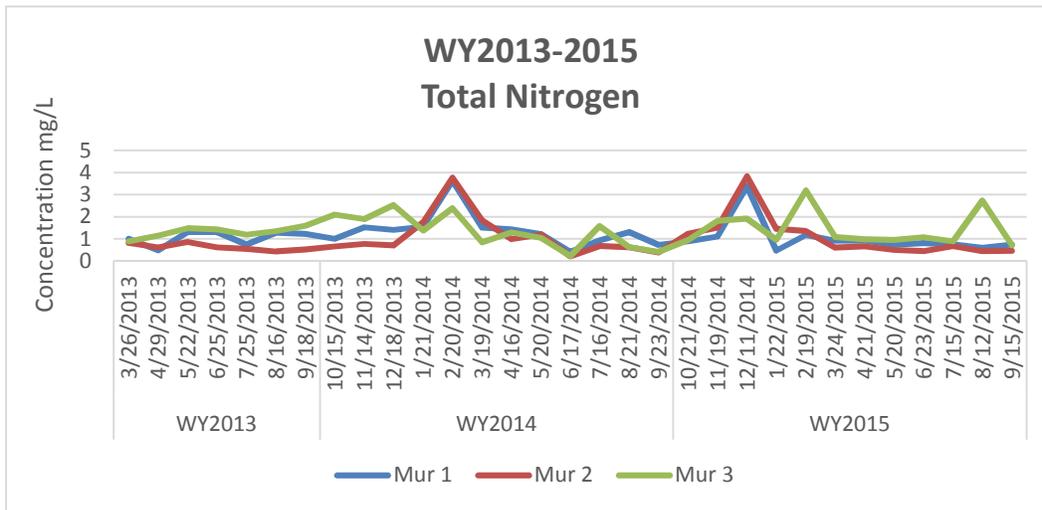
III. NUTRIENT AND FLOW DATA

All water quality measurements were performed according to an Approved Quality Assurance Project Plan. There were 32 monthly monitoring events along Murden Creek and its' tributary, Meigs Creek, which included three storm events during this project.

In Figure 3, all nutrient levels and load calculations are shown for total nitrogen, total phosphorus, total nitrate-nitrite and total ammonia for each water year from 2013-2015. Data shows that there are some seasonal variations in nutrient levels and loading. Typically during higher flows, as seen in Figure 3, total nitrogen and total nitrate-nitrite levels increase and total phosphorus levels decrease. Noticeable peaks occurred on 2/20/2014 and 12/11/2014, rain events of 0.22 and 2.15 inches respectively in the previous 24 hours. As the charts show, total nitrogen is higher during the winter season and total phosphorous is higher during the summer. The total nitrogen levels during the winter follow the observed pattern of elevated levels of nitrogen from surface waters, as established in the USGS (Paulson et al. 2006) report findings. These findings also delineated the sources of the nitrogen from atmospheric input, shallow subsurface flow, regional ground water and surface water. Our study did not speciate nutrients and therefore we do not know the source of the nitrogen.

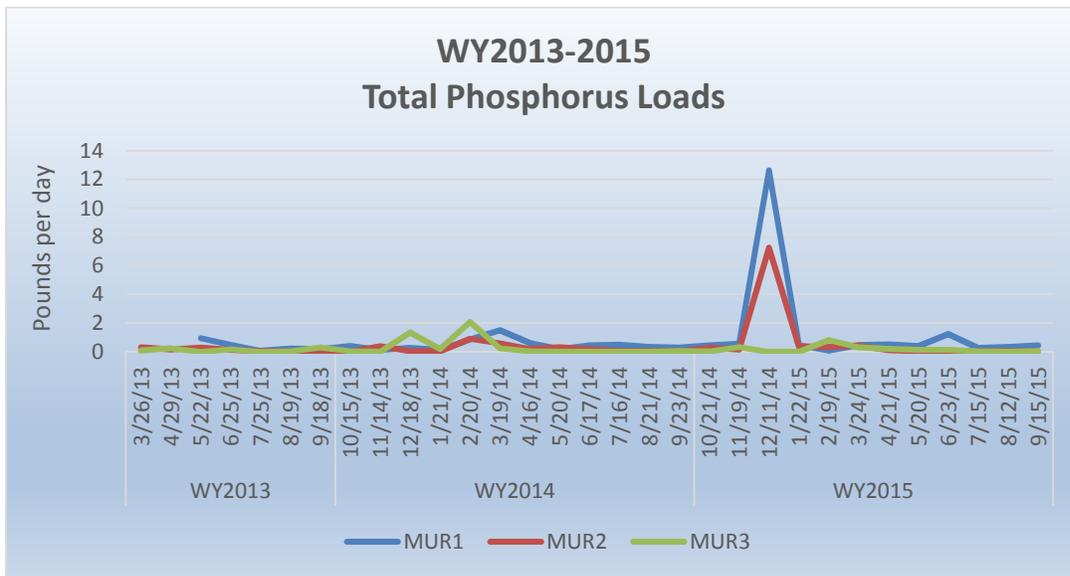
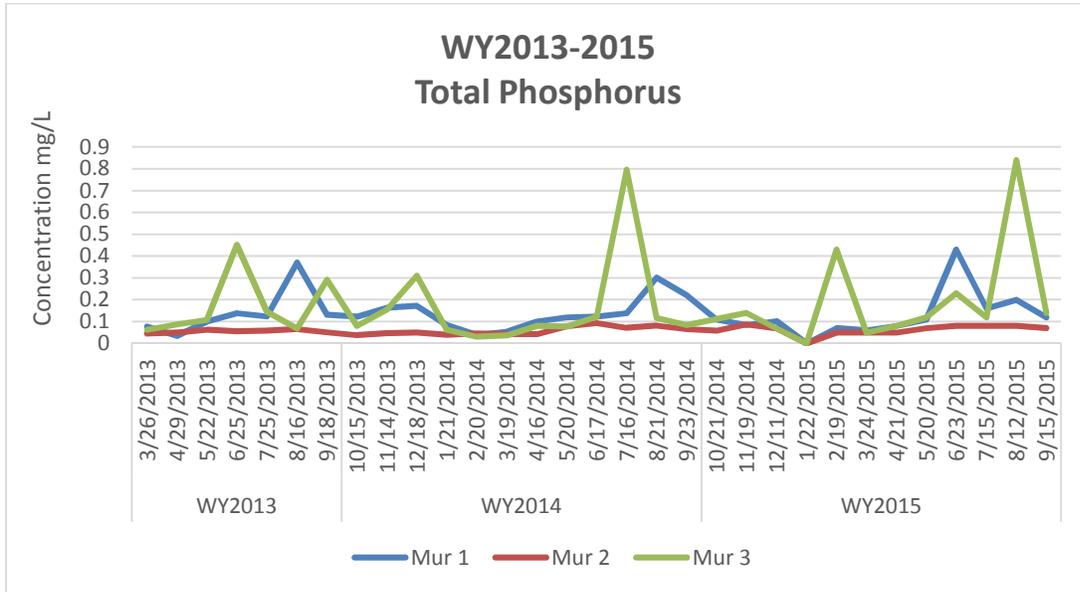
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Figure 3. Nutrient Levels, Loads and Flow Measurements



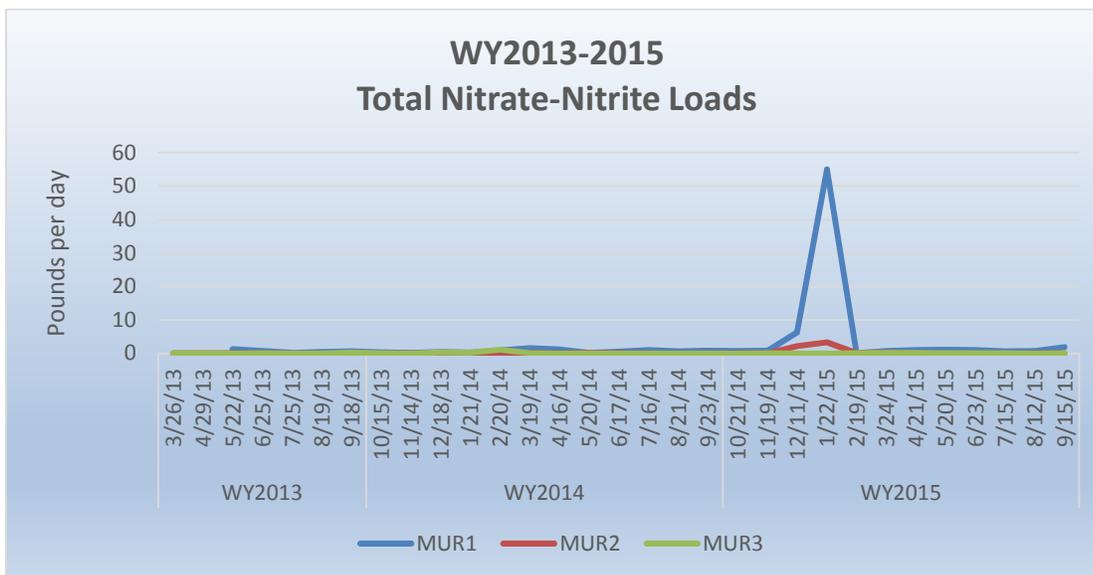
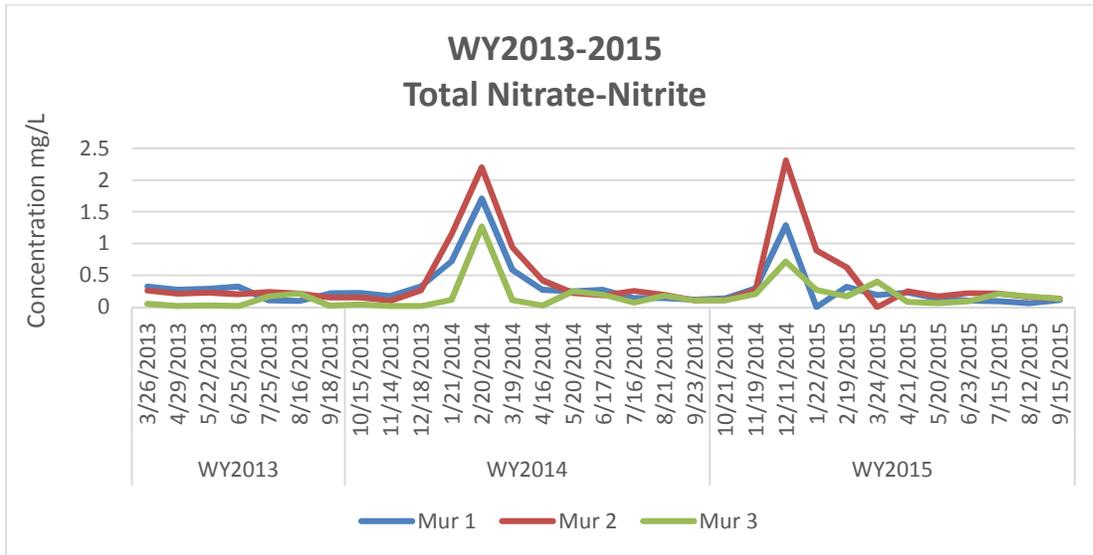
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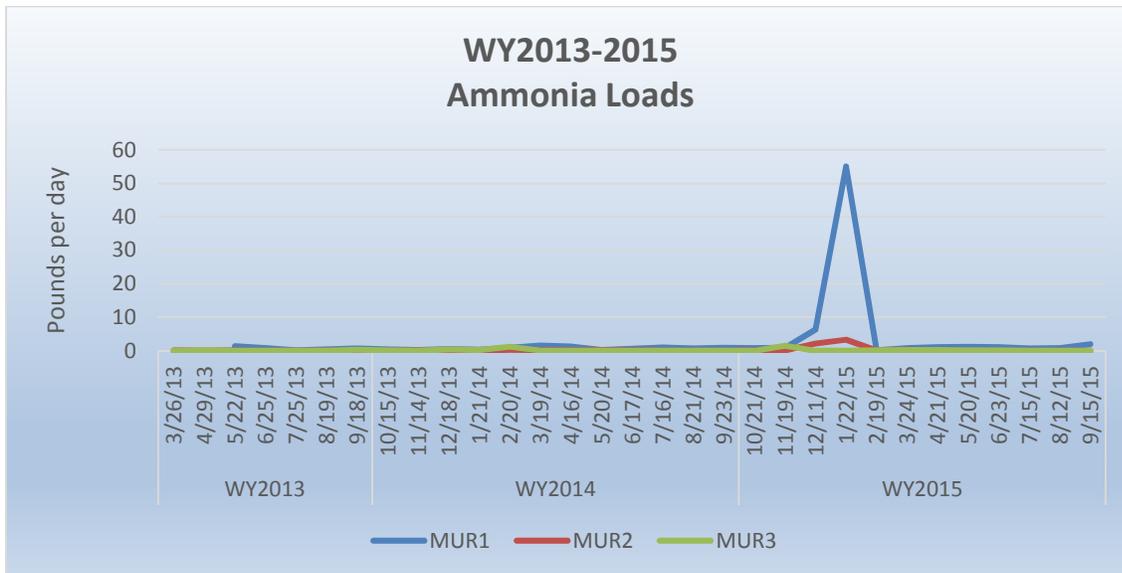
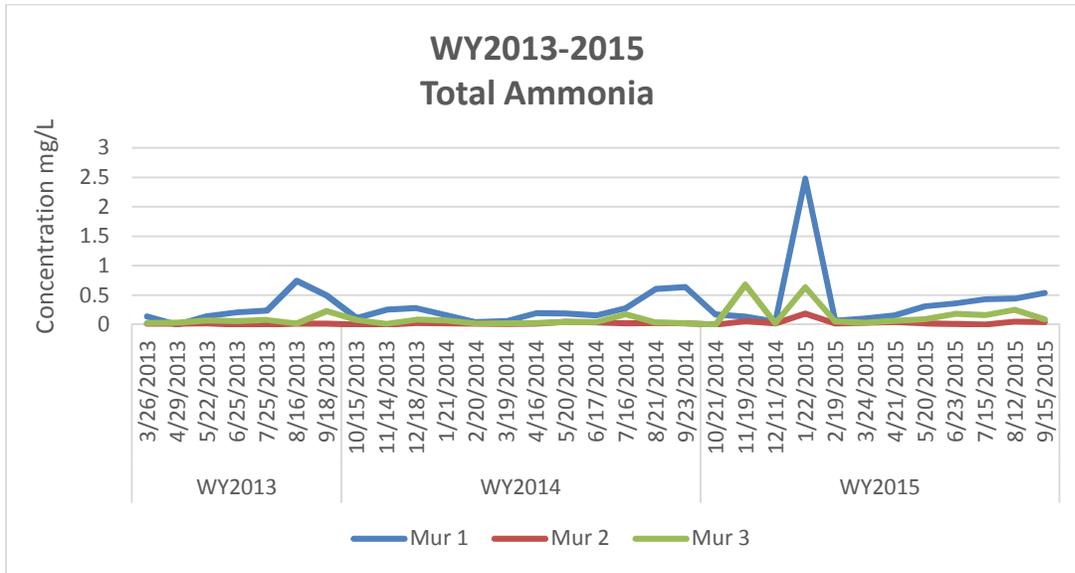
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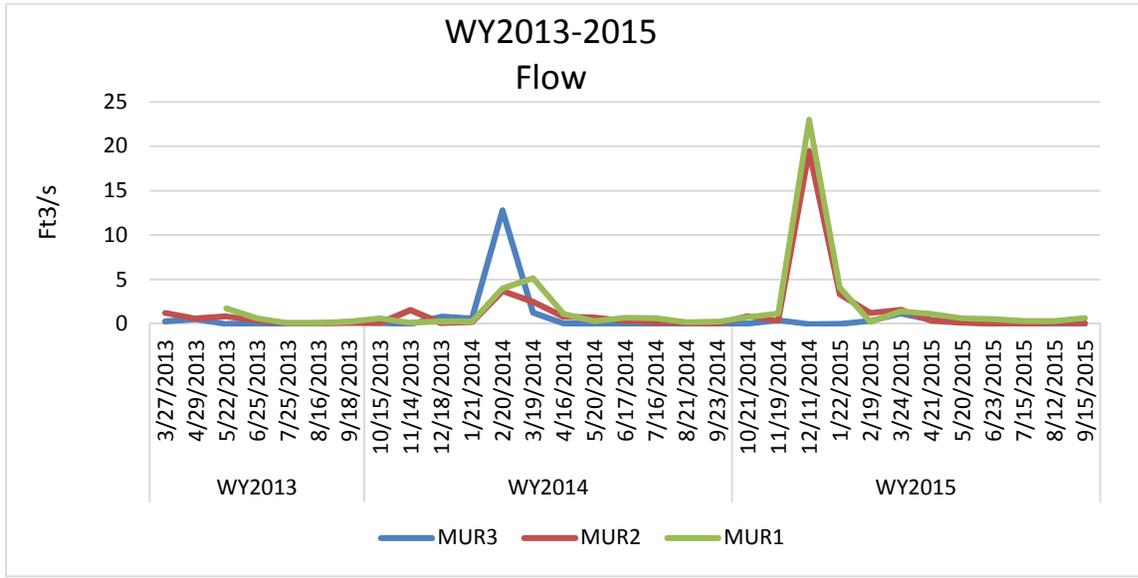
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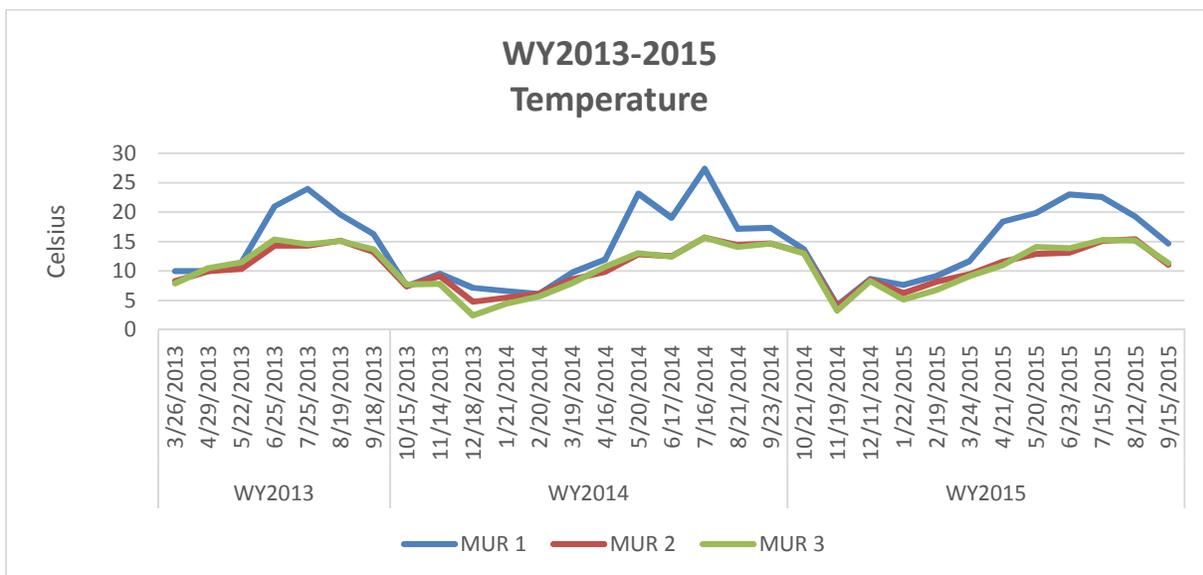
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IV. PHYSICAL PARAMETERS RESULTS

Measurements for physical parameters of temperature, conductivity, salinity, dissolved oxygen and pH were taken during the 32 monthly sampling events. As can be seen by the results in Figure 4 below, temperatures rose at all stations during the dry weather and were fairly uniform, except for slightly warmer temperatures at MUR1, the nearshore station. Typically, when temperatures are higher, dissolved oxygen is lower, however a definitive correlation is not apparent during our sampling events. It does appear as though MUR3, Meig’s Creek, is impacting the dissolved oxygen levels, since a beaver dam is above the sampling location. This results in an area of stagnant water that flows through and over the beaver dam into the sampling area and may be a contributing factor.

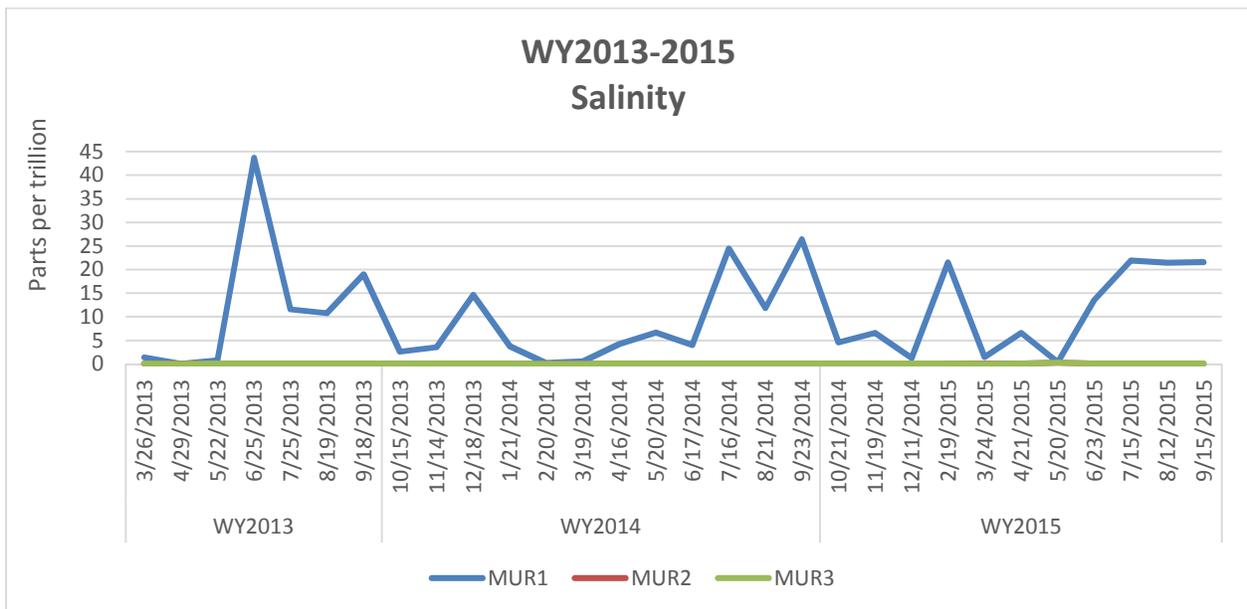
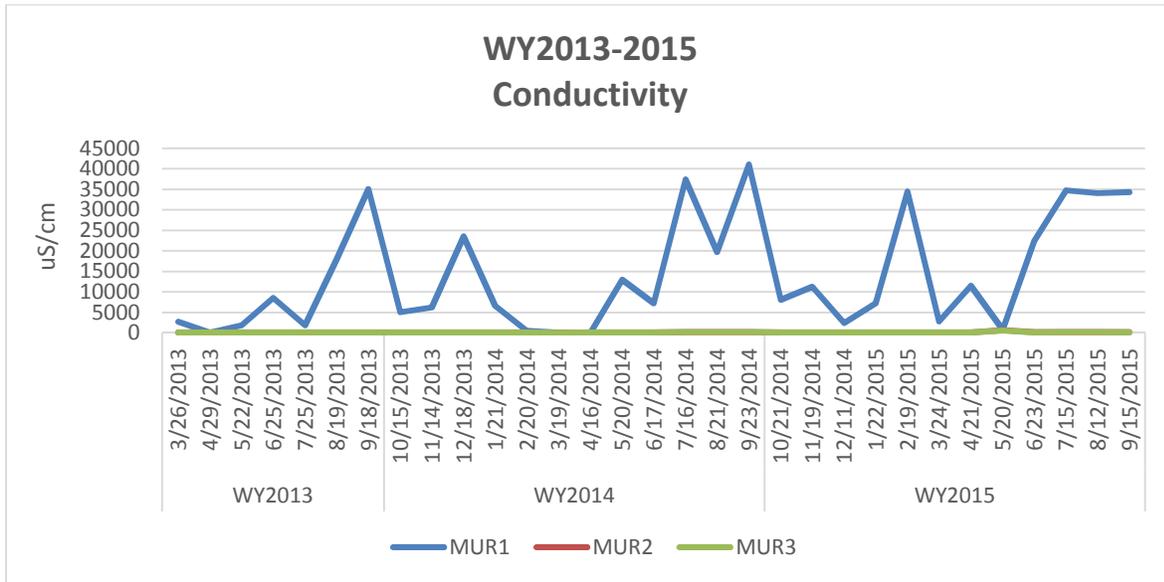
In Table 4, averages and ranges for the physical parameters are shown. The average and range in temperature at MUR1 is noticeably higher than the other stations. This area is at the mouth of the creek which empties into Murden Cove. No trees shade the sample location area, so this is not surprising. In addition, the conductivity and salinity measurements also show higher values in Figure 4 and Table 4, which is also expected because even at low tides there is saltwater influence. Dissolved Oxygen levels are depressed throughout the sampling locations and one peak in levels is unexplained at this time.

Figure 4. Physical Parameters Results



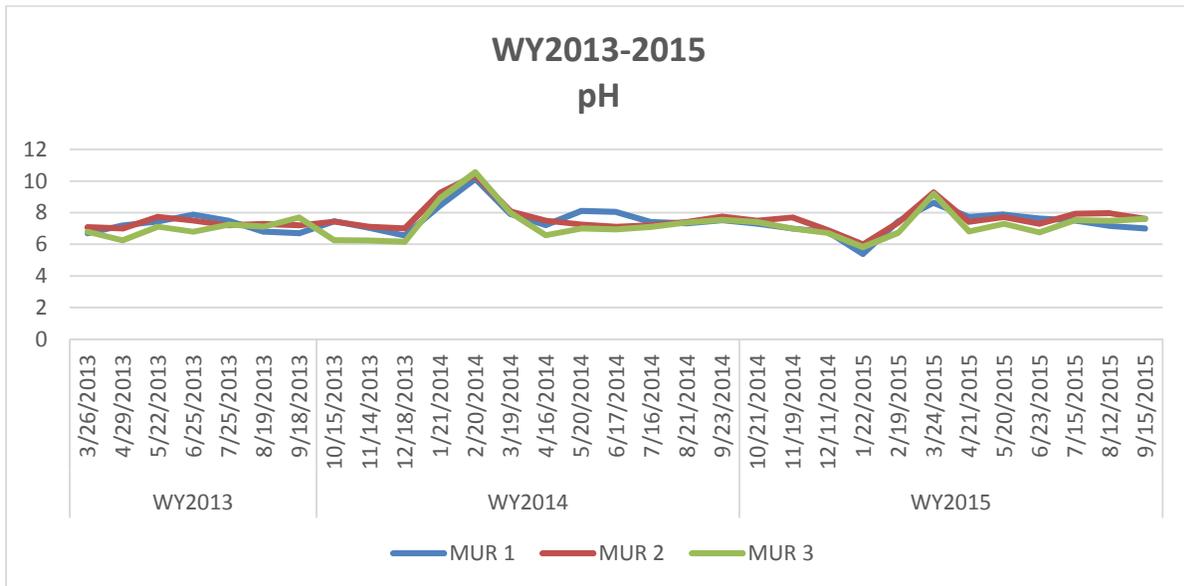
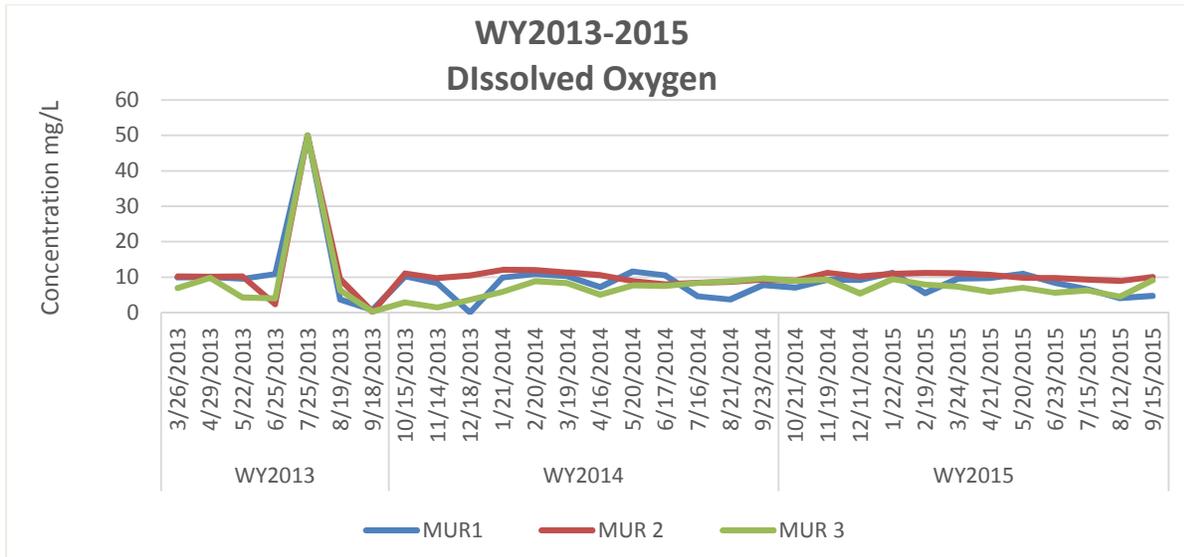
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Table 4. PHYSICAL PARAMETERS (AVERAGE AND RANGES)

| Station | Temperature (Celsius) | | Conductivity (uS/cm) | | Salinity (ppt) | | Dissolved Oxygen (mg/L) | | pH | |
|---------|-----------------------|-----------|----------------------|-------------|----------------|-----------|-------------------------|--------|---------|------------|
| | Average | Range | Average | Range | Average | Range | Average | Range | Average | Range |
| MUR1 | 14.36 | 4.2-27.4 | 14313.24 | 10.45-41072 | 10.54 | 0.05-43.7 | 9.12 | 0-50 | 7.43 | 5.4-10.17 |
| MUR2 | 10.83 | 4.0-15.7 | 160.12 | 72.2-641 | 0.08 | 0.04-0.31 | 10.78 | 0.2-50 | 7.59 | 6-10.37 |
| MUR3 | 10.71 | 2.48-15.7 | 146.65 | 65.6-564 | 0.07 | 0.03-0.28 | 8 | 0.3-50 | 7.25 | 5.84-10.57 |

V. EDUCATION AND OUTREACH

There were 275 property inspections completed during the project. PIC staff distributed fact sheets, homeowner's septic system manuals, pet waste management and natural yard care information and other related brochures. PIC staff also provided residents with their specific onsite septic system records (e.g. sewage permits, as-built drawings etc.). These records are used as a training and outreach tool to assist residents in understanding their type of system, verify its location and help them recognize signs of septic system problems. In addition, regular septic tank inspection/pumping was discussed. To determine if our project was successful in leading people to have their septic tanks inspected, we compared the number of inspections completed pre-project (1/1/10-12/31/12) to post project start (1/1/13-3/15/16) in Table 5. Results indicate that there was an 18.8% increase in tank inspection/pumping in Murden Creek, 15.6% increase in Murden Cove and 12.2% increase in Fletcher Bay.

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Table 5. Inspection/Pumping data

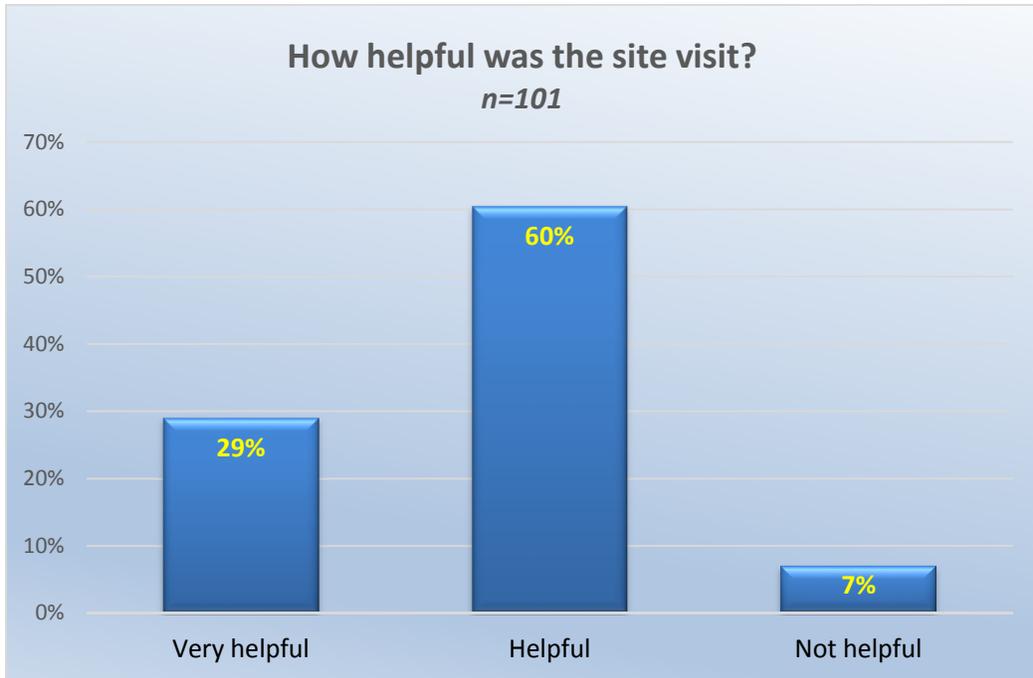
| Murden Creek | | | |
|-------------------------------|--|--|--------------|
| | Inspected/Pumped 01/01/2010-12/31/2012 | Inspected/Pumped 01/01/2013 - 03/15/2016 | Increase by |
| Total Sites | 64 | 64 | |
| Total Pumped/Inspected | 29 | 41 | |
| % Pumped Inspected | 45.3% | 64.1% | 18.8% |
| | | | |
| Murden Cove | | | |
| | Inspected/Pumped 01/01/2010-12/31/2012 | Inspected/Pumped 01/01/2013 - 03/15/2016 | |
| Total Sites | 122 | 122 | |
| Total Pumped/Inspected | 70 | 89 | |
| % Pumped Inspected | 57.4% | 73.0% | 15.6% |
| | | | |
| Fletcher | | | |
| | Inspected/Pumped 01/01/2010-12/31/2012 | Inspected/Pumped 01/01/2013 - 03/15/2016 | |
| Total Sites | 82 | 82 | |
| Total Pumped/Inspected | 41 | 51 | |
| % Pumped Inspected | 50.0% | 62.2% | 12.2% |
| | | | |

Following most property inspections, a mail-in postcard survey was sent to residents, see Figure 5 results. There were 211 postcards mailed, 157 to Murden Cove watershed residents and 54 to Fletcher Bay residents. One hundred and one completed surveys were received for a response rate of 48%. The following charts show the results from each question in the survey. Eighty-nine percent of respondents indicated that the site visit was very helpful or helpful and 7% didn't find it helpful. Forty-four percent of respondents learned something new about their septic system and implemented septic tank pumping or maintenance and monitoring (M&M), while 38% stated that they did not make any changes. In addition, 12% of respondents implemented natural yard care management.

Information regarding pet waste and livestock manure responses showed that 45% of respondents will continue to pick up and dispose of waste, 6% will begin to pick up and dispose of waste and 6% will continue to manage livestock waste with 1% contacting the Conservation District for assistance.

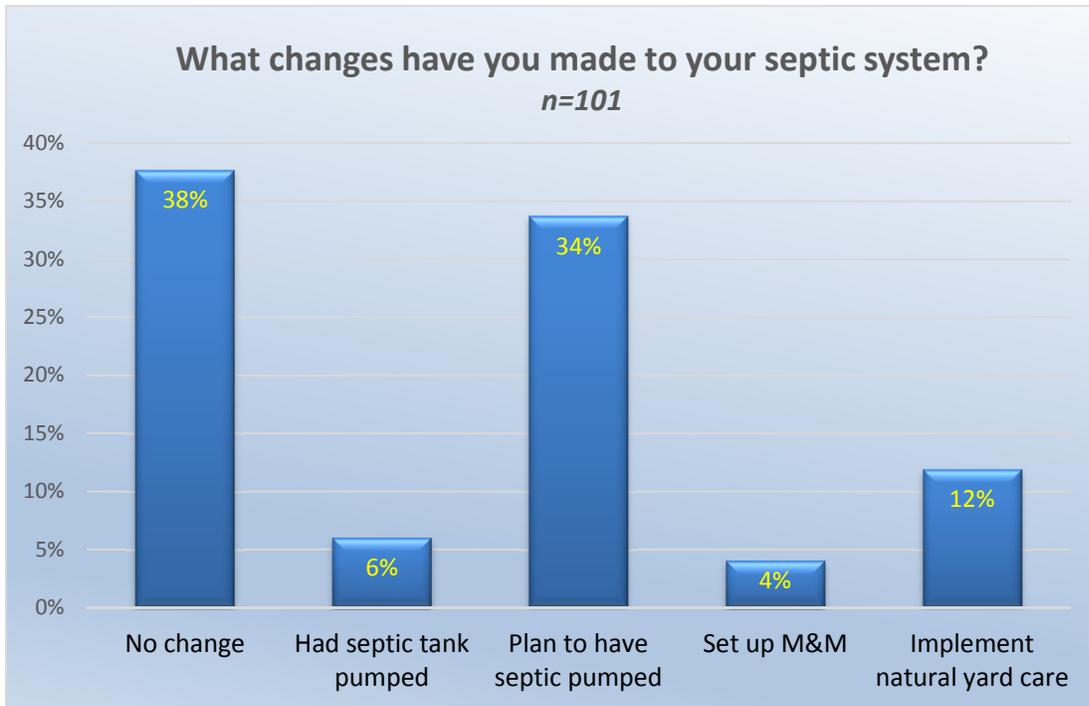
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Figure 5. Follow-up Postcard Survey Results



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In addition to the responses above, there were 50 written comments included in the surveys.

A summary of these written comments are shown in Table 6 below;

Table 6. Written Comments

| Appreciation | Specific information/aspect of visit | Other comments |
|---|---|---|
| 15 written comments included statements of "Thank You" to naming specific staff and commenting positively on their knowledge and expertise. | 23 written comments that included statements regarding either information or aspects of the visit, e.g "Tried baking soda and vinegar in drain", "Discontinued Rid-X", "Use mulching mower, no fertilizers or herbicides", "OSS Life", "Plan to pump tank soon", "Appreciate raccoon pamphlet", "OSS placard for tenants reference", "Limiting use of garbage disposal", etc. | 4 written comments that included: "We learned all this when we moved in", "Although I didn't learn anything new, the information is good and others may benefit", "... One-on-one visits seem expensive though...", "I think your map may need to be expanded. For example, there's a small stream that flows down Kalgren, under Valley, under Beachcrest and into Murden Cove. Flows a lot following rain". |

As part of the outreach component, two public meetings were held to announce the project. Prior to the first public meeting, a presentation was given to the City Council of Bainbridge Island. Then a public kick-off meeting was held on April 24, 2013 to announce the project. There were nineteen attendees. The meeting covered project area information, OSS care and maintenance, use of fertilizers, livestock and pet waste management along with distribution of brochures and fact sheets. Over the course of the project, a mid-project update postcard was mailed to 260 homes in the Murden Cove watershed in March of 2015. At the same time, a postcard was mailed to 92 homes in the Fletcher Bay watershed to announce the addition of this watershed to the project.

In preparation for the final public meeting on December 10, 2015, postcards were mailed to 260 homes in the Murden Cove watershed and 111 in Fletcher Bay to announce the meeting. Announcements were also placed in the community calendars of two local papers; the

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Bainbridge Island Review and Inside Bainbridge. Nineteen residents attended the final public meeting to hear about our findings.

VI. SUCCESSES AND FAILURES OF PROGRAM TO ADDRESS NUTRIENT SOURCES

Since the OSS failure rate for the Murden Cove watershed was at 1%, and we exceeded our property inspection numbers, it would suggest that onsite septic systems and yard care were not significant human sources of nutrient loading to the watershed.

It also important to note that during the project, all stations in the Murden Cove Watershed showed improvements in fecal bacteria concentrations, with the nearshore station meeting both Part 1 and 2 of the Water Quality Standards. In addition, in the Fletcher Bay watershed, the marine station that prompted a threatened status designation is beginning to show improvements in water quality as well.

VII. REFLECTIONS ON PROJECT

Kitsap Public Health District demonstrated the ability to successfully complete door-to-door surveys in both project areas. In addition to finding four failing septic systems, the educational component of the surveys will help to prevent future septic system problems from going undetected and encourage continuation of routine tank inspection/pumping. As was demonstrated in the follow-up postcard survey, 89% of respondents found the site visits very helpful or helpful. The responses were helpful in providing us with an understanding about what residents learned during the site visit and what changes they might make as a result of the visit. The surveys were anonymous so in retrospect it would have been helpful to have had contact information to follow up with those residents indicating they would make changes to their behavior like having their septic tanks pumped. Future projects that include mail in surveys will be re-designed to include this element so we can follow up on changes in behaviors and/or actions.

Additionally we learned that there was only one property with a problematic manure management issue and no other properties were found to have livestock, pet waste or other land use practice problems.

March 31, 2016

VIII. RECOMMENDATIONS FOR FUTURE WORK

Kitsap Public Health District will continue to monitor Marine Station 457 through its trend monitoring program until the threatened status is removed. If bacterial levels begin to rise, it may be difficult to implement a targeted, intensive Pollution, Identification and Correction program in the Fletcher Bay area. However, we respond to water quality complaints and deficient pump reports on Bainbridge Island, so any problems discovered during site visits will be addressed during those investigations.

Future work in the Murden Cove and Fletcher Bay watersheds may benefit from Microbial Source Tracking or other types of library methods to evaluate the contribution of wildlife or pet waste in a particular drainage system.