Montana Economic Revitalization and Development Institute (MERDI)

# Assessment of Nitrogen Loading to Silver Bow and Blacktail Creeks Resulting from Sewage Contamination

## 2016 Butte Area One Small Restoration Project Proposal

Prepared for:
Butte Natural Resource Damage Restoration Council (BNRC)
65 E. Broadway
Butte, MT 59701

November 15, 2016

## Contact Information

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## Project Summary and Map

The Assessment of Nitrogen Loading to Silver Bow and Blacktail Creeks Resulting from Sewage Contamination project is a collaborative effort between MERDI (project sponsor) and the BSB Public Works Department to evaluate the influx of nitrogen loading to Silver Bow and Blacktail Creeks resulting from sewage contamination from septic systems, aging sewer lines and cross-connected sewer mains and storm drains located near the creeks. Project activities are expected to commence in the fall of 2017, with monitoring activities occurring into the summer of 2019. The funding request from BNRC for this project is $48,448 with matching funds of $119,281 from Butte-Silver Bow.


## Project Goals and Objectives

The primary goals of the Assessment of Nitrogen Loading to Silver Bow and Blacktail Creeks Resulting from Sewage Contamination project are to evaluate the nitrogen (as nitrate) influx to these streams resulting from septic systems, aging sewer lines and cross-connected sewer mains and storm drains.

The project objectives pursued under this project include:

1. Identify septic systems located within the municipal sewer system and evaluate risk of nitrate contamination to either creek based upon the location of system.

2. Identify locations of cross-connected sewer mains and storm drains evaluate risk of nitrate contamination to either creek based upon the location of cross-connection and frequency of back-flow events.
3. Prepare a sampling plan that identifies analytes, sample sites, monitoring schedule and parameters that will classify sewage contamination.
4. Identify neighborhoods or areas that pose the greatest possibility of nitrate contamination to either creek from leaking sewer lines based upon previous studies and the age of the sanitary infrastructure in place.
5. Perform smoke tests on sewer lines to identify the extent of sewage leaks in neighborhoods or areas identified as posing a nitrate contamination risk to surface water in Blacktail and Silver Bow Creek.
6. Identify and monitor ground- and surface-water wells most likely to register the impact of nitrate reductions as repairs and/or replacements are made.
7. Compile report.

Past studies indicate that nitrogen levels for the Clark Fork River Basin should be maintained at less than 0.35 mg/L to prevent nuisance algal growth. As a general guideline, a concentration of inorganic nitrogen greater than 0.30 mg/L in surface water is recognized as having the potential to cause eutrophication or algal growth. Because ground water is a major component of stream baseflow, elevated nitrate levels in Butte groundwater represents an ecological threat to both Blacktail and Silver Bow Creek. Nutrient enrichment can cause a host of negative ecological effects on these creeks, including loss of water clarity, proliferation of aquatic weeds, algae blooms, and drop-offs in dissolved oxygen (a critical factor for fish and other aquatic life). In the map on page 1 of this proposal, 57 % of the groundwater wells in the green highlighted area of Butte contained more than 2 mg/L nitrate and the median of 4.8 mg/L nitrate.

As early as 1914, a USGS hydrogeologic investigation of Butte's groundwater resources warned of the high potential for pollution by sewage and mine wastes due to poor soil characteristics in this area (high porosity, low organic matter). Again in 1969, 1970 and 1980 reports were published warning of potential threats to the ecosystem from septic systems, rating Butte's soils as "severely limited" for septic tank filter sand, making the use of septic systems in this area questionable. According to the Butte-Silver Bow County Growth Policy (2008 Update), there are approximately 200 miles of sewer lines in Butte serving 12,598 households. The 2010 U.S. Census lists 16,373 housing units in Butte, suggesting that roughly 23% of the housing units in Butte are served by septic systems or other wastewater systems. This agrees with 2002 EPA OWTS study that concludes that between 29% and 37% of Montana residents utilize septic systems. The same EPA study finds that although septic systems efficiently remove most wastewater contaminants, they typically contain 40-100 mg/L total nitrogen and remove only 10-20% of the nitrogen from the effluent.

The 2008 Butte-Silver Bow County Growth Policy states that "the community's sanitary system requires significant improvement. Currently, the system is being maintained through repair, but a long-term strategy for main trunk replacement is required in order to maintain capacity and provide room to grow." Much of Butte's original concrete & clay sewer system has been eroded by acidic mine water overflow resulting from antiquated cross-connections between sewer lines and storm drains. This erosion has resulted in complete disintegration of the sewer line in some areas. Testing utilizing a smoke machine and drone to identify areas in greatest need of repair or replacement will enable authorities to implement actions with immediate nitrate reduction benefits.

Assessment of Nitrogen Loading to Silver Bow and Blacktail Creeks Resulting from Sewage Contamination
Septic systems are among the many sources of nutrients found in groundwater and surface water—other major sources include fertilizers, livestock manure, municipal wastewater, and storm-water runoff. A 2004 report published by the Montana Bureau of Mines and Geology investigated the impact of high nitrate levels in groundwater on surface drainages and discovered many of the most contaminated groundwater wells occurred beneath the sewered area in East Butte as well as several unsewered subdivisions utilizing septic systems south of Butte. The analyses of nitrogen and oxygen isotopes in this study indicate animal or septic waste source for the nitrate rather than fertilizer. It would appear from this report that both leaking municipal sewage from an aging infrastructure and septic system use in the area contribute heavily to the nitrate influx to Silver Bow and Blacktail Creeks. This project intends to further isolate and identify areas of municipal sewage infiltration and rank each area based upon the risk posed to the ecological health of Silver Bow and Blacktail Creek.

## Project Benefits

Identifying the source of nitrate influx in Blacktail and Silver Bow Creek will allow governing bodies to focus infrastructure repair efforts on those areas identified as posing the highest risk to stream ecology.

## Project Implementation

### Phase I

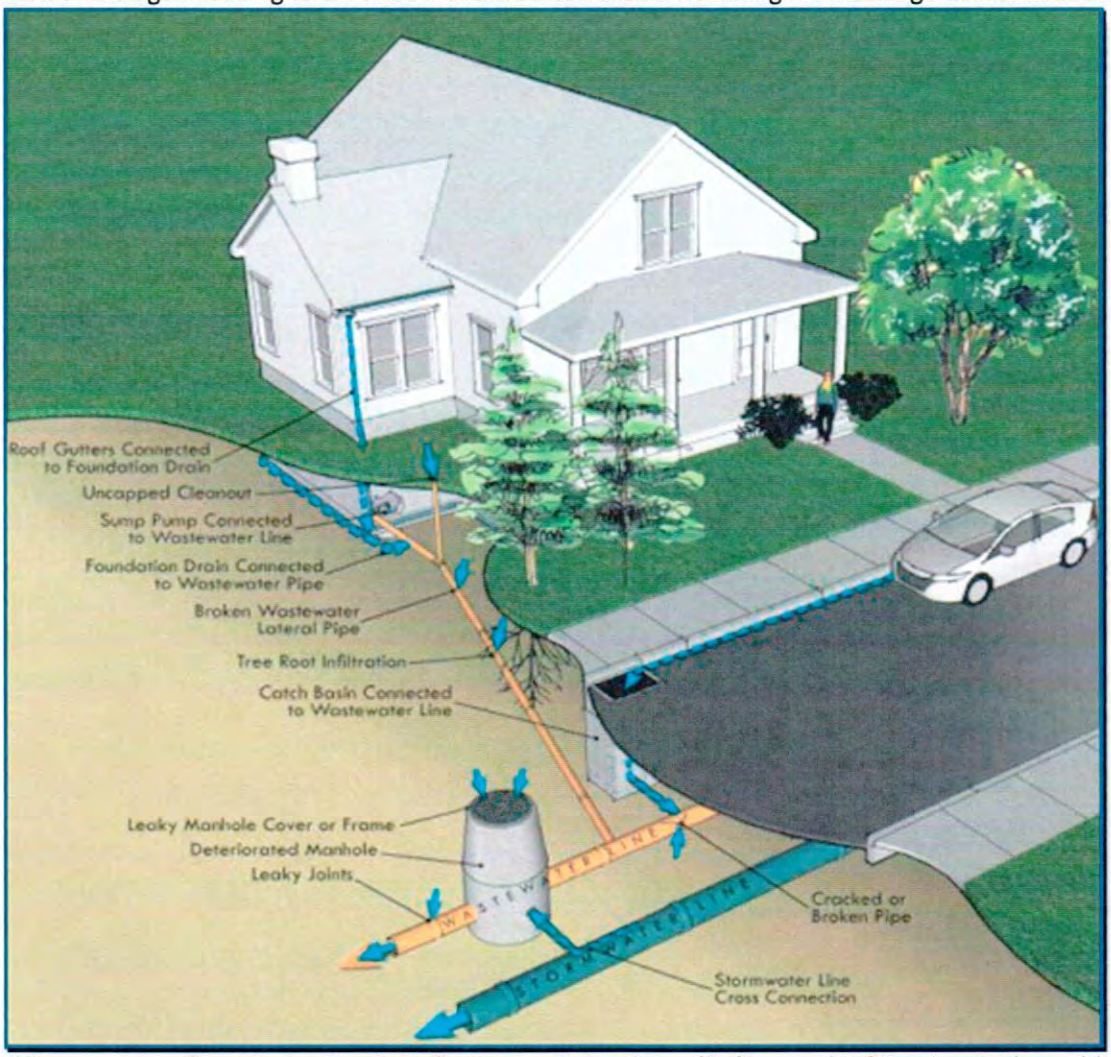
1. Identify septic systems located within the municipal sewer system and evaluate risk of nitrate contamination to either creek based upon the location of system.
2. Identify locations of cross-connected sewer mains and storm drains evaluate risk of nitrate contamination to either creek based upon the location of cross-connection and frequency of back-flow events.
3. Identify neighborhoods or areas that pose the greatest possibility of nitrate contamination to either creek from leaking sewer lines based upon previous studies and the age of the sanitary infrastructure in place.

### Phase II

1. Prepare a sampling plan that includes:
   a. Identifying analytes of interest that would assist in identifying sewage contamination, including nitrate as nitrogen, total nitrogen, total phosphorus, total suspended solids and fecal coliform; Identifying other agencies that may already be monitoring these parameters and, if so, determining whether the results will be publicized and a timeline for publication;
   b. Defining data quality objectives;
   c. Locating optimum sampling locations and obtaining permission to sample, as necessary;
2. Perform baseline sampling and analysis.

### Phase III

1. Perform smoke tests on sewer lines to identify the extent of sewage leaks in neighborhoods or areas identified as posing a nitrate contamination risk to surface water in Blacktail and Silver Bow Creek. Property owners in areas where smoke testing will take place will be notified of testing, but permission is not required to perform the testing. Because this testing cannot be conducted during rainy periods or very windy conditions a general timeline of when testing will be conducted will be provided to property owners.




The purpose of smoke testing is to find potential points of inflow and infiltration in the public portion of the sanitary sewer system that could lead to high flows during storms and snow melt events. Smoke testing can also help locate the following:

- Points of groundwater or surface water intrusion into the sewer
- Any cross connections between sanitary sewers and storm drains
- Defective sewer connections or leaks.

During smoke testing, field crews blow air and smoke into the sanitary sewer system in the street and monitor where smoke escapes the system. The smoke under pressure will fill the main line as well as any connections and then follow the path of any leak to the ground surface, quickly revealing the source of the problem. For instance, if smoke permeates up through a yard, it indicates breaks in the sewer line. Only enough force to overcome atmospheric pressure is required.

During testing, photo and video data will be recorded utilizing a drone equipped with a camera to document leaks in addition to information recorded on field sheets.

For each sewer main tested, a field log identifying each point of smoke exfiltration from:

- ✓ Roof gutters.
- ✓ Sewer cleanouts
- ✓ Leakage in house laterals.
- ✓ Patio or area drains.
- ✓ Storm drain cross connections.
- ✓ Any other source not stated above
- ✓ Indicate if roof vents showed evidence of smoke or not.

Defects shall be logged as "private", "public owned", or "commercial". The points of exfiltration shall be referenced and dimensioned to permanent landmarks, GPS coordinates, and/or house or lot numbers.

A photograph of all leaks using a digital camera or approved substitute shall be included in the field log. Photographs of smoke evidence shall have a location indicated in the photograph using a heavy marker and heavy card stock and/or recorded on a DVD disk if specified. All photographs shall be clearly cross-referenced to the field log indicating the location of the leak. Photographs of smoke evidence shall have a location indicated in the photograph using a defect flag and be assigned a unique number.

2. Compile a Smoke Testing Report for the neighborhoods and areas included in this project. The report will include:
   a. Scanned field forms;
   b. An Excel table that includes a listing of all defects, defect number, description of defect, GPS coordinates of defect, digital photograph number corresponding to defect, testing date, inflow potential rating of the defect; and,
   c. A Google Earth map with testing locations clearly identified.

## Phase IV

1. Determine data validation & usability.
2. Compile report that will:
   a. Include baseline nitrate results;
   b. Identify those areas and systems that pose the greatest nitrate risk to both Silver Bow and Blacktail Creek based upon the results of previous studies, septic system evaluation, smoke testing and comparison to existing groundwater flow maps;
   c. Evaluate alternative wastewater systems that more effectively treat nitrates than septic systems and associated costs of implementing those systems;
   d. Identify and evaluate the costs associated with upgrades or repairs to leaking sewer lines;
   e. Evaluate costs associated with the elimination of cross-connections of sewer mains and storm drains.

## Phase V

Monitor ground- and surface-water wells most likely to register the impact of nitrate reductions as repairs and/or replacements are made.

1. Re-evaluate sampling plan from Phase II and update to include:
   a. Inclusion of additional analytes of interest;
   b. Re-defining data quality objectives, as necessary;

   c. Re-evaluating optimum sampling locations and obtaining permission to sample, as necessary;
   d. Determine monitoring schedule based upon repairs/upgrades made to sewer infrastructure and/or septic system replacement;
2. Perform ongoing sampling and analysis.
3. Report results of sampling and analysis.

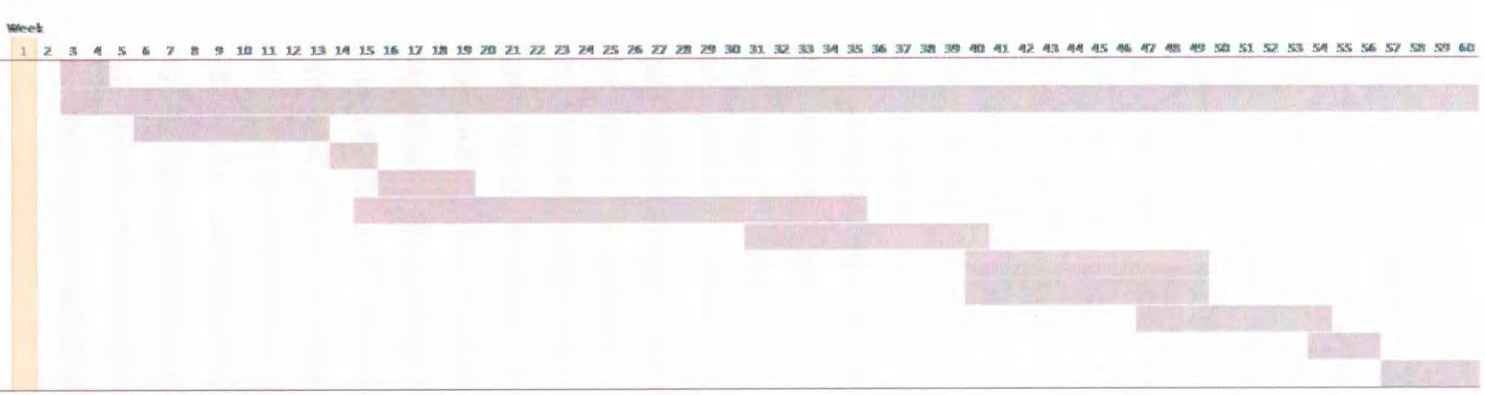
## Project Schedule

The anticipated project schedule is estimated to take place over approximately 1.5 years.

**Project Planner**

Period Highlight: 1 | Plan | Actual | % Complete | Actual (beyond plan) | % Complete (beyond plan)

| ACTIVITY | PLAN START | PLAN DURATION | PERCENT COMPLETE |
|---|---|---|---|
| Activity IA: Sep Sys ID/Loc | 1 | 2 | 0% |
| Activity IB: X-Conn Loc | 1 | 100 | 0% |
| Activity IC: Area Ranking | 4 | 8 | 0% |
| Activity IIA: Samp Plan Prep | 12 | 2 | 0% |
| Activity IIB: Samp & Analy | 14 | 4 | 0% |
| Activity IIIA: Smoke Testin | 13 | 21 | 0% |
| Activity IIIB: Smoke Tst Rpt | 29 | 10 | 0% |
| Activity IVA: Data comp/eval | 38 | 10 | 0% |
| Activity IVB: R/R Cost eval | 38 | 10 | 0% |
| Activity IVC: Test Report | 45 | 8 | 0% |
| Activity VA: Monit Plan | 52 | 3 | 0% |
| Activity VB: Monit S&A | 55 | 90 | 0% |



## Monitoring Activities

Project activities will be reported in quarterly reports as indicated in the following table.

| **Phase I:** | | | | | |
|---|---|---|---|---|---|
| **Activity #** | **Project measures** | **How will progress be measured** | **When will progress be measured** | **What tools/ resources are required to measure progress** | **Who is responsible for measuring progress** |
| **IA) Identification of septic systems within sewer system** | **# septic systems located within municipal sewer system**<br>**location septic systems located within municipal sewer system** | **Complete list of systems with GPS coordinates and distance to SBC and BT Creeks** | **Quarterly** | **GPS Coordinates & Mapping** | **M.Cameron** |
| **IB) Identify locations of cross-connected sewer mains and storm drains** | **# cross connected sewer mains & storm drains located within municipal sewer system**<br>**location cross connected sewer mains & storm drains located within municipal sewer system** | **Complete list of cross-connections with GPS coordinates and distance to SBC and BT Creeks** | **Ongoing (Risk - high: There are potentially thousands of cross-connections)** | **GPS Coordinates & Mapping** | **M. Cameron** |
| **IC) Identify neighborhoods or areas that pose the greatest possibility of nitrate contamination to SBC or BT Creek** | **Evaluate previous studies**<br>**Evaluate infrastructure upgrades**<br>**Rank areas from greatest to least risk of contamination** | **Creation of list of areas ranked highest to lowest for nitrate contamination risk for further study** | **Quarterly** | **Internet and database search; interviews** | **M. Cameron** |
| **Phase II:** | | | | | |
| **Activity #** | **Project measures** | **How will progress be measured** | **When will progress be measured** | **What tools/ resources are required to measure progress** | **Who is responsible for measuring progress** |
| | **Identify analytes of interest** | | **Quarterly** | **Review** | **M.Cameron** |

| | | | | | |
|---|---|---|---|---|---|
| **IIA) Prepare Sampling Plan** | **Identify data quality objectives**<br>**Identify sampling locations** | **Completed Sampling Plan** | | | |
| **IIB) Sampling and Analysis** | **Perform sampling**<br>**Analyze samples**<br>**Validate analytical data**<br>**Evaluate data as it relates to project** | **Analytical Report** | **Ongoing (Risk - low: No nitrate contamination) (Risk – moderate: inconclusive or invalid data)** | **Laboratory; Field and sampling instrumentation and equipment; GPS** | **M. Cameron** |
| **Phase III:** | | | | | |
| **Activity #** | **Project measures** | **How will progress be measured** | **When will progress be measured** | **What tools/ resources are required to measure progress** | **Who is responsible for measuring progress** |
| **IIIA) Perform Smoke Tests** | **Notify residents/occupants**<br>**Notify emergency responders**<br>**Traffic control**<br>**Conduct testing** | **Field logs, progress reports, schedules** | **Quarterly (Risk – high: test cannot be performed with high winds, rain, or wet ground)** | **Weekly meetings and correspondence** | **M. Moore** |
| **IIIB) Compile Report** | **List of defects**<br>**Locations of defects**<br>**Inflow Potential Ratings**<br>**Map of defects with ranking** | **Report detailing severity ranking of defects** | **Quarterly (Risk - low: no defects) (Risk – moderate: most defects rank severe)** | **GPS Coordinates & Mapping** | **M. Moore** |
| **Phase IV:** | | | | | |
| **Activity #** | **Project measures** | **How will progress be measured** | **When will progress be measured** | **What tools/ resources are required to measure progress** | **Who is responsible for measuring progress** |
| **IVA) Evaluate data and information collected during Phases I-III** | **Septic systems**<br>**Leaking sewage lines**<br>**Previous studies**<br>**Baseline nitrate data**<br>**Smoke testing results** | **Estimate to completion** | **Quarterly** | **Internet and database search; interviews** | **M.Cameron**<br>**M. Moore** |

| | | | | | |
|---|---|---|---|---|---|
| | Groundwater flow maps | | | | |
| IVB) Evaluate replacement/repair costs | Replacement cost of septic systems with systems capable of greater nitrate reduction<br>Repair costs to sewer infrastructure posing greatest threat<br>Replacement cost of sewer infrastructure posing greatest threat<br>Costs associated with the elimination of cross-connections in high-contamination risk areas | Estimate to completion | Ongoing (Risk: There are potentially thousands of cross-connections) | Internet and database search; quotes, cost estimating | M.Cameron<br>M. Moore |
| IVC) Report | Compile report including findings from IVA and IVB. | Progress reports and draft updates | Quarterly | | M.Cameron<br>M. Moore |
| **Phase V:** | | | | | |
| **Activity #** | **Project measures** | **How will progress be measured** | **When will progress be measured** | **What tools/ resources are required to measure progress** | **Who is responsible for measuring progress** |
| VA) Revise Sampling Plan | Re-evaluate analytes of interest<br>Re-evaluate data quality objectives<br>Re-evaluate sampling locations | Completed revised Sampling Plan | Quarterly | Review | M.Cameron |
| VB) Sampling and Analysis | Perform sampling<br>Analyze samples<br>Validate data<br>Evaluate data as it relates to project | Analytical Report | Ongoing (Risk - moderate: No nitrate reduction)(Risk – moderate: no repairs) | Laboratory; Field and sampling instrumentation and equipment; GPS | M. Cameron |

## Project Budget

An estimated project budget is provided below. Butte-Silver Bow Public Works department will provide labor and materials to perform smoke testing in the area outlined in green in the map in the Project Summary section. This section currently consists of over 400,000 feet of sewer line; however, Phase I of this project will be focused in a smaller footprint nearer to the creeks. Hourly estimates below are based upon a BSB 4 man crew being able to complete 3600 feet of smoke testing and a 6 hour work day, resulting in an estimate to completion of 5.5 months for 400,000 feet of sewer line. Because this area of Butte is not currently the focus of BSB's smoke testing, the cost of drone services will be covered by the project.

The total amount requested for this project is $48,448 with a total match of $119,281.

Butte Area One Small Project Proposal

Assessment of Nitrogen Loading to Silver Bow and Blacktail Creeks Resulting from Sewage Contamination

| Personnel Name | Category | Billing Rate | Hours | Cost | Role |
|---|---|---|---|---|---|
| Marcee Cameron | Project Manager, Chemist | $ 120.00 | 120 | $ 14,400.00 | Project Management, Field Sampling Plan, Perform Sampling, Quarterly & Final Reports |
| Kitrina Wilkins | Chemist | $ 80.00 | 80 | $ 6,400.00 | Review Field Sampling Plan, Perform Sampling, Data Compilation and Review Final Report |
| Tyler Rye | Field Tech | $ 55.00 | 80 | $ 4,400.00 | Field Sampling |
| Miriam King | Administrative | $ 80.00 | 8 | $ 640.00 | Administrative Tasks |
| Matt Moore/MERDI | | $ 140.00 | 60 | $ 8,400.00 | Reporting |
| Matt Moore/BSB | Project Manager, PE | $ 110.00 | 60 | $ 6,600.00 | Project Management, Project Engineer, Work Permits, Notifications, Scheduling |
| 4 Man Crew (per day) | Supervisor & 3 man crew | $ 1,200.00 | 90 | $ 108,000.00 | Supervision of Field Crew, Safety, Recording Field Data, traffic control, blower operator, line walking, laborer (Est 6 hr days, 3600 feet/day for 5.5 months - total 400,000 feet sewer line) |
| Hayes Novich | Certified Drone Operation, Contracted Services | $ 70.00 | 60 | $ 4,200.00 | Camera Operator; 4 wing drone with real-time video and hover capabilities |
| | | $ 85.00 | 60 | $ 5,100.00 | Pilot; 4 wing drone with real-time video and hover capabilities |
| | | Labor Subtotal | 468 | $ 43,540.00 | |
| | | Labor Match | 420 | $ 114,600.00 | |

| Item | Category | Unit Cost | Units | Total Cost | |
|---|---|---|---|---|---|
| Lab Analysis | Direct Cost | $ 89.25 | 55 | $ 4,908.75 | Nitrate as Nitrogen, Total Nitrogen, Total Phosphorus, Total Suspended Solids, Fecal Coliform |
| Lab Analysis | Match Cost MSE | $ 15.75 | 55 | $ 866.25 | Discounted laboratory costs |
| 1750-4500 cfm blower | Match Cost BSB | $ 2,320.00 | 1 | $ 2,320.00 | Smoke Testing (4000 cfm @ 4.0 static pressure) |
| Superior Smoke Fluid | Match Cost BSB | $ 1,495.00 | 1 | $ 1,495.00 | Smoke Testing ($1495/55 gal) |
| | | | Subtotal | $ 4,908.75 | |
| | | | MSE Match | $ 866.25 | |
| | | | BSB Match | $ 3,815.00 | |
| | | | Total Request: | $ 48,448.75 | |
| | | | Total Match: | $ 119,281.25 | |

## Drone Aircraft Photography Estimate

# Hazer Live

ESTIMATE / 11152016

Hayes Novich
124 Main Street
Butte, MT 59701
406.599.7286

**MERDI**
65 E. Broadway, Suite 5
Butte, MT 59701

**ESTIMATED COST**
**$9,300.00**

Assessment of Nitrogen Loading to Silver Bow and Blacktail Creeks Resulting from Sewage Contamination Project

Photographic and real-time video documentation of sanitary sewer system smoke testing using DJI Inspire 1 Pro multi-rotor with 4K video & 12 MP stills with >1 mile radio range and GPS-based flight control & stabilization system.

| Item Description | Estimated Time | Estimated Cost |
|---|---|---|
| Camera Operator @ $70/hour | 60 hours | $4,200.00 |
| Certified Drone Pilot @ $85/hour | 60 hours | $5,100.00 |
| | | |
| | | |
| | Subtotal | $9,300.00 |
| | Discount - 0% | $0.00 |
| | TOTAL | $9,300.00 |

*Prompt payment is appreciated. Secured payment is required for service after or before drone aircraft photography service is completed unless otherwise agreed in writing. Thank you.*

## Signatures

Your Name Date Client's Name Date

# Laboratory Services Quote

MSE Lab Services
*P.O. Box 4078*
*Butte, MT 59702*
TEL: *(406) 494-7334* FAX: *(406) 494-7320*

15-Nov-16

## QUOTATION for ANALYTICAL SERVICES

**Quote: 540**

Company: MERDI
Contact: Marcee Cameron
Address: 65 E. Broadway, Suite 5
Butte, MT 59701
Phone: (406) 533-6700 Fax:

Project: BNRC BAO Small Project Proposal
TAT: 15 working days
QC Level:

Submitted By:
Sara Ward

Quote Expires: 2/13/2018

| Test Name | Matrix | Test | Remarks | # Samp | Unit Price | Test Total |
|---|---|---|---|---|---|---|
| Nitrate+Nitrite by ION CHROMATOGRAPH | Aqueous | E300.0 | | 55 | $15.00 | $825.00 |
| FECAL COLI SM9222-D | Aqueous | A9222D | | 55 | $25.00 | $1,375.00 |
| TOTAL PHOSPHOROUS - E365.3 | Aqueous | E365.3 | | 55 | $25.00 | $1,375.00 |
| TOTAL PERSULFATE NITROGEN | Aqueous | A4500-NO3- | | 55 | $25.00 | $1,375.00 |
| TOTAL SUSPENDED SOLIDS | Aqueous | A2540D | | 55 | $15.00 | $825.00 |

| | |
|---|---|
| Sub total: | $5,775.00 |
| Misc: | $0.00 |
| Discount: | 15.00% |
| **TOTAL:** | **$4,908.75** |

Misc Comments:

**Comments:**

*1 of 1*