APPENDIX A
ANNUAL COMPLIANCE REPORT CONDITION REQUIREMENTS
CONDITION 3.0

Condition 3: Fish and Fish Habitat

3.1.1 *The Proponent shall minimize changes caused by the Designated Project to water levels and water flows in the Pinewood River, the Minor Creek System, and the Modified Minor Creek System in such a way as to protect fish and fish habitat, by implementing mitigation measures including, but not limited to: recycling of water, for ore processing, from the TMA and ponds constructed for water management*.

Status: Ongoing

Supporting Analysis:

In 2017, the Mill, the Water Management Pond (WMP) and the Tailings Management Area (TMA) Starter Cel (Cell 1) were commissioned, and operated with zero discharge. Water was recycled from the open pit, under the authorization and subject to Conditions 3.2 through 3.5 of Permit to Take Water (PTTW) 7631-9VULMS, the WMP and TMA to assist in the milling of ore. The mine infrastructure was designed to encourage recycling of water.

Water was drawn from the Pinewood River to build the initial water inventory needed to start operations, under the authorization and subject to Conditions 3.2 and 3.3 of PTTW 8776-9W2QN3. It is not anticipated that there will be any discharges from the WMP to the Pinewood River until 2019, at which time water will only be discharged when Condition 5 of Environment Compliance Approval 5178-9TUPD9 is met. Prior to discharge New Gold will need to obtain a Lakes and Rivers Improvement Act Approval (LRIA) from the Ministry of Natural Resources and Forestry (MNRF) to construct a rock groin in the Pinewood River for direct discharges from the WMP. The purpose of this groin is to; i) protect against erosion, ii) create a water mixing zone, iii) disperse water energy.

3.1.2 *The Proponent shall minimize changes caused by the Designated Project to water levels and water flows in the Pinewood River, the Minor Creek System, and the Modified Minor Creek System in such a way as to protect fish and fish habitat, by implementing mitigation measures including, but not limited to: optimizing the timing, position and quantity of final effluent discharge between the final effluent discharge points.*

Status: Ongoing

Supporting Analysis:

In 2017, the Water Management Pond (WMP), Tailings Management Area (TMA) Starter Cell and Mine Rock Pond (MRP) were commissioned, which increased the site capture of watershed drainage areas associated with the Rainy River Mine (RRM). As per Condition 3.3 of Permit to Take Water (PTTW) 8776-9W2QN3, the volume of water captured by site catchments was included in the total direct taking from the Pinewood River.

During the construction of the WMP, TMA, MRP and development of the Open Pit, there were construction related discharges to the environment subject to the Effluent Limits in Condition 7 of Environmental Compliance Approval (ECA) 5781-9VJQ2J. The construction related discharge points were obtained through the Environment Canada Metal Mining Effluent Notification Process, and subject to the Metal Mining Effluent Regulations.

Condition 5 of ECA 5178-9TUPD9 dictates the discharge quality criteria, timing and volume restrictions for release of effluent from the four (4) final discharge points, Constructed Wetland Final Discharge, Water Management Pond Pipeline Discharge, Sediment Pond #1 and Sediment Pond #2. To date, there have been zero discharges from the specified final discharge locations as they have not been constructed.

3.1.3 The Proponent shall minimize changes caused by the Designated Project to water levels and water flows in the Pinewood River, the Minor Creek System, and the Modified Minor Creek System in such a way as to protect fish and fish habitat, by implementing mitigation measures including, but not limited to: filling the open pit during the decommissioning and abandonment phases in a manner which meets the flow requirements in the Pinewood River while allowing the pit to be filled as expeditiously as possible to reduce any adverse environmental effects.

Status: Not applicable at this time

Supporting Analysis:

The Closure Plan for the Rainy River Mine outlines the close out and rehabilitation methods that will be used at the time of mine closure. With regard to the open pit, the pit walls will be reviewed by a professional engineer to insure compliance with the Ontario Mine Rehabilitation Code. Safety measures that include a berm, rock boulders and signage will be installed and then the pit will be allowed to fill naturally (rain, groundwater seeps) and from water inputs using a staged approach. This approach will involve water being taken from the Mine Rock Pond, seepage from the East Mine Rock Stockpile, and potentially runoff from the outside of the Tailings Management Area dams.

Additional water taking from the Pinewood River to enhance the rate of flooding is not currently under consideration. This option may be further evaluated during the life of the mine as additional flow data is obtained, and in consultation with regulatory agencies.

Flooding the final open pit is expected to take 60 to 75 years.

Section *3.1.4 The Proponent shall minimize changes caused by the Designated Project to water levels and water flows in the Pinewood River, the Minor Creek System, and the Modified Minor Creek System in such a way as to protect fish and fish habitat, by implementing mitigation measures including, but not limited to: not taking water from the Pinewood River when flows are below the minimum threshold set by Ontario*

Status: Ongoing

Supporting Analysis:

During 2017, water was taken from the Pinewood River to build the initial water inventory, as permitted by the MOECC under PTTW 8776-9W2QN3, upon completion of the Water Management Pond. Water taking commenced on April 26, 2017 and continued until November 7, 2017 when flows were above the minimum threshold set by Ontario and consistent with all other permit conditions. A total of 921,339 m3 of water was taken from the Pinewood River over 94 days at a rate determined by the Pinewood River flow on the specific days of taking.

3.2.1 The Proponent shall, for all effluent, comply with the MMER, the Fisheries Act and any site-specific water quality requirements set by Ontario. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: treat effluent prior to discharge to the environment.

Status: Ongoing

Supporting Analysis:

In 2017, effluent discharges to the environment were from; overburden and mine rock stockpile ditching, temporary seepage collection systems and pit dewatering systems that were constructed between 2015 and 2017. Effluent was generated from storm water runoff, water associated with overburden dumps and mine rock stockpiles, and water associated with blasting bedrock for the development of infrastructure foundations and Open Pit. The discharge water had not been through the mill nor had it been in contact with Potentially Acid Generating rocks.

In early 2017, treatment for ammonia consisted of a combination of dry ice and a portable water treatment plant to reduce ammonia concentrations, and flocculent addition to reduce total suspended solids. The use of flocculent for treatment was discontinued due to toxicity concerns after an Acute Toxicity bioassay failure on February 21, 2017. The use of dry ice and the portable water treatment plant ceased upon the commissioning of the Water Management Pond (WMP) on April 25, 2017, after which date any effluent that did not meet discharge criteria was pumped to the WMP to assist in building the initial project water inventory, and will receive further treatment prior to discharge to the environment.

To maintain compliance with Environment Canada Environmental Effects Monitoring requirements and the Environmental Compliance Approval (No. 5781-9VJQ2J) issued for the project, RRM conducts semi-annual sublethal toxicity testing of its primary final effluent, water quality monitoring, sediment quality monitoring, benthic invertebrate community monitoring and fish population monitoring. A copy of the 2017 Phase 1 Environmental Effects Monitoring Interpretive Report for the

New Gold Rainy River Project (February 2018) can be found in the Supporting Documentation in Appendix A.

3.2.2 The Proponent shall, for all effluent, comply with the MMER, the Fisheries Act and any site-specific water quality requirements set by Ontario. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: treat tailings slurry to break down cyanide and precipitate heavy metals.

Status: Ongoing

Supporting Analysis:

Authorization to deposit tailings in the Tailings Management Area (TMA) Starter Cell (Cell 1) was received on September 28, 2017. Before tailings slurry can be deposited in Cell 1, or any subsequent cell in the TMA, the slurry must be treated by an in-plant tailings slurry cyanide destruction (SO2/Air) treatment facility located in the process plant as permitted in Environmental Compliance Approval (ECA) 5178-9TUPD9. The Water Management Pond (WMP) received effluent flow from the TMA during 2017. However an effluent treatment plant, situated between the TMA and the WMP is planned for the treatment of metals. Ammonia will be treated in the WMP and residual metals, nitrates and sulfates will be treated in the constructed wetland. The WMP will discharge primarily to the constructed wetland by way of the Water Discharge Pond with a potential to discharge to the Pinewood River should the water meet criteria in Condition 5 of ECA 5178-9TUPD9. The effluent treatment plant and Constructed Wetlands are currently in the design phase, with small scale pilot tests planned for the spring of 2018. Construction of the effluent treatment plant and Constructed Wetlands will follow in late 2018.

3.2.3 The Proponent shall, for all effluent, comply with the MMER, the Fisheries Act and any site-specific water quality requirements set by Ontario. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: collect site contact water and seepage in ditches and divert to either the TMA or water management facilities for release via final discharge points.

Status: Ongoing

Supporting Analysis:

Site water generated from blasting, overburden and mine rock stockpiles, and construction related activities is collected in a temporary water management facility on the Plant Site, stockpile areas and Open Pit. The water is treated and sampled for compliance with all regulatory water quality requirements before discharge, or diverted to either the Tailings Management Area Cell 1, Water Management Pond (WMP) or Mine Rock Pond (MRP) for recycling and further treatment before eventual release via final discharge points. The WMP, TMA Cell 1, tailings pipeline were commissioned in 2017. MRP construction is completed, but insufficient water have prevented its commissioning in 2017. These structures have seepage collection systems, or drainage ditches, and water from these collection systems will be either put back into the structure or the water will first be recycled in mill processing prior to discharge into the TMA.

3.2.4 The Proponent shall, for all effluent, comply with the MMER, the Fisheries Act and any site-specific water quality requirements set by Ontario. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: install and operate a water quality control structure in the constructed wetland to prevent the release of final effluent discharge not compliant with the Regulations or requirements

Status: Not applicable at this time

Supporting Analysis:

Construction of the constructed wetland is scheduled to begin in late 2018 and will include a water quality control structure.

3.2.5 The Proponent shall, for all effluent, comply with the MMER, the Fisheries Act and any site-specific water quality requirements set by Ontario. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: install secondary containment on pipelines that cross the West Creek Diversion Channel to prevent accidental discharge of effluent.

Status: This commitment is now complete and can be closed

Supporting Analysis:

Pipelines associated with mill processing and tailings transportation from the plant to the Tailings Management Area were installed in 2017. A design modification was completed which included secondary containment of the pipeline that cross the West Creek Diversion channel and also where the pipeline crosses West Creek. The secondary containment consists of sleeves (pipe within a pipe) made from 36" high density polyethylene (HDPE). The rest of the pipeline has a double wall thickness for protection. The entire tailings pipeline also rest into a corridor which is also lined with a fused geomembrane and is slope to drain into the multiple sumps in case of emergency.

3.3.1 The Proponent shall control acid rock drainage and metal leaching so that all effluent and passive outflow from the Project Site comply with the MMER, any site-specific water quality requirements set by Ontario, and the Fisheries Act, as applicable at any time. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: line the former Clark Creek channel (under the east mine rock stockpile) with non-potentially acid generating material.

Status: Ongoing

Supporting Analysis:

To comply with MMER and provincial permitting requirements, effluent and passive outflow from the Potentially Acid Generating (PAG) rock drainage and metal leaching from active areas of East Mine Rock Stockpile area was collected in the Mine Rock Pond seepage collection system. Clark Creek continued to channel non-contact water from the site into the Pinewood River via remnant Clark

Creek channel ditch. Closure of Clark Creek channel is scheduled for early Q1 of 2018 when non-potentially acid generating rock will be used to line the former creek channel bed under the East Mine Rock Stockpile area.

3.3.2 The Proponent shall control acid rock drainage and metal leaching so that all effluent and passive outflow from the Project Site comply with the MMER, any site-specific water quality requirements set by Ontario, and the Fisheries Act, as applicable at any time. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: sort waste rock into potentially acid generating and non-potentially acid generating rock stockpiles through the development and implementation of a detailed mine rock segregation program using criteria for determining potentially acid generating material set by Ontario.

Status: Ongoing

Supporting Analysis:

A Geochemical Monitoring Plan for the Construction and Operation Phases was issued in accordance with MOECC ECA 5178-9TUPD9 requirements, and has been implemented at the Rainy River Mine. Monitoring was ongoing during 2017.

3.3.3 The Proponent shall control acid rock drainage and metal leaching so that all effluent and passive outflow from the Project Site comply with the MMER, any site-specific water quality requirements set by Ontario, and the Fisheries Act, as applicable at any time. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: design and construct the perimeter ditching around the east mine rock stockpile and low grade ore stockpile to accommodate a 100-year flood event.

Status: Ongoing

Supporting Analysis:

Designs to construct perimeter ditching that will accommodate a 100 year flood event were completed in 2017 and are planned for construction in 2018. All runoff from the East Mine Rock Stockpile and Low Grade Ore Stockpile reports to the Mine Rock Pond.

3.3.4 The Proponent shall control acid rock drainage and metal leaching so that all effluent and passive outflow from the Project Site comply with the MMER, any site-specific water quality requirements set by Ontario, and the Fisheries Act, as applicable at any time. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: use potentially acid generating material only for the purpose of constructing the tailing management dam, where saturated conditions can be maintained. Potentially acid generating material must not be used for any other construction purpose.

Status: Ongoing

Supporting Analysis:

Potentially acid generating material is either used for construction of the interior of the Tailings Management Area dams, or it is used to construct roads within the open pit.

3.3.5 The Proponent shall control acid rock drainage and metal leaching so that all effluent and passive outflow from the Project Site comply with the MMER, any site-specific water quality requirements set by Ontario, and the Fisheries Act, as applicable at any time. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: place an engineered cover over the east mine rock stockpile and any remaining ore stockpiles at or before the decommissioning phase. The cover should be designed to prevent infiltration of water and to limit infiltration of air during the decommissioning and abandonment phases.

Status: Ongoing

Supporting Analysis:

An engineered cover will be placed over the east mine rock stockpile and any remaining ore stockpiles at or before the decommissioning phase as per sections 6.1 and 9.14 of the Rainy River Mine (RRM) Closure Plan (January 2015). During 2017 a test plot containing potentially acid generating rock was covered with an engineered cover as per design in section 6.1 of the RRM Closure Plan. Further testing will be conducted in 2018. Monitoring of this stockpile commenced during Q4 of 2017 and will continue into 2018.

3.3.6 The Proponent shall control acid rock drainage and metal leaching so that all effluent and passive outflow from the Project Site comply with the MMER, any site-specific water quality requirements set by Ontario, and the Fisheries Act, as applicable at any time. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: cover the tailings with water and maintain the tailings in a perpetually saturated state during the decommissioning and abandonment phases.

Status: Not applicable at this time

Supporting Analysis:

At the time of mine closure New Gold intends on maintaining the tailings in a perpetually saturated state during the decommissioning and abandonment phases. Further information regarding mine reclamation and decommissioning can be found in the Updated Rainy River Mine Closure Plan (March 2018). This condition currently doesn't apply to the operational state of the mine.

3.3.7 The Proponent shall control acid rock drainage and metal leaching so that all effluent and passive outflow from the Project Site comply with the MMER, any site-specific water quality requirements set by Ontario, and the Fisheries Act, as applicable at any time. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: fill the open pit, in accordance with condition 3.1.3 and 3.1.4, as rapidly as practicable during the decommissioning and abandonment phases, using all available means, including directing drainage from the east mine rock stockpile into the pit.

Status: Not applicable at this time

Supporting Analysis:

During the decommissioning and abandonment phases, the open pit will fill and be managed according to the requirements specified in section 9.3 of the Rainy River Mine Closure Plan (January 2015). During the first 10 years of flooding, waters from the Mine Rock Pond will be piped into the open pit. Following this initial flooding period, seepage from the east mine rock stockpile area will be piped into the open pit. With the additional input of natural water sources (rain, ground water seeps, TMA dam runoff) it is estimated that it will take 75 years to flood the open pit.

3.3.8 The Proponent shall control acid rock drainage and metal leaching so that all effluent and passive outflow from the Project Site comply with the MMER, any site-specific water quality requirements set by Ontario, and the Fisheries Act, as applicable at any time. To ensure compliance, the Proponent shall implement, at a minimum, the following mitigation measures: control water quality in the open pit lake during the abandonment phase.

Status: Not applicable at this time

Supporting Analysis:

This condition is not relevant to the construction and operations phases. It will be implemented during the "closing out" stage of the Rainy River Mine as stipulated in the Rainy River Mine Closure Plan (January 2015), Sections 9.3 and 10.2.

3.4 The Proponent shall design and construct new road watercourse crossings for the realignment of Highway 600 to allow for fish passage in accordance with the Environmental Guide for Fish and Fish Habitat.

Status: Complete

Supporting Analysis:

During the realignment of Highway 600 there was one water crossing required over a fish bearing watercourse located at the Pinewood River. In the fall of 2015, a clear span bridge was installed over the Pinewood River. There was no in water work required for the installation therefore no alterations to the original river channel that would impact or alter fish habitat or passage.

3.5 The Proponent shall design and construct new road watercourse crossings for the realignment of Highway 600 to meet the Highway Drainage Design Standards of the MTO.

Status: Complete

Supporting Analysis:

During the design phase of the Highway 600 realignment routine meetings were held between New Gold Inc. (formally Rainy River Resources) and the Ministry of Transportation of Ontario (MTO). The road and its associated crossings have been designed and constructed to meet MTO standards and was completed under the MTO Construction Administration and Inspection Task Manual (CAITM) protocol. Highway 600 was turned over to the MTO in 2017.

3.6 The Proponent shall design and construct water intakes meeting standards set out in the Freshwater Intake End-of-Pipe Fish Screen Guideline of the DFO.

Status: Ongoing

Supporting Analysis:

In 2016 the Pinewood River Pumphouse and Intake was completed and operated in 2017. This facility provides water to the Water Management Pond to utilize in mill processing in the event that there is not enough fresh water in the sites recycling process.

The pump intake enters the Pinewood River and is isolated by chain link fence that is installed below the high-water mark of the Pinewood River. In order to meet DFO guidelines and continue to allow successful suction of water, a fish screen was installed over the chain link fence running from the base of the Pinewood River to the above high-water mark.

During low flow periods, the screen is periodically monitored to ensure that it remains secure and free of debris.

3.7 The Proponent shall both offset any residual serious harm to fish in accordance with subsection 35(2) of the Fisheries Act and associated regulations, and compensate for the loss of fish habitat resulting from the deposition of a deleterious substance into a tailings impoundment area in accordance with the MMER, by recreating fish habitat in the West Creek Diversion Channel, West Creek Pond, Stockpile Pond Diversion Channel, Stockpile Pond, Clark Creek Diversion Channel, Clark Creek Pond, and Teeple Road Pond.

Status: Ongoing

Supporting Analysis:

Fish habitat compensation was designed by qualified experts and was reviewed by the Ministry of Natural Resources and Forestry (MNRF) and the Department of Fisheries and Oceans Canada (DFO) during the permit approval phase.

In 2016, Teeple Pond and Diversion channel construction concluded and the system was commissioned that fall. In 2017 the design team conducted a review of the system and produced an Annual Monitoring Report for the Department of Fisheries and Oceans to meet the requirements of Fisheries Act Authorization No. 15-HCAA-00039. The review concluded substantial conformance between the as built specifications and the design criteria and that the area or replacement habitat was greater than the required 8.41ha. In 2017 field research indicated 7 of the targeted 9 minnow species had returned to the system and were utilizing the constructed fish pools during periods of low water flow.

This monitoring will continue for the next 4 years to ensure compliance with Fisheries Act Authorization No. 15-HCAA-00039. A copy of the Teeple Pond and Diversion Annual Monitoring Report (Version 1) can be found in the Supporting Documentation for this section.

Construction of the remaining offsetting habitat (West Creek Pond and Diversion Channel, Stockpile Pond and Diversion Channel, and Clark Creek Pond and Diversion Channel) was completed in July 2017. As part of fulfilling the as-constructed survey condition of the approval, an interim As-Constructed compensation measures review was conducted during 2017 and a report submitted to DFO. Monitoring is planned to begin for this offsetting habitat in 2018 and is scheduled to happen annually for the next 5 years.

3.8.1 The Proponent shall monitor water quality and quantity, and fish and fish habitat, to determine the effectiveness of the mitigation measures under conditions 3.1, 3.2, 3.3 and 3.7. In doing so, the Proponent shall monitor, at a minimum: water levels and flows, with respect to minimum flow thresholds for the Pinewood River set by Ontario, during periods of water taking as authorized pursuant to the Ontario Water Resources Act.

Status: Ongoing

Supporting Analysis

During 2015, a flow monitoring station was installed in the Pinewood River to track water level elevations and flow rates for the Pinewood River System. A flow monitoring station belonging to the Water Survey of Canada (WSC) is also located downstream of the project on the Pinewood River.

In April 2017, the Water Management Pond (WMP) was commissioned and direct water takings from the Pinewood River began to build the initial water inventory for operations start up. The water takings were in accordance with Permit to Take Water (PTTW) 8776-9W2QN2.The WMP will require monitoring for the life of the mine.

Under PTTW 8776-9W2QN2, New Gold was required to develop and submit a Biological Monitoring Plan that addresses methods for monitoring and identifying fish kills and fish stranding, and a contingency plan to address adverse effects. This monitoring plan was submitted in early 2016, and commenced upon MOECC approval. The monitoring continued in 2017.

The project has 5 additional PTTWs for the Mine Workings, Tailings Management Area (TMA), Construction Workings and Aggregate Dewatering. All water takings are monitoring using calibrated flow meters and data obtained from these takings is submitted annually via the Ministry of the Environment and Climate Change (MOECC) online reporting protocol.

3.8.2 The Proponent shall monitor water quality and quantity, and fish and fish habitat, to determine the effectiveness of the mitigation measures under conditions 3.1, 3.2, 3.3 and 3.7. In doing so, the Proponent shall monitor, at a minimum: effluent quality as per the requirements set out in the MMER.

Status: Ongoing

Supporting Analysis:

During 2017, effluent discharges to the environment as defined by the Metal Mining Effluent Regulation (MMER) were related to temporary seepage collection, overburden and rock stockpile runoff, and pit dewatering systems. Effluent was generated from storm water runoff and contact water associated when blasting bedrock for the development of infrastructure foundations and open pit development.

Treatment consisted of addition of flocculent to reduce the total suspended solids, dry ice and a portable water treatment plant to reduce the un-ionized ammonia concentrations. All water was treated and tested in accordance with applicable permits and legislation from Environment Canada (EC), Ministry of the Environment and Climate Change (MOECC), and the Department of Fisheries and Oceans Canada (DFO).

In 2017 there were 58 effluent discharges from construction, overburden and rock stockpile, and pit dewatering sediment ponds which are designed to capture water and provide adequate treatment for total suspended solids (TSS) and un-ionized ammonia prior to discharge to the environment.

These discharges occurred between January and October. All discharged water met the water quality objectives outlined in the EC MMER and the MOECC Environmental Compliance Approval (ECA), with the exception of the following;

- An acute lethality exceedance from Sump 2 on February 20, 2017.
- A total suspended solids exceedance from the remnant Clark Creek on March 27, 2017. (87.5mg/L)

- A total suspended solids exceedance from the remnant Clark Creek on July 5, 2017. (145mg/L)
- A monthly total suspended solids exceedance from the Mine Rock Pond Polishing Pond for August 2017 (15.1 mg/L)
- A total suspended solids exceedance from the remnant Clark Creek on October 2, 2017. (109 mg/L)

Beginning late September 2017, tailings from ore reclaiming was deposited in the TMA Cell 1 for treatment. Water quality objectives and sampling requirements for the Rainy River Mine are outlined in the MMER and MOECC ECA for Construction and Operations.

3.8.3 The Proponent shall monitor water quality and quantity, and fish and fish habitat, to determine the effectiveness of the mitigation measures under conditions 3.1, 3.2, 3.3 and 3.7. In doing so, the Proponent shall monitor, at a minimum: the effectiveness of recreated fish habitat. The monitoring shall be designed in accordance with any authorizations pursuant to subsection 35(2) of the Fisheries Act and associated regulations and/or the MMER.

Status: Ongoing

Supporting Analysis:

Fish habitat compensation was designed by qualified experts and was reviewed by the Ministry of Natural Resources and Forestry and the Department of Fisheries and Oceans Canada (DFO) during the permit approval phase.

By the end of 2017, all fish habitat had been recreated. The As-Constructed Report for Teeple Pond and Diversion Channel was completed and submitted to the DFO at the end of 2016. The first year of monitoring had been completed. A monitoring report was submitted to the DFO at the end of 2017. This monitoring will occur for the next 4 years with a report submitted annually.

The As-Constructed Report for West Creek Pond, Stockpile Pond, Clark Creek Pond and associated diversions was submitted to the DFO at the end of 2017 but monitoring of these systems will not begin until 2018. This monitoring will occur every year for the next 5 years.

3.8.4 The Proponent shall monitor water quality and quantity, and fish and fish habitat, to determine the effectiveness of the mitigation measures under conditions 3.1, 3.2, 3.3 and 3.7. In doing so, the Proponent shall monitor, at a minimum: the effectiveness of the potentially acid generating and non-potentially acid generating rock segregation program through ongoing geochemical verification of the waste rock during any period that waste rock is generated.

Status: Ongoing

Supporting Analysis

Potential acid generating and non-potentially acid generating rock is sampled and segregated per the Geochemical Monitoring Plan.

3.8.5 The Proponent shall monitor water quality and quantity, and fish and fish habitat, to determine the effectiveness of the mitigation measures under conditions 3.1, 3.2, 3.3 and 3.7. In doing so, the Proponent shall monitor, at a minimum: water quality in the open pit, pursuant to any requirements set by Ontario in the Mine Closure Plan for the Designated Project.

Status: Not applicable at this time

Supporting Analysis:

This condition is currently not relevant as the mine is in its operational phase.

3.8.6 The Proponent shall monitor water quality and quantity, and fish and fish habitat, to determine the effectiveness of the mitigation measures under conditions 3.1, 3.2, 3.3 and 3.7. In doing so, the Proponent shall monitor, at a minimum: the maintenance of a perpetually saturated state of the tailings, for 25 years from the start of the decommissioning phase of the Designated Project.

Status: Not applicable at this time

Supporting Analysis:

This condition currently doesn't apply to the project as the mine was in a construction and operational phase in 2017. However, the Closure Plan for the project outlines the process in which tailings will be rehabilitated in a saturated state.

Supporting Documentation

Condition 3.2.1 – 2017 Phase 1 Environmental Effects Monitoring Interpretive Report for the New Gold Rainy River Project (February 2018)

Condition 3.7 – 2017 Teeple Pond and Diversion Annual Monitoring Report Version 0 (December 2017)

Phase 1 Environmental Effects Monitoring Interpretive Report for the New Gold Rainy River Project

Prepared for:
New Gold Inc.
Emo, Ontario

Prepared by:
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Georgetown, Ontario

March 2018

Phase 1 Environmental Effects Monitoring Interpretive Report for the New Gold Rainy River Project

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EXECUTIVE SUMMARY

The Rainy River Project (RRP), operated by New Gold Inc., is an open pit and underground gold mine located approximately 65 km northwest of Fort Frances, and approximately 420 km west of Thunder Bay, Ontario. Commercial production started in late 2017 and ore is milled and refined on site to produce doré bars at an estimated annual rate of approximately 325,000 ounces. Mill tailings are treated to destroy cyanide and conveyed to the RRP tailings management area (TMA). Reclaimed water from the TMA is returned to the mill for re-use. Excess water is treated in a polishing pond prior to discharge into a constructed wetland at Loslo Creek or by direct pipeline to the Pinewood River downstream of McCallum Creek. The constructed wetland is the primary effluent discharge path. The pipeline is available to discharge excess effluent if necessary in order to maintain wetland water retention time and reduce wetland erosion. Under average effluent discharge rates and Pinewood River flow, the effluent concentration in the Pinewood River is calculated to be up to approximately 14% after mixing.

Sublethal toxicity tests conducted on grab samples of RRP final effluent at Final Discharge Point 2 (FDP2) and Final Discharge Point 3 (FDP3) over the Phase 1 EEM period (2016 to 2017) indicated that effluent was generally of high quality with the lowest reported effects occurring at effluent concentrations of 37% and 95% for FDP2 and FDP3 respectively. Overall, sublethal toxicity data indicate good effluent quality and the observed responses occurred at effluent concentrations well above those expected in the receiving environment.

Water quality of the Pinewood River downstream of RRP was only moderately influenced by effluent discharge. Influence of RRP effluent was evident in higher conductivity, hardness, calcium, potassium, and sodium in the effluent-exposed area relative to upstream. Nitrite was elevated in the effluent-exposed area compared to both the reference area and the water quality guideline for the protection of aquatic life on one occasion in 2016. Additionally, aluminum and iron were the only other parameters measured that did not meet water quality guidelines for the protection of aquatic life, however, this occurred at both the effluent-exposed and reference areas, indicating that these substances are naturally elevated in this area. Overall, water quality data collected during the EEM study were consistent with the routine monitoring data and indicated a detectable, but minor, effect of RRP effluent on water quality of the Pinewood River, confirmed during the April and September field studies on the basis of measured *in situ* measurements.

The inorganic sediment fraction was composed predominantly of silt (37-69%) and clay (25-41%), with some sand (2-31%). There were significant differences between the effluent-exposed and reference area sediments on the basis of total organic carbon, as well as the silt and clay fractions, with significantly more TOC and silt in the effluent-exposed area, and significantly less clay.

Sediment concentrations of chromium and nickel were elevated in both the effluent-exposed and reference areas, compared to Provincial Sediment Quality Guideline (PSWQG) Lowest Effect Levels (LEL). Additionally, effluent-exposed sediment concentrations of manganese and phosphorus were elevated compared to reference area concentrations and the PSQG LEL. Total organic carbon (TOC) was above the PSQG LEL in both areas. There were no Severe Effects Level (SEL) exceedances except for total Kjeldahl nitrogen (TKN) at the effluent-exposed area; TKN was greater than LEL at the reference area.

The benthic invertebrate community survey showed only subtle differences between the effluent-exposed area and the reference area. At the family level of taxonomic resolution, the benthic invertebrate community of the Pinewood River effluent-exposed area did not differ significantly from the Sturgeon Creek reference area on the basis of density, richness, or Simpson's E. The Bray-Curtis distance was significantly higher at the exposed area of Pinewood River compared to the reference area of Sturgeon Creek, likely due to a difference in the habitat between the two areas rather than an effluent related influence.

No major differences in fish community composition were observed between the two areas, although the effluent-exposed area on Pinewood River supported a higher species diversity. Female brook stickleback downstream of the RRP differed significantly from reference female brook stickleback based on relative gonad size, relative liver size, and body condition, with the magnitude of differences exceeding the applicable critical effect sizes (CES). A similar pattern was observed for effluent-exposed female central mudminnow, with significant differences in relative gonad size, relative liver size, and body condition, although only relative gonad size exceeded the applicable CES. Effluent-exposed male brook stickleback differed significantly from males captured at the Sturgeon Creek reference based on larger relative liver size and body condition, with the magnitude of difference outside of the applicable CES for both endpoints. Similarly, male effluent-exposed central mudminnow showed the same pattern as the male brook stickleback (larger relative liver size and body condition) in terms of significance and magnitude of difference outside of applicable CES.

Based on the findings of the Phase 1 RRP EEM study conducted in April and September 2017, it is recommended that the mine implements the Phase 2 EEM biological study ("periodic monitoring – surveillance") three years after Phase 1.

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1 INTRODUCTION

1.1 Site Description

New Gold Inc. owns the Rainy River Project (RRP), located in northwestern Ontario in the Township of Chapple and District of Rainy River, approximately 65 km northwest of Fort Frances, and approximately 420 km west of Thunder Bay (Figure 1.1). The RRP is located within the Pinewood River watershed. The Pinewood River flows past the RRP and drains into the Rainy River approximately 37 km downstream.

Earliest exploration of the RRP began in 1967. Rainy River Resources Ltd. acquired the project in 2005 and began conducting baseline studies in 2008. The RRP was acquired by New Gold Inc. in 2013 and an Environmental Assessment (EA) report was submitted in 2014 (AMEC 2014). Site construction began following provincial and federal EA approvals in 2015. Upon completion, the RRP site construction will include an open pit mine, an underground mine, ore storage facilities, a process plant, a Tailings Management Area (TMA), watercourse diversions, site drainage works, a fuel tank farm, explosives manufacturing facilities, and explosives storage facilities (Figure 1.2). Mine commissioning occurred in September 2017.

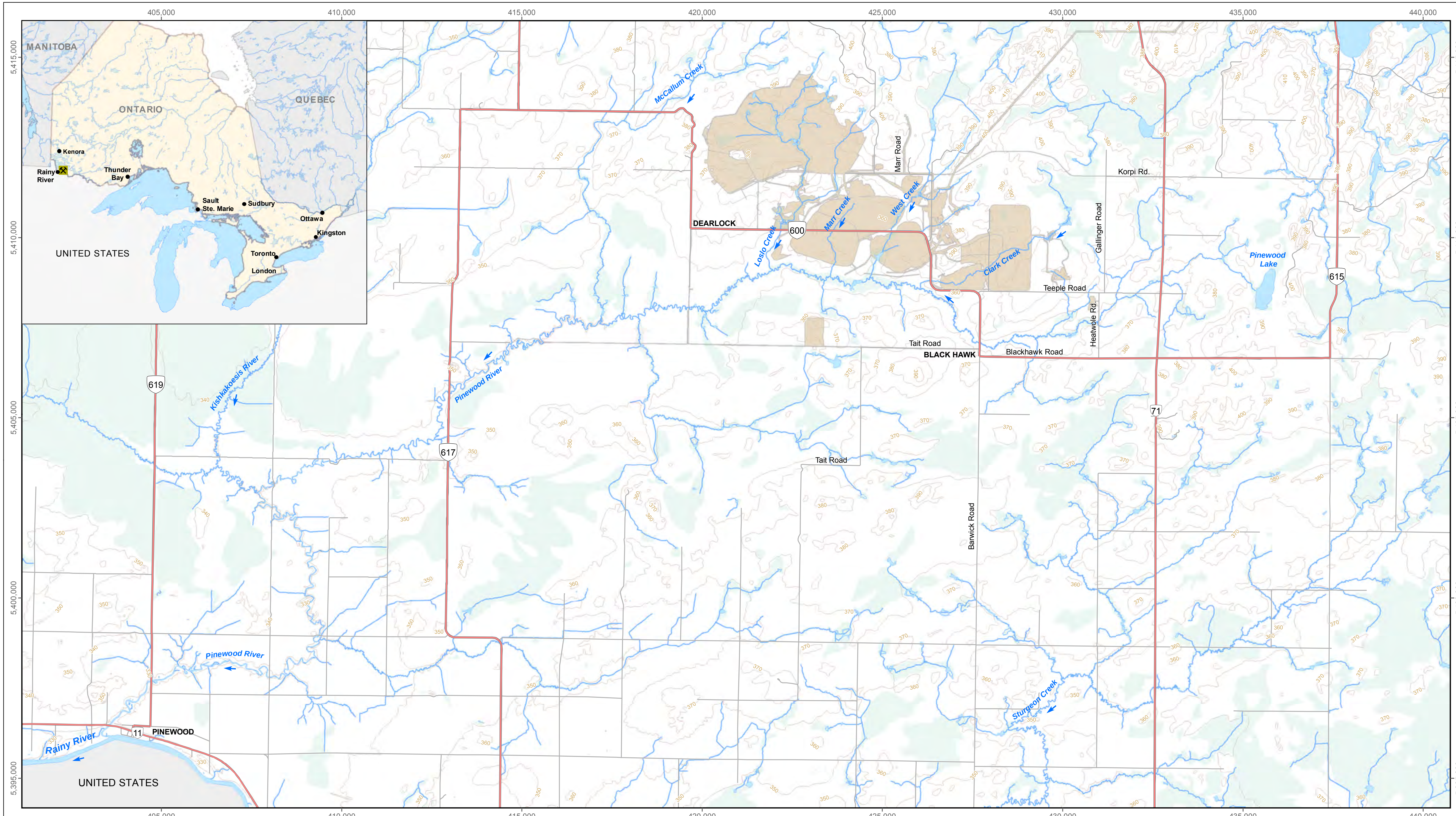
The RRP is expected to sustain mining operations for approximately 16 years, with an anticipated ore production capacity of 27,000 tonnes per day (tpd) as well as an anticipated milling capacity of 21,000 tpd (CEAA 2015).

1.2 Effluent Characteristics

Under the MMER, RRP was required to conduct effluent characterization, sublethal toxicity testing, and water quality monitoring starting not later than six months after the day on which the mine became subject to the MMER. RRP became subject to the MMER on September 17th, 2015 and thus was required to start monitoring on March 17th, 2016.

Treated effluent from the RRP's s seven discharges has complied with the MMER (Table 1.1), with only three exceptions during the Phase 1 EEM time period (2016 to 2017). Three incidences of elevated Total Suspended Solids (TSS) occurred, on April 15, 2016 at FDP2 (42 mg/L), September 28, 2016 at FDP6 (31 mg/L), and January 28, 2017 at FDP7 (39 mg/L; Table 1.1).

Effluent discharge is intermittent for all seven Final Discharge Point (FDP)s usually related to increased precipitation, this was especially relevant in 2016 as this was during the construction phase, so the mine pits needed periodic pumping (Figure 1.3). The nature of this unpredictable discharge schedule meant that effluent characterization could not always occur a minimum of 30 days apart (Table 1.1). The mean annual discharge in 2017 was increased compared to 2015 or 2016 for five of the seven FDPs (Table 1.2). However, two of the FDPs (FDP 6 and 7), had



LEGEND

Mine Infrastructure

Contour (10 m)

0 1.5 3 6
km

N W E S

Map Projection: UTM Zone 15 NAD 1983
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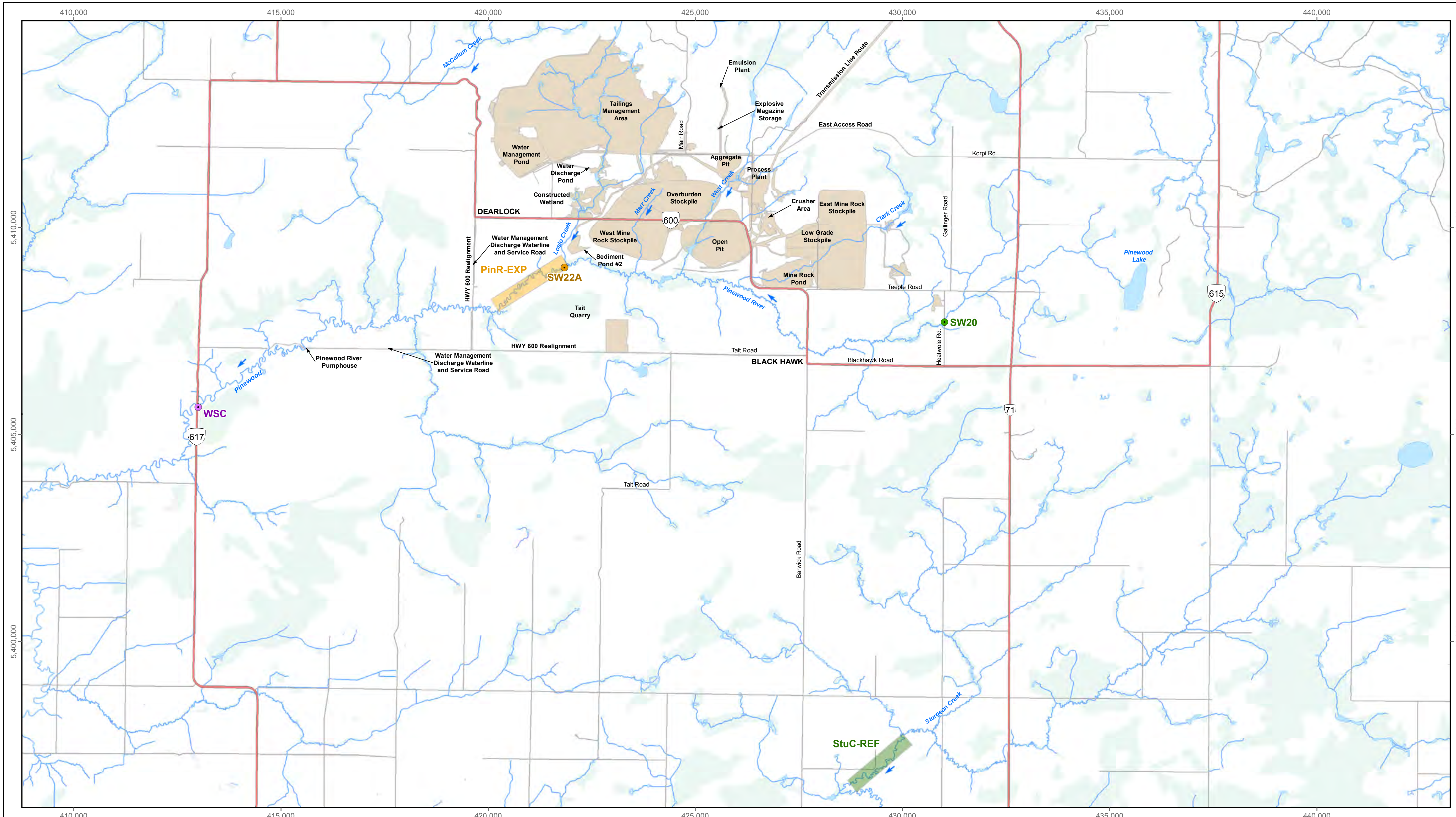
Location and Future Layout of the Rainy River Project

Date: March 2018
Project 177202.0012

minnow environmental inc.

Figure 1.1

Document Path: S:\Projects\177202\177202.0012 - RRP Phase 1 EEM Implementation\6 - GIS Mapping\Report\17-12 Fig 1.1 Layout.mxd



LEGEND

Mine-exposed Water Monitoring Area	Effluent-exposed
Reference Water Monitoring Area	Reference
WSC Station 05PC023	Mine Infrastructure

0 1.25 2.5 5
km

N W E S

Map Projection: UTM Zone 15 NAD 1983
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Anticipated Future Mine Infrastructure, Rainy River Project

Date: March 2018
Project 177202.0012

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Figure 1.2

Document Path: S:\Projects\177202\177202.0012 - RRP Phase 1 EEM Implementation\6 - GIS Mapping\Report\17-12 Fig 1.2 Location and Layout.mxd

Table 1.1: Effluent Characterization, Mean Annual Effluent Flow, and Effluent Acute Toxicity for the RRP for Phase 1

a) FDP2 (Sump 3,6)

Variables	Units	Regulatory Limits				Phase 1											
		MMER		ECA		2015				2016				2017			
		Daily	Monthly	Daily	Monthly	13-Dec	-	-	-	15-Apr	27-Jun	28-Aug	30-Sep	22-Mar	25-Apr	28-May	17-Oct
Mean Annual Flow Rate	m^3/day					17				375				367			
Non-metals																	
Alkalinity	mg/L					344	-	-	-	243	164	252	306	336	278	349	333
Ammonia	mg/L					0.02	-	-	-	4.3	0.1	5.9	11.9	4.5	3.5	0.7	0.4
Cyanide	mg/L	2	1			-	-	-	-	-	-	-	-	0.037	0.004	0.003	<0.002
Hardness	mg/L					341	-	-	-	283	212	302	327	365	327	374	392
Lab pH	pH unit	6.0 - 9.5	6.0 - 9.5		6.0 - 9.5	-	-	-	-	7.98	8.34	8.09	7.78	7.14	8.13	7.96	7.87
Nitrate	mg/L					0.025	-	-	-	6.87	1.25	8.19	17.80	5.37	4.73	0.67	0.83
Total Suspended Solids (TSS)	mg/L	30	15	30	15	-	-	-	-	42	14	25	3	7	1	14	5
Metals																	
Aluminum	mg/L					-	-	-	-	<0.0050	0.250	0.380	0.091	0.194	0.020	0.290	0.083
Arsenic	mg/L	1	0.5	0.0340	0.0170	-	-	-	-	0.0032	0.0027	0.0016	0.0035	0.004	0.0037	0.0026	0.0018
Cadmium	mg/L					<0.000017	-	-	-	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	0.000075
Copper	mg/L	0.6	0.3	0.028	0.014	-	-	-	-	0.0059	0.0013	0.0010	0.0019	0.0051	0.0010	0.0013	0.0034
Iron	mg/L					-	-	-	-	<0.01	0.29	0.31	0.09	0.19	0.01	0.39	0.24
Lead	mg/L	0.4	0.2	0.030	0.015	-	-	-	-	<0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury	mg/L					-	-	-	-	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	mg/L					-	-	-	-	0.0178	0.0144	0.0135	0.0298	0.0138	0.0144	0.0061	0.0054
Nickel	mg/L	1	0.5	0.094	0.047	-	-	-	-	0.0047	<0.002	0.0015	0.0028	0.0034	0.0024	0.0016	0.0032
$Radium^{226}$	Bq/L	1.1	0.37			-	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	1	0.5	0.348	0.174	-	-	-	-	0.076	0.132	0.005	0.007	0.004	0.0015	0.0025	0.0045
Acute Toxicity in 100% Effluent																	
Daphnia magna	% mortality	50%		50%		-	-	-	-	-	-	0	0	0	0	0	0
Rainbow Trout	% mortality	50%		50%		-	-	-	-	-	-	0	0	0	0	0	0

MMER - Metal Mining Effluent Regulations.

ECA - Environmental Compliance Approval.

Table 1.1: Effluent Characterization, Mean Annual Effluent Flow, and Effluent Acute Toxicity for the RRP for Phase 1

b) FDP3 (Sump 4, 5)

Variables	Units	Regulatory Limits				Phase 1											
		MMER		ECA		2015				2016				2017			
		Daily	Monthly	Daily	Monthly	-	-	-	-	30-May	30-Jun	24-Aug	22-Sep	19-Jan	3-Apr	6-May	13-Oct
Mean Annual Flow Rate	m^3/day					-				630				607			
Non-metals																	
Alkalinity	mg/L					-	-	-	-	279	221	311	286	418	333	352	309
Ammonia	mg/L					-	-	-	-	3.7	1.6	5.3	5.5	5.4	3.4	3.46	2.6
Cyanide	mg/L	2	1			-	-	-	-	-	-	-	-	0.061	0.013	0.011	<0.002
Hardness	mg/L					-	-	-	-	327	269	385	403	447	366	384	384
Lab pH	pH unit	6.0 - 9.5	6.0 - 9.5		6.0 - 9.5	-	-	-	-	8.26	8.19	7.89	7.05	7.35	7.90	8.12	8.08
Nitrate	mg/L					-	-	-	-	3.22	2.37	6.72	8.30	5.1	4.0	4.08	6.57
Total Suspended Solids (TSS)	mg/L	30	15	30	15	-	-	-	-	4	5	7	5	5	<2	10	5
Metals																	
Aluminum	mg/L					-	-	-	-	0.0800	0.105	0.148	0.369	0.078	0.071	0.177	0.044
Arsenic	mg/L	1	0.5	0.0340	0.0170	-	-	-	-	0.0034	0.0027	0.0028	0.0039	0.0035	0.0032	0.0041	0.0023
Cadmium	mg/L					-	-	-	-	<0.000017	<0.000017	<0.000017	0.000025	0.000025	<0.000017	<0.000017	0.00004
Copper	mg/L	0.6	0.3	0.028	0.014	-	-	-	-	0.0010	0.0014	0.0015	0.0031	0.0016	0.0035	0.0035	0.0030
Iron	mg/L					-	-	-	-	0.11	0.13	0.19	0.42	0.12	0.08	0.20	0.06
Lead	mg/L	0.4	0.2	0.030	0.015	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury	mg/L					-	-	-	-	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	mg/L					-	-	-	-	0.0113	0.0158	0.0145	0.0179	0.0191	0.0121	0.0133	0.0124
Nickel	mg/L	1	0.5	0.094	0.047	-	-	-	-	0.0028	<0.0020	0.0032	0.0039	0.0071	0.0034	0.0052	0.0027
$Radium^{226}$	Bq/L	1.1	0.37			-	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	1	0.5	0.348	0.174	-	-	-	-	<0.003	<0.003	0.010	0.010	0.0155	0.0065	0.006	0.0035
Acute Toxicity in 100% Effluent																	
Daphnia magna	% mortality	50%		50%		-	-	-	-	0	0	0	0	0	10	0	0
Rainbow Trout	% mortality	50%		50%		-	-	-	-	0	0	0	0	0	0	0	0

MMER - Metal Mining Effluent Regulations.
ECA - Environmental Compliance Approval.

Table 1.1: Effluent Characterization, Mean Annual Effluent Flow, and Effluent Acute Toxicity for the RRP for Phase 1

c) FDP5 (Process Plant Overburden Pile)

Variables	Units	Regulatory Limits				Phase 1											
		MMER		ECA		2015				2016				2017			
		Daily	Monthly	Daily	Monthly	-	-	-	-	6-Jun	25-Jul	24-Aug	23-Nov	6-May	5-Jul	17-Aug	17-Sep
Mean Annual Flow Rate	m^3/day					-				50				190			
Non-metals																	
Alkalinity	mg/L					-	-	-	-	156	127	117	131	155	244	188	201
Ammonia	mg/L					-	-	-	-	<0.02	<0.02	<0.02	<0.02	0.008	0.038	0.416	0.122
Cyanide	mg/L	2	1			-	-	-	-	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Hardness	mg/L					-	-	-	-	189	207	202	286	249	362	376	411
Lab pH	pH unit	6.0 - 9.5	6.0 - 9.5		6.0 - 9.5	-	-	-	-	8.39	8.43	8.54	8.05	8.28	8.47	8.56	8.46
Nitrate	mg/L					-	-	-	-	<0.02	0.25	<0.04	0.01	0.765	1.42	3.99	2.2
Total Suspended Solids (TSS)	mg/L	30	15	30	15	-	-	-	-	13	7	7	4	8	14	5	10
Metals																	
Aluminum	mg/L					-	-	-	-	0.373	0.102	0.094	0.028	0.259	0.341	0.065	0.461
Arsenic	mg/L	1	0.5	0.0340	0.0170	-	-	-	-	0.0012	0.0016	0.0020	0.0014	0.0010	0.0018	0.0021	0.0027
Cadmium	mg/L					-	-	-	-	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017
Copper	mg/L	0.6	0.3	0.028	0.014	-	-	-	-	0.0021	0.0022	0.0019	0.0022	0.0024	0.0036	0.0034	0.0033
Iron	mg/L					-	-	-	-	0.28	0.10	0.11	0.03	0.24	0.39	0.06	0.26
Lead	mg/L	0.4	0.2	0.030	0.015	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury	mg/L					-	-	-	-	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	mg/L					-	-	-	-	0.0077	0.0088	0.0092	0.0086	0.0044	0.0042	0.0059	0.0054
Nickel	mg/L	1	0.5	0.094	0.047	-	-	-	-	<0.002	<0.002	<0.002	<0.002	<0.002	0.0025	0.0024	0.0025
$Radium^{226}$	Bq/L	1.1	0.37			-	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	1	0.5	0.348	0.174	-	-	-	-	0.003	0.002	0.002	0.002	0.005	0.0035	0.004	0.0035
Acute Toxicity in 100% Effluent																	
Daphnia magna	% mortality	50%		50%		-	-	-	-	-	-	-	0	-	-	0	0
Rainbow Trout	% mortality	50%		50%		-	-	-	-	-	-	-	0	-	-	0	0

MMER - Metal Mining Effluent Regulations.
ECA - Environmental Compliance Approval.

Table 1.1: Effluent Characterization, Mean Annual Effluent Flow, and Effluent Acute Toxicity for the RRP for Phase 1

d) FDP6 (Process Plant Site)

Variables	Units	Regulatory Limits				Phase 1											
		MMER		ECA		2015				2016				2017			
		Daily	Monthly	Daily	Monthly	17-Sep	19-Oct	7-Nov	8-Dec	24-Mar	2-May	25-Jul	28-Sep	3-Apr	6-Apr	12-Apr	-
Mean Annual Flow Rate	m^3/day					82				147				31			
Non-metals																	
Alkalinity	mg/L					217	218	218	230	228	237	165	168	161	186	180	
Ammonia	mg/L					2.06	1.17	0.004	0.604	0.2	0.1	0.1	0.2	0.1	0.1	0.134	
Cyanide	mg/L	2	1			-	-	-	-	-	-	-	<0.002	<0.002	<0.002	<0.002	
Hardness	mg/L					275	273	275	298	257	248	221	214	195	232	204	
Lab pH	pH unit	6.0 - 9.5	6.0 - 9.5		6.0 - 9.5	-	-	-	-	8.00	8.39	8.32	8.33	7.99	8.14	8.31	
Nitrate	mg/L					10.6	-	-	8.36	2.04	0.79	7.46	7.73	3.75	6.1	2.8	
Total Suspended Solids (TSS)	mg/L	30	15	30	15	-	-	-	-	11	17	10	31	8	6	17	
Metals																	
Aluminum	mg/L					0.186	-	-	0.250	0.2730	0.395	-	1.510	0.236	0.218	0.553	
Arsenic	mg/L	1	0.5	0.0340	0.0170	-	-	-	-	<0.001	0.0014	0.0014	0.0015	<0.001	<0.001	<0.001	
Cadmium	mg/L					0.00002	0.00002	<0.000017	0.00002	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	0.00002	
Copper	mg/L	0.6	0.3	0.028	0.014	-	-	-	-	0.0035	0.0032	0.0026	0.0034	0.0034	0.0042	0.0059	
Iron	mg/L					0.28	-	-	0.24	0.31	0.36	-	1.29	0.19	0.24	0.58	
Lead	mg/L	0.4	0.2	0.030	0.015	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Mercury	mg/L					<0.00001	-	-	<0.00001	<0.00001	<0.00001	-	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum	mg/L					0.0147	-	-	0.013	0.0055	0.0038	-	0.0072	0.0037	0.0055	0.004	
Nickel	mg/L	1	0.5	0.094	0.047	-	-	-	-	0.0023	0.0020	<0.0020	0.0021	<0.0020	0.0024	0.0028	
Radium^{226}	Bq/L	1.1	0.37			-	-	-	-	-	-	-	-	<0.01	<0.01	<0.01	
Zinc	mg/L	1	0.5	0.348	0.174	-	-	-	-	0.081	0.004	<0.0030	0.006	0.017	0.017	0.02	
Acute Toxicity in 100% Effluent																	
Daphnia magna	% mortality	50%		50%		-	-	-	-	-	-	-	-	-	0	-	
Rainbow Trout	% mortality	50%		50%		-	-	-	-	-	-	-	-	-	0	-	

MMER - Metal Mining Effluent Regulations.
ECA - Environmental Compliance Approval.

Table 1.1: Effluent Characterization, Mean Annual Effluent Flow, and Effluent Acute Toxicity for the RRP for Phase 1

e) FDP7 (South Pond)

Variables	Units	Regulatory Limits				Phase 1											
		MMER		ECA		2015				2016				2017			
		Daily	Monthly	Daily	Monthly	-	-	-	-	9-Jun	18-Jul	11-Oct	11-Dec	28-Jan	30-Jan	2-Apr	-
Mean Annual Flow Rate	m^3/day					-				231				65			
Non-metals																	
Alkalinity	mg/L					-	-	-	-	166	132	152	216	275	269	162	
Ammonia	mg/L					-	-	-	-	<0.002	<0.002	0.202	<0.020	0.226	0.074	0.092	
Cyanide	mg/L	2	1			-	-	-	-	-	-	<0.002	<0.002	0.002	<0.002	<0.002	
Hardness	mg/L					-	-	-	-	213	180	216	272	302	312	203	
Lab pH	pH unit	6.0 - 9.5	6.0 - 9.5		6.0 - 9.5	-	-	-	-	8.48	8.24	8.36	7.97	7.86	7.88	7.89	
Nitrate	mg/L					-	-	-	-	0.82	2.28	2.47	1.51	3.08	3.66	3.82	
Total Suspended Solids (TSS)	mg/L	30	15	30	15	-	-	-	-	4	16	7	4	39	2	19	
Metals																	
Aluminum	mg/L					-	-	-	-	0.404	0.491	0.105	0.120	0.594	0.032	0.35	
Arsenic	mg/L	1	0.5	0.0340	0.0170	-	-	-	-	0.0012	0.0014	0.0011	0.0010	0.0011	<0.0010	<0.0010	
Cadmium	mg/L					-	-	-	-	<0.000017	<0.000017	<0.000017	<0.000017	0.00003	0.00002	0.00002	
Copper	mg/L	0.6	0.3	0.028	0.014	-	-	-	-	0.0037	0.0046	0.0041	0.0058	0.0081	0.0067	0.0045	
Iron	mg/L					-	-	-	-	0.28	0.52	0.10	0.14	1.06	0.06	0.40	
Lead	mg/L	0.4	0.2	0.030	0.015	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Mercury	mg/L					-	-	-	-	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	
Molybdenum	mg/L					-	-	-	-	0.0074	0.0057	0.0073	0.0052	0.0041	0.0048	0.0045	
Nickel	mg/L	1	0.5	0.094	0.047	-	-	-	-	<0.0020	0.0022	<0.0020	0.0026	0.0038	0.0029	0.0024	
$Radium^{226}$	Bq/L	1.1	0.37			-	-	-	-	-	-	-	-	<0.010	<0.010	<0.01	
Zinc	mg/L	1	0.5	0.348	0.174	-	-	-	-	0.009	0.006	0.008	0.023	0.109	0.036	0.024	
Acute Toxicity in 100% Effluent																	
Daphnia magna	% mortality	50%		50%		-	-	-	-	0	-	-	-	0	-	0	
Rainbow Trout	% mortality	50%		50%		-	-	-	-	0	-	-	-	0	-	0	

MMER - Metal Mining Effluent Regulations.
ECA - Environmental Compliance Approval.

Table 1.1: Effluent Characterization, Mean Annual Effluent Flow, and Effluent Acute Toxicity for the RRP for Phase 1

f) FDP8 (North Pond)

Variables	Units	Regulatory Limits				Phase 1											
		MMER		ECA		2015				2016				2017			
		Daily	Monthly	Daily	Monthly	-	-	-	-	-	-	-	-	12-Jun	-	-	-
Mean Annual Flow Rate	m^3/day					-				-				38			
Non-Metals																	
Alkalinity	mg/L					-	-	-	-	-	-	-	-	141	-	-	-
Ammonia	mg/L					-	-	-	-	-	-	-	-	0.15	-	-	-
Cyanide	mg/L	2	1			-	-	-	-	-	-	-	-	<0.002	-	-	-
Hardness	mg/L					-	-	-	-	-	-	-	-	184	-	-	-
Lab pH	pH unit	6.0 - 9.5	6.0 - 9.5		6.0 - 9.5	-	-	-	-	-	-	-	-	8.2	-	-	-
Nitrate	mg/L					-	-	-	-	-	-	-	-	2.48	-	-	-
Total Suspended Solids (TSS)	mg/L	30	15	30	15	-	-	-	-	-	-	-	-	8	-	-	-
Metals																	
Aluminum	mg/L					-	-	-	-	-	-	-	-	0.136	-	-	-
Arsenic	mg/L	1	0.5	0.0340	0.0170	-	-	-	-	-	-	-	-	0.0011	-	-	-
Cadmium	mg/L					-	-	-	-	-	-	-	-	<0.000017	-	-	-
Copper	mg/L	0.6	0.3	0.028	0.014	-	-	-	-	-	-	-	-	<0.001	-	-	-
Iron	mg/L					-	-	-	-	-	-	-	-	0.12	-	-	-
Lead	mg/L	0.4	0.2	0.030	0.015	-	-	-	-	-	-	-	-	<0.001	-	-	-
Mercury	mg/L					-	-	-	-	-	-	-	-	<0.00001	-	-	-
Molybdenum	mg/L					-	-	-	-	-	-	-	-	0.0064	-	-	-
Nickel	mg/L	1	0.5	0.094	0.047	-	-	-	-	-	-	-	-	<0.002	-	-	-
$Radium^{226}$	Bq/L	1.1	0.37			-	-	-	-	-	-	-	-	<0.01	-	-	-
Zinc	mg/L	1	0.5	0.348	0.174	-	-	-	-	-	-	-	-	0.006	-	-	-
Acute Toxicity in 100% Effluent																	
Daphnia magna	% mortality	50%		50%		-	-	-	-	-	-	-	-	-	-	-	-
Rainbow Trout	% mortality	50%		50%		-	-	-	-	-	-	-	-	-	-	-	-

MMER - Metal Mining Effluent Regulations.
ECA - Environmental Compliance Approval.

Table 1.1: Effluent Characterization, Mean Annual Effluent Flow, and Effluent Acute Toxicity for the RRP for Phase 1

g) FDP9 (Overburden and West Mine Rock Stockpile Temp Ponds, Sump 1, 2)

Variables	Units	Regulatory Limits				Phase 1											
		MMER		ECA		2015				2016				2017			
		Daily	Monthly	Daily	Monthly	-	-	-	-	4-Sep	4-Oct	11-Nov	21-Nov	27-Jan	7-Apr	23-Aug	12-Oct
Mean Annual Flow Rate	m^3/day					-				127				393			
Non-metals																	
Alkalinity	mg/L					-	-	-	-	257	185	346	367	407	284	174	173
Ammonia	mg/L					-	-	-	-	2.89	1.15	4.5	4.4	5.9	3.3	0.058	0.178
Cyanide	mg/L	2	1			-	-	-	-	<0.002	<0.002	0.009	0.008	0.052	0.029	<0.002	<0.002
Hardness	mg/L					-	-	-	-	275	222	395	389	420	300	190	217
Lab pH	pH unit	6.0 - 9.5	6.0 - 9.5		6.0 - 9.5	-	-	-	-	7.89	8.26	7.24	7.20	7.68	7.48	8.62	8.08
Nitrate	mg/L					-	-	-	-	5.24	6.02	6.79	6.75	6.05	3.86	0.01	0.22
Total Suspended Solids (TSS)	mg/L	30	15	30	15	-	-	-	-	2	19	8	8	7	3	5	4
Metals																	
Aluminum	mg/L					-	-	-	-	0.082	0.520	0.072	0.084	0.068	0.200	0.177	0.27
Arsenic	mg/L	1	0.5	0.0340	0.0170	-	-	-	-	0.0018	0.0017	0.0020	0.0020	0.0052	0.0026	0.0052	0.0021
Cadmium	mg/L					-	-	-	-	<0.000017	<0.000017	<0.000017	<0.000017	0.000025	0.000025	<0.000017	<0.000017
Copper	mg/L	0.6	0.3	0.028	0.014	-	-	-	-	0.0012	0.0022	0.0011	<0.001	<0.001	0.0025	0.002	0.0023
Iron	mg/L					-	-	-	-	0.08	0.59	0.11	0.10	0.10	0.19	0.17	0.26
Lead	mg/L	0.4	0.2	0.030	0.015	-	-	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury	mg/L					-	-	-	-	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Molybdenum	mg/L					-	-	-	-	0.0137	0.0135	0.0148	0.0182	0.0192	0.0103	0.0083	0.0049
Nickel	mg/L	1	0.5	0.094	0.047	-	-	-	-	<0.002	<0.002	0.0034	0.0029	0.0074	0.0038	<0.002	<0.002
$Radium^{226}$	Bq/L	1.1	0.37			-	-	-	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	1	0.5	0.348	0.174	-	-	-	-	0.006	0.004	0.006	0.005	0.013	0.015	<0.003	0.003
Acute Toxicity in 100% Effluent																	
Daphnia magna	% mortality	50%		50%		-	-	-	-	-	-	0	0	-	0	0	0
Rainbow Trout	% mortality	50%		50%		-	-	-	-	-	-	0	0	-	0	0	0

MMER - Metal Mining Effluent Regulations.
ECA - Environmental Compliance Approval.

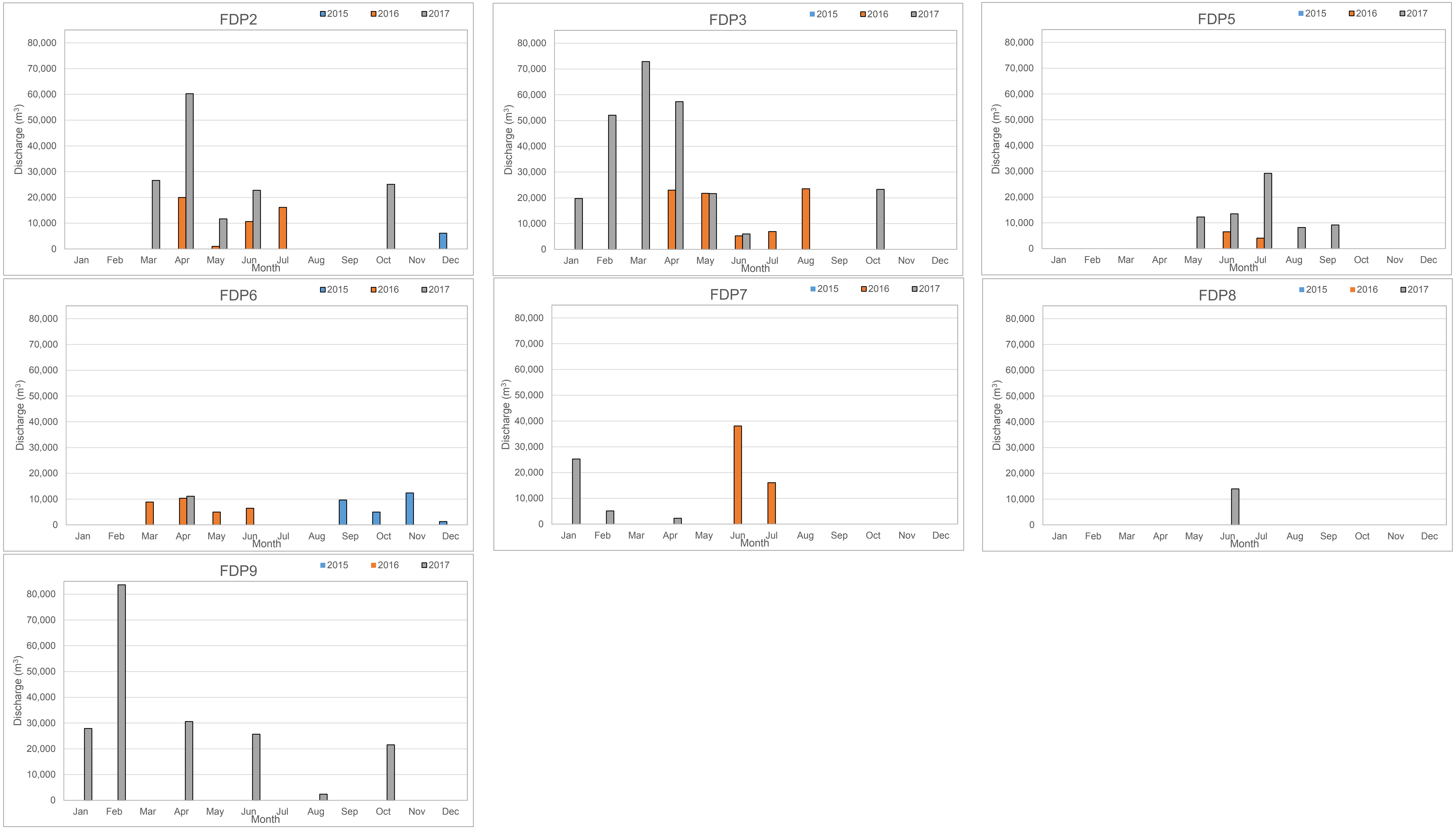


Figure 1.3: Rainy River Final Discharge Points Average Monthly Effluent Discharge During the Phase 1 EEM Study Period, 2015 to 2017

decreased discharge volumes in 2017 (Table 1.2). Additionally, RRP plans on reducing the number of FDPs in the future, however this will be determined at a later date.

Table 1.2: Annual MMER Effluent Discharge Totals for the New Gold RRP, 2015 to 2017

Final Discharge Point	Year		
	2015	2016	2017
FDP2	6,158	47,854	146,513
FDP3	0	80,445	252,911
FDP5	0	6,540	72,393
FDP6	29,752	30,601	11,138
FDP7	0	54,148	32,686
FDP8	0	0	3,600
FDP9	0	0	191,830

RRP Mine effluent was usually non-lethal (< 50% mortality in 100% effluent) to *Daphnia magna* and rainbow trout during the Phase 1 EEM acute toxicity bioassay tests, however there were two failed tests due to rainbow trout mortalities (Table 1.3). New Gold retained Minnow to perform a preliminary review of the effluent chemistry data associated with toxicity testing at RRP following these rainbow trout (*Oncorhynchus mykiss*) mortality events (ranging from 10 to 90% mortality). Note that 10% mortality is a level acceptable in test controls (Environment Canada 2007a). The review of effluent chemistry results identified ammonia as the most likely toxicant.

For the review, the effluent chemistry data associated with mortality events were first screened against guidelines to identify any possible toxicants. Effluent concentrations consistently achieved water quality guidelines for the protection of aquatic life and therefore this initial screening did not identify any toxicants. However, in Minnow's experience, ammonia is often a contributor to acute toxicity in mine effluents (due to blasting using ammonium nitrate). Furthermore, fish mortalities in laboratory tests of mine effluent are often due to changes in ammonia toxicity over the duration of the test.

The toxicity of ammonia in aqueous solutions is dependent on the equilibrium between the un-ionized (NH_3) and ionized (NH_4^+) species. The speciation of ammonia in water is largely determined by pH and temperature, with higher proportions of the toxic un-ionized species being associated with higher pH and higher temperature (CCME 2010). Within a bioassay test, the experimental pH and temperature of the effluent solution can be different from *in situ* conditions, and may change over the duration of the 96 hour test. The toxicity of ammonia (i.e., proportion of un-ionized ammonia) may increase during the test due to a progressive increase in pH as a

Table 1.3: Acute Toxicity Results as Percent Mortality, RRP Phase 1 EEM

Location	Date	*Dapnia magna*	Rainbow Trout
FDP2	15-Jul-16	0	0
	16-Oct-16	0	0
	8-Nov-16	0	0
	22-Nov-16	0	0
	7-Dec-16	0	0
	20-Dec-16	0	0
	22-Mar-17	0	0
	28-Mar-17	0	40
	4-Apr-17	0	10
	11-Apr-17	0	0
	17-Apr-17	0	0
	25-Apr-17	0	0
	5-May-17	0	0
	28-May-17	0	0
	17-Oct-17	0	0
	29-Oct-17	0	0
FDP3	30-May-16	0	0
	24-Aug-16	0	0
	22-Sep-16	0	0
	6-Nov-16	0	0
	16-Nov-16	0	0
	11-Dec-16	0	0
	29-Dec-16	0	60
	14-Jan-17	0	0
	19-Jan-17	0	0
	23-Jan-17	0	10
	30-Jan-17	0	0
	6-Feb-17	0	0
	15-Feb-17	0	0
	23-Feb-17	0	0
	24-Feb-17	0	10
	4-Mar-17	0	0
	4-Mar-17	0	0
	12-Mar-17	0	0
	16-Mar-17	0	0
	18-Mar-17	0	0
	22-Mar-17	0	0
	25-Mar-17	0	0
	30-Mar-17	7	0
	3-Apr-17	0	10
	7-Apr-17	0	0
	10-Apr-17	0	0
	16-Apr-17	0	10
	20-Apr-17	0	0
	30-Apr-17	0	0
	6-May-17	0	0
	10-May-17	0	0
	30-May-17	0	0
	19-Jun-17	0	0
	13-Oct-17	0	0

Denotes a failed acute toxicity result (> 50%)

Table 1.3: Acute Toxicity Results as Percent Mortality, RRP Phase 1 EEM

Location	Date	*Dapnia magna*	Rainbow Trout
FDP5	23-Nov-16	0	0
	5-May-17	0	0
	4-Jun-17	0	0
	21-Jun-17	0	0
	6-Jul-17	0	0
	16-Jul-17	0	0
	31-Jul-17	0	10
	17-Aug-17	0	0
	17-Sep-17	0	0
FDP6	24-Mar-16	0	10
	4-Jun-16	0	0
	23-Nov-16	0	0
	6-Apr-17	0	0
FDP7	9-Jun-16	0	0
	12-Oct-16	0	0
	11-Dec-16	0	0
	28-Jan-17	0	0
	2-Apr-17	0	0
FDP8	27-Nov-16	0	0
FDP9	4-Sep-16	0	0
	3-Oct-16	0	0
	17-Oct-16	0	0
	21-Oct-16	0	0
	11-Nov-16	0	0
	21-Nov-16	0	0
	27-Jan-17	0	0
	28-Jan-17	0	0
	5-Feb-17	0	0
	10-Feb-17	0	0
	17-Feb-17	0	0
	20-Feb-17	0	90
	23-Feb-17	0	0
	24-Feb-17	3	20
	25-Feb-17	0	0
	4-Mar-17	0	0
	5-Mar-17	0	0
	7-Mar-17	0	0
	12-Mar-17	0	0
	24-Mar-17	53	0
	3-Apr-17	0	0
	7-Apr-17	0	0
	22-Apr-17	0	0
	27-Apr-17	0	0
	18-Jun-17	0	0
	23-Aug-17	0	0
	12-Oct-17	0	0

Denotes a failed acute toxicity result (> 50%)

result of aeration and the associated decline in dissolved CO_2 (Environment Canada 2007a). As expected, the pH of RRP bioassay test solutions increased over the test duration.

Un-ionized ammonia concentrations in bioassay tests were calculated using total ammonia concentrations as well as the pH and temperature for three condition scenarios: (1) *in situ* field conditions, (2) the initial bioassay conditions at the start of the test, and (3) the final bioassay conditions at the end of the test. Calculation of un-ionized ammonia for these three scenarios indicated that, over the duration of the bioassay test, pH levels in RRP bioassay tests increase to levels where concentrations of un-ionized ammonia exceed 96 hour acute mortality LC_{50} levels for juvenile rainbow trout (i.e., 0.4 - 0.673 mg/L HN_3; Figure 1.4; CCME 2010, USEPA 1984), but this would not occur *in situ* with the conditions naturally found in the Pinewood River.

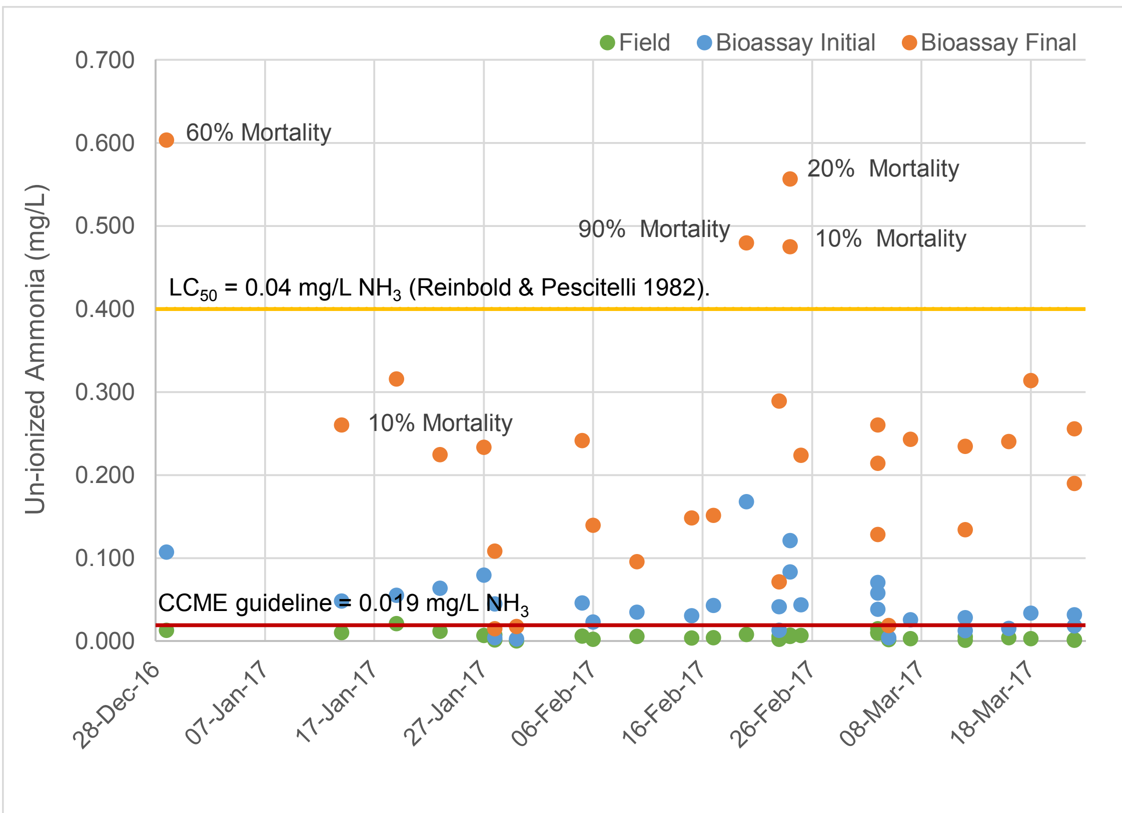


Figure 1.4: Calculated Un-ionized Ammonia Concentrations in Bioassay Test Solutions and Corresponding Mortality Events

This pH drift under test conditions can be controlled in the laboratory. The Environment Canada guidance document indicates that, if effluent samples contain an appreciable quantity of ammonia or other constituent whose toxicity is highly pH-dependent, and concern exists about pH drift during testing and its contribution to sample toxicity, a second (concurrent) test may be conducted. This second test could be undertaken using various means (e.g., oxygenating rather than aerating solutions, addition of CO_2 to test solutions or enclosed atmospheres above the solutions, testing solutions in sealed containers with oxygen atmospheres) to reduce or prevent pH drift during the test (Environment Canada 2007a).

Therefore, it was recommend that RRP speak to their bioassay laboratory about running a second (concurrent) pH-controlled test for future acute toxicity tests.

Overall the effluent from RRP is of high quality and should have minimal impact on the receiving environment, especially at calculated concentrations found within the Pinewood River (~14% total volume; Minnow 2016).

1.3 Receiving Environment Characteristics

The Pinewood River is the secondary receiver of the RRP's effluent discharge from Process Plant Site, South Pond, Sump 3, and Sump 4, as well as from PPOP via Clark Creek. Currently, all discharge is controlled by pumping. Fish and benthic invertebrate sampling was conducted downstream of the primary FDP, at water quality monitoring station SW22A and downstream, with specific locations based on accessibility and habitat conditions. The effluent-exposed biological monitoring area will be referred to as PinR-EXP (Figure 1.2). SW22A is approximately 5 km downstream of the confluence of West Creek (which receives effluent from the current primary FDP) and the Pinewood River (2.9 km downstream in a direct line). SW22A is also approximately 150 m downstream of Loslo Creek, which will receive effluent discharge from the TMA once the mine is fully operational (Figure 1.2).

The Pinewood River originates at the outlet of Pinewood Lake (24.2 km upstream of SW22A, or approximately 13.5 km east overland) and flows southwest into the Rainy River, which then drains into the southern end of Lake of the Woods. The Rainy River forms part of the international border between Ontario, Canada and Minnesota, United States. Total length of the main stem of the Pinewood River is 75 km. At the confluence of the Pinewood River and the Rainy River, the Pinewood River drains a watershed of approximately 576 km^2. Flow in the Pinewood River is highly variable, with highest flows occurring during freshet and low flows during winter (Government of Canada 2016). The Pinewood River has a mean annual flow of 4.60 m^3/s at the confluence with Rainy River. The mean annual flows at the WSC station 05PC023 and the water quality monitoring station SW22A are and 1.85 m^3/s and 0.83 m^3/s, respectively (Government of Canada 2016, SDI 2015).

The Pinewood River is a relatively shallow, meandering river, with a low gradient (average < 0.1%; KCB 2011). The substrate is predominantly fines, clay, silt, and detritus, with some sand and, in some areas, sparse gravel, and boulder (AMEC 2014). Average wetted width varies along the river, from 1.5 m to as much as approximately 40 m at the widest part near the confluence with the Rainy River (AMEC 2012, KCB 2011). Near the RRP site, wetted width is generally around 10 m, while the depths were 0.3 to 1 m in July (AMEC 2012; KCB 2011). Stream cover is mostly provided by overgrowth, and to some extent large woody debris.

The effluent-exposed area of the Pinewood River is generally comprised of flat morphology with some pools (AMEC 2014) and contains two main habitat types. The first habitat type has narrower floodplain widths, with forested riparian vegetation extending close to the channel edge (AMEC 2014). Aquatic vegetation is dominated by red-head pondweed (*Potamogeton richardsonii*) and hornwort coontail (*Ceratophyllum demersum*; AMEC 2014). The second main habitat type has relatively open channels, with maximum floodplain widths of 50 m and a riparian zone of sedge species (Cyperaceae), speckled alder (*Alnus incana*), and willow species (*Salix* sp.; AMEC 2014). Aquatic vegetation is dominated by yellow cowlily (*Nuphar lutea*), broadleaf arrowhead (*Sagittaria latifolia*), tape grass (*Vallisneria spiralis*), and hornwort coontail. Mixed forest species associated with the upper Pinewood River (effluent-exposed area) included: black spruce (*Picea mariana*), larch (*Larix* sp.), balsam poplar (*Populus balsamiferous*), white elm (*Ulmus americana*), and white birch (*Betula papyrifera*; AMEC 2014). Beaver dams are present in many locations in the Pinewood River and, although not considered permanent barriers to fish movement, may act as obstacles, particularly to larger-bodied fish (AMEC 2014). In 2010, beaver dams were observed at approximately 1 km, 1.8 km, and 3.7 km downstream of SW22A (i.e., potentially downstream of or within the PinR-EXP area; KCB 2011). Manmade water crossings along the Pinewood River have been observed to allow for sufficient river flow and thus did not present as a barrier to fish movement (AMEC 2014).

In the lower Pinewood River, widths and depths increase as the river approaches the Rainy River, reaching maximum bankfull depths of 4.5 m (AMEC 2014). Here the substrate, although still predominantly clay and fines, has a larger proportion of coble, gravel, and boulder (AMEC 2014). The riparian zone is comprised of mixed forest including black spruce, larch, balsam poplar, white birch, and white elm (AMEC 2014).

Gravel and cobble shoals provide fish spawning and nursery habitat for numerous species, including walleye. This type of spawning habitat has only been identified in the lower Pinewood River (downstream of the confluence with McCallum Creek; AMEC 2014). Spawning habitat for northern pike and yellow perch is shallow vegetation, particularly the heavily vegetated floodplains of streams or lakes (Holm et al. 2010). This type of habitat is abundant in the upper Pinewood River (upstream of McCallum Creek) and its upper tributaries (AMEC 2014), in part as a result of flooding by beaver ponds.

1.4 Summary of the Approved Phase 1 Design

The Study Design for the Phase 1 EEM was submitted to Environment and Climate Change Canada (ECCC) in September 2016 (Minnow 2016).

1.5 Report Organization

Methods of sample collection, sample analysis, and data analysis during the Phase 1 EEM study for RRP are presented in Section 2. Section 3 presents a summary of the effluent sub-lethal toxicity test data collected to date. Supporting field measures and water quality data are presented in Section 4. Sediment quality data are presented in Section 5 and the benthic invertebrate community survey results are presented in Section 6. Section 7 presents the findings of the fish survey and the conclusions of the RRP Phase 1 EEM and recommendations for the next Phase are provided in Section 8. All the references cited throughout this document are listed in Section 9.

2 METHODS

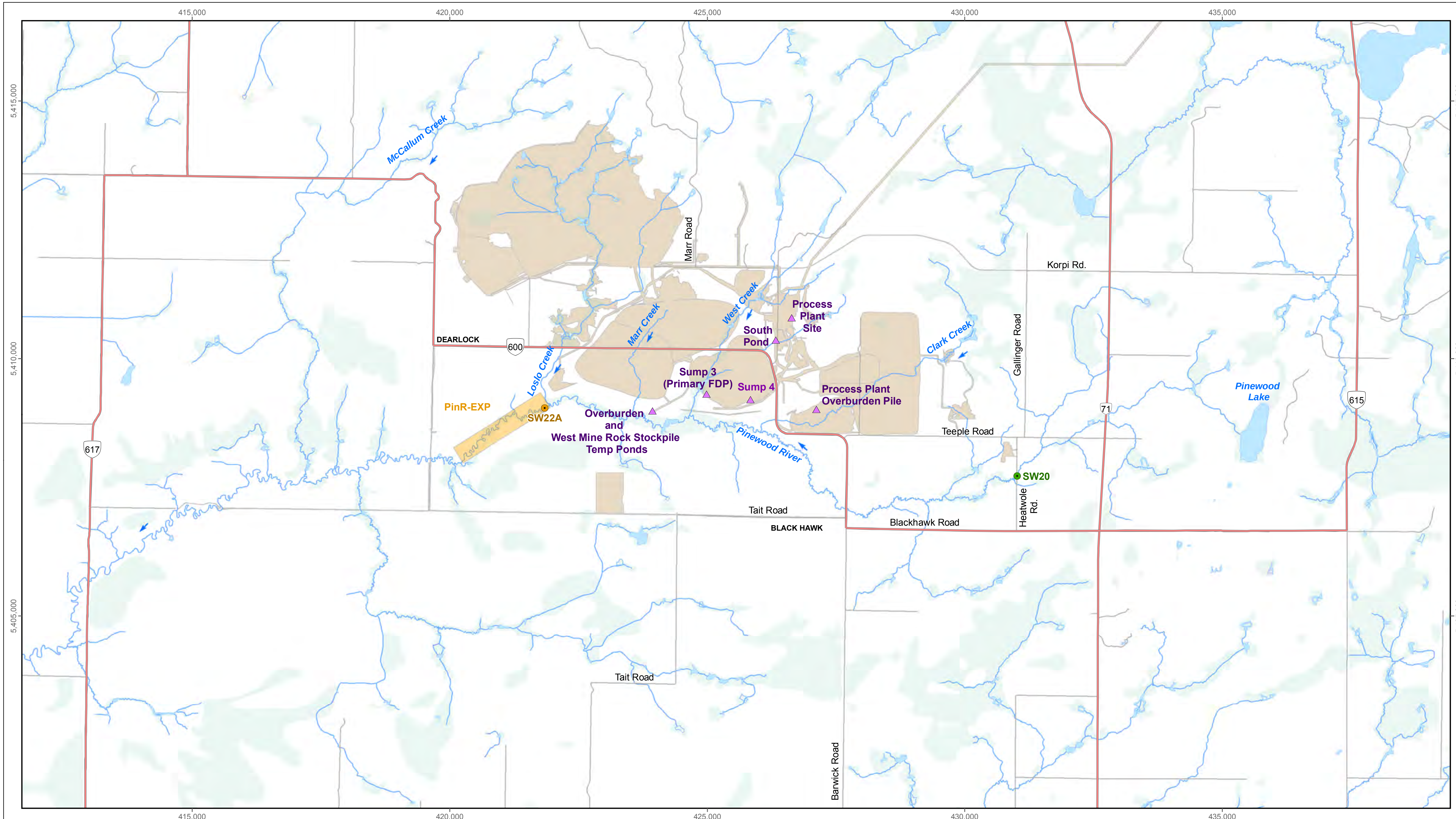
2.1 Overview

The RRP Phase 1 EEM consisted of effluent sublethal toxicity testing, water quality monitoring, sediment quality monitoring, benthic invertebrate community monitoring and fish population monitoring. RRP conducts semi-annual sublethal toxicity testing of its primary final effluent and monitors water quality in effluent-exposed and reference areas a minimum of four times per year in accordance with EEM requirements (Environment Canada 2012) and the Environmental Compliance Approval (No. 5781-9VJQ2J) monitoring requirements for the Pinewood River. Fish community monitoring was conducted from April 21st to 25th, 2017 and the benthic invertebrate community monitoring was completed from September 13th to 17th, 2017. This monitoring, supported by a number of field measures and observations, was undertaken in effluent-exposed Pinewood River and the upstream Pinewood River and Sturgeon Creek reference areas (Figure 2.1).

2.2 Effluent Sublethal Toxicity

Sublethal toxicity tests were conducted on effluent from the RRP primary FDPs. Samples were collected into labelled HDPE (High Density Polyethylene) containers. Following collections, samples were put on ice inside coolers and shipped to AquaTox Testing and Consulting Inc. in Guelph, Ontario. Sample arrival time, temperature, dissolved oxygen, conductivity, pH and hardness were recorded upon arrival at the laboratory, and any unusual characteristics were also noted.

Sublethal toxicity tests were conducted on fathead minnow (*Pimephales promelas*; 7-d survival and growth test), a cladoceran invertebrate (*Ceriodaphnia dubia*; 7-d survival and reproduction test), an algae (*Psuedokirchneriella subcapitata*; formerly referred to as *Selenastrum capricornutum*; 3-d inhibition test) and duckweed (*Lemna minor*; 7-d growth inhibition test) using standard test methods (i.e., Environment Canada 2011, 2007b,c,d). For fathead minnow and *C. dubia* chronic toxicity tests, LC_{50} (i.e., lethal concentration to 50% of test organisms) was calculated from the mortality data by the laboratory (e.g., Stephan 1977). Chronic toxicity test IC_{25} (inhibitory concentration that reduced larval fathead minnow growth by 25%, reduced the number of *C. dubia* neonates produced by 25%, inhibited *P. subcapitata* and *L. minor* growth and/or frond production by 25%) values were calculated from the growth or reproduction data. Reference toxicant testing was employed to ensure that all test systems met protocol criteria during effluent testing. All IC_{25} data were derived by the toxicity laboratory using linear interpolation aided by Comprehensive Environmental Toxicity Information System (CETIS) software (Tidepool Scientific Software, McKinleyville, CA). Sublethal toxicity data were



LEGEND

Proposed Benthic Invertebrate and Fishing Sampling Area

- Effluent-exposed
- Reference
- Final Discharge Point
- Effluent-exposed Water Monitoring Area
- Reference Water Monitoring Area
- Mine Infrastructure

0 1 2 4 km

Map Projection: UTM Zone 15 NAD 1983
Data Source: Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Rainy River Project Phase 1 EEM Biological Sampling Areas, Final Discharge Points (FDPs), and Water Quality Monitoring Areas

Date: March 2018
Project 177202.0012

Figure 2.1

Document Path: S:\Projects\177202\177202.0012 - RRP Phase 1 EEM Implementation\6 - GIS Mapping\Report\17-12 Fig 2.1 Phase 1 EEM.mxd subsequently reported to Environment Canada as part of RRP annual reporting and have been summarized in this report.

2.3 Receiving Water Quality

In accordance with the approved Study Design, routine receiving environment water sampling was conducted by the mine at the Pinewood River effluent-exposed area (SW22A) and a Pinewood River reference area upstream of the RRP (SW20; Figure 2.1). Water sampling for the biological survey was undertaken at the Pinewood River effluent-exposed area (PinR-EXP), and the Sturgeon Creek reference area (StuC-REF) during both the spring and fall surveys. This included an assessment of chemical parameters as well as supporting measures.

2.3.1 Sample Collection and Laboratory Analysis

Routine receiving water samples were collected at least four times per year at areas designated as reference (SW20) and effluent-exposed area (SW22A) to meet the EEM monitoring requirements (Figure 1.2). Routine water quality samples were collected at arm's length below the water surface to avoid floating material and facing upstream to avoid any potential influence of the individual collecting the sample. Samples were collected into pre-labelled and pre-preserved (if required) bottles provided by ALS Thunder Bay laboratory. Immediately after sampling, the samples were placed into coolers on ice for transport to the mine environmental laboratory for immediate shipment to ALS Thunder Bay. In the event that the samples were not shipped immediately, they were placed in a refrigerator at the mine environmental laboratory for shipment the next day. Analytes included those required under EEM: hardness, alkalinity, aluminum, arsenic, cadmium, copper, iron, lead, mercury, molybdenum, nickel, selenium, zinc, conductivity, total suspended solids, ammonia, nitrate, pH, cyanide, and radium-226 (Environment Canada 2012).

In accordance with the approved Study Design, water quality samples were collected at each of the study areas (Pinewood River effluent-exposed area and Sturgeon Creek reference) during the biological sampling in April and September 2017 (Figure 2.1). These water quality samples were collected as described above and were shipped the day after collection to ALS Environmental in Thunder Bay, Ontario for analysis of the EEM analytes listed above. Field duplicates were sampled to permit assessment of field precision (see Appendix B).

2.3.2 Supporting Measures

A number of environmental variables were monitored to support the EEM. The location of each sample and each fishing effort was recorded using a Geographic Position System (GPS) with coordinates recorded in latitudes and longitudes (degrees, minutes and seconds to one-tenth of a second using the North American Datum of 1983). Field-based measurements were collected at all ten benthic invertebrate community stations and at the fish sampling areas. These included pH, dissolved oxygen, specific conductance, and temperature that were measured using a YSI 556 MPS (Multiprobe System) equipped with a multi-parameter Sonde. In addition, station depth, sediment texture, sediment odour and presence of plants or algae were recorded for each station. Sediment samples were also collected for chemical analyses (see Section 2.4). All observations associated with the sampling station or the samples were recorded on field sheets.

2.3.3 Data Analysis

All water quality data were evaluated by qualitative comparison of concentrations among areas (i.e., comparison of concentrations at the effluent-exposed area to reference area) and by comparison to water quality objectives for the protection of aquatic life. Provincial Water Quality Objectives (PWQO; OMOEE 1994) and Canadian Water Quality Guidelines (CWQG; CCME 2017) were both considered in the evaluation of water quality data for the RRP. Supporting measures were also statistically compared using Studentized T-test comparisons based on assumptions of normality and homogeneity of variance.

2.4 Sediment Quality

In accordance with the approved Study Design, sediment sampling was undertaken at all benthic invertebrate community sampling stations in both the effluent-exposed area (PinR-EXP) and reference (StuC-REF) areas (Figure 2.1). This included an assessment of physical and chemical parameters as well as supporting measures.

2.4.1 Sample Collection

Sediment samples were collected for analyses using a stainless steel Petite Ponar sampler (0.023 m^2 sampling area). A composite sample was created at each station by collecting the top five centimetres of surficial sediment from each of three acceptable Petite Ponar grabs (i.e., full to each edge of sampler) into a plastic tub. The composite sample was homogenized before being spooned (using a stainless steel spoon) directly into polyethylene bags. The top 5 cm was selected because it is the fraction in which most benthic fauna reside. Details about samples (e.g., sample penetration, depth, substrate characteristics) were recorded on field sheets. One duplicate sample was also assessed for quality assurance (see Appendix B).

Immediately after collection, samples were placed in a cooler on ice, and later placed in a refrigerator at the mine environmental laboratory at approximately 4 °C until submission for analysis. Sediment samples were submitted to ALS Environmental, Thunder Bay, Ontario for analysis of total organic carbon (TOC), particle size[1], total Kjeldahl nitrogen (TKN), total phosphorus, and metals.

Additional supporting sediment measurements and observations collected at all benthic invertebrate monitoring stations included sediment texture and colour, and presence of algae or plants on or in the sediment.

2.4.2 Data Evaluation

The sediment quality data for the Pinewood River effluent-exposed area was evaluated relative to: 1) concentrations measured at the reference area, and 2) applicable Provincial Sediment Quality Guidelines (PSQG). PSQG are numerical criteria that are protective of sediment-dwelling organisms based on long-term exposure (OMOE 1993). The PSQG include lowest effect level (LEL) and severe effect level (SEL) values. LEL is defined as a concentration that can be tolerated by the majority of benthic organisms (i.e., at least 90-95% of species) and reflects sediments that can be considered clean to moderately polluted (OMOE 1993). The SEL is the concentration at which pronounced disturbance of the benthic community (i.e., 90-95% of benthic species) can be expected (OMOE 1993) and is typically about five times higher than the LEL. However, natural background concentrations, particularly in mineralized areas of the Canadian Shield, can be higher than LELs for many substances. Therefore, sediment concentrations at the EEM sampling stations were compared to both the PSQG LEL and SEL.

Principal component analysis (PCA) was also used to assist with the interpretation of general trends and patterns of variability in the sediment quality data among study areas. Data were screened to ensure that any variables with no variation (i.e., all less than detect) were removed from the data matrix. Principal component axes were then generated from the correlation matrix of the original sediment quality variables. PCA scores for each station were subsequently plotted and used as summary variables to test for differences among study areas using ANOVA with post-hoc comparisons as well as the correlation analysis.

2.5 Benthic Invertebrate Community Survey

In accordance with the approved study design, benthic invertebrate sampling was undertaken in the Pinewood River effluent-exposed area and Sturgeon Creek reference area (Figure 2.1). Target sampling station characteristics included a depth of approximately 1 m, bottom water velocity of less than 0.02 m/s and fine sediment with little to no gravel.

[1] Particle size determination was based on the Wentworth scale. Prior to particle size analysis, organic content was burned off (loss on ignition) to eliminate any chance of misclassification of small organic debris.

2.5.1 Sample Collection

Benthic invertebrate samples were collected using a steel petite-Ponar sampler (15.24 cm x 15.24 cm). Five stations were sampled in each area, at a minimum of three bankfull widths apart, to provide adequate statistical power to detect differences of +/- two standard deviation at an α and β of 0.10 which is consistent with EEM guidance (Environment Canada 2012). One sample was collected at each station and was composed of a three-grab composite (0.0697 m^2 of bottom area in total), to ensure each sample was representative of the station. Upon retrieval, all samples were closely examined to ensure that only high quality, comparable samples were retained (based on factors such as particle size, organic matter, presence, or absence of plants or algae). Each grab was placed into a tub to evaluate whether the grab was complete (i.e., that the grab captured the surface material and was full to each edge) and to evaluate the depth to which the grab penetrated. Unacceptable grabs were discarded. If the grab was acceptable, the Ponar was rinsed into the tub to ensure complete removal of all material. The sample was then placed into a 500 µm mesh sieve bag and sieved free of material less than 500 µm in diameter. Sampling was repeated until three acceptable grabs were collected. Details about each acceptable grab were recorded on field sheets. The retained sample from the three composited grabs was carefully transferred to one or more labelled 2-L wide mouth plastic jars using a stainless steel spoon and wash bottle while working over a plastic tub to avoid any potential loss of organisms. Any organisms still adhering to the sieve bag were removed with tweezers and added to the sample. All samples were labelled internally (using wooden sticks) and externally with the station number, area identifier, Minnow project number, date and field personnel in order to ensure correct identification at the laboratory. Samples were preserved with buffered formalin solution to achieve a nominal concentration of 10%. Supporting measures (GPS coordinates, station depth, water quality, and sediment quality) were collected at each benthic station as previously described.

2.5.2 Sample Processing

All benthic invertebrate samples were shipped to Zaranko Environmental Assessment Services (ZEAS), Nobleton, Ontario. Upon arrival at the laboratory, each benthic invertebrate sample was inspected to verify adequate preservation and a biological stain was added to improve sorting efficiency. Prior to sorting, benthic samples were washed free of formalin in a 500 µm sieve under well-ventilated conditions. Samples were then examined by a technician under a stereomicroscope at a magnification of at least ten times. All benthic organisms were removed from the sample debris and placed into vials containing 70% ethanol. A senior taxonomist then enumerated and identified the benthic organisms to the lowest practical level (typically genus or species) utilizing the most up-to-date taxonomic keys. Following identification, representative specimens of each species were preserved in 75% ethanol (with 3% glycerol) in separately labelled vials to form a voucher collection.

Quality assurance/quality control (QA/QC) for benthic laboratory operations was conducted as recommended by Environment Canada (Environment Canada 2013, Glozier et al. 2002; Appendix B). Comparisons of fractions sorted were assessed for 10% of samples to verify that sub-sampling precision was within 20%. In addition, 10% of samples were re-sorted to verify that less than 10% of total organisms were missed (Environment Canada 2012). See Appendix B for full QA/QC analysis.

2.5.3 Data Analysis

Benthic invertebrate communities were evaluated at the Family Level [FL][2] using summary metrics of mean taxon richness, mean invertebrate abundance (or "density"; average number of organisms per m^2), Simpson's Evenness Index (E) and the Bray-Curtis Index of Dissimilarity as required under the MMER (Environment Canada 2012). Taxon richness included all separate 19 taxa identified to the lowest practical level, excluding any life stages that could not be conclusively identified as separate taxa. In some instances, for the purposes of data analysis, invertebrate taxa were combined at a generic taxonomic level in order to incorporate abundance associated with indeterminate taxa. This was only done when there were few species in the genus and indeterminates made up a significant proportion of generic abundance.

Simpson's indices of diversity ("D") and evenness ("E"), and the Bray-Curtis (B-C) index were computed from custom MS Excel macros and spreadsheets following the formulae presented by Environment Canada (2012). The B-C metric takes into account the abundance of each taxon at each station compared to the median abundance computed from the reference station data to compute an index of the relative "distance" of each station from a hypothetical reference median station. Larger B-C index values indicate greater dissimilarity from reference.

The relative proportions of the most abundant taxa were also computed (calculated as the abundance of each respective dominant/indicator taxon relative of the total number of organisms in the sample). Dominant/indicator taxon groups were defined as those groups representing greater than 25% of total organism abundance in at least one replicate sample or any groups considered to be important indicators of environmental stress. In the Phase 1 EEM, chironomids, bivalves, EPT taxa (Ephemeroptera, Plecoptera, and Trichoptera taxa), and oligochaetes were examined.

[2] Summary metrics were also calculated based on organisms sorted to lowest practical level [LPL] results can be found in Appendix D.

Community structure was also assessed using a multivariate technique known as correspondence analysis (CA). CA is used to calculate synthetic axes, which can be thought of as new variables summarizing variation in the relative abundance of benthic taxa. When depicted in two-dimensional plots, taxa that tend to co-occur will have similar CA axis scores and will plot together, while those that rarely co-occur plot farther apart. Similarly, stations sharing many taxa plot closest to one another, while those with little in common plot farther apart. The greatest variation among either taxa or stations is explained by the first axis, with other axes accounting for progressively less variation. Therefore, this type of multivariate analysis describes not only which stations have distinct benthic invertebrate communities but also how these communities differ among stations (i.e., which particular taxa differ). Prior to CA, the data were screened for rare taxa, and taxa occurring at 10% or fewer of the stations were removed as these can distort results. After screening and data reduction, abundances were log (x+1) transformed. Scores for both stations and for taxa were calculated using the ADE-4 package (Thioulouse et al. 1997).

All required and supplementary endpoints were summarized by separately reporting mean, median, minimum, maximum, standard deviation, standard error, and sample size for each sampling area (Environment Canada 2012). These endpoints were also plotted to explore spatial patterns and differences between effluent-exposed and reference areas to assist in data interpretation. Statistical comparisons between effluent-exposed and reference areas were conducted for each endpoint using Studentized T-tests. Data were assessed for normality and transformed as required to stabilize variances and satisfy assumptions of the T-Tests. Non-parametric techniques were used in instances in which transformation was unsuccessful in normalizing data or homogenizing variances. Statistical tests and plots were generated using SPSS Version 12 (SPSS Inc., Chicago, IL). Interpretation of benthic community metrics was enhanced by inspection of raw data and taxonomic proportions to detect patterns of ecologically relevant differences between effluent-exposed and reference areas. Benthic metrics calculated as explained above were then plotted to explore spatial patterns in the benthic community data with respect to the location of stations. Ecological and habitat requirements of taxa were assessed using standard references (Clarke 1981, Edmunds et al. 1976, Merritt and Cummins 1984, Merritt et al. 2008, Weiderholm 1983, Wiggins 1996).

The Technical Guidance Document (Environment Canada 2012) states that the benthic invertebrate community survey should minimally have sufficient power to detect a difference (effect size) of ± two standard deviations (SDs). Therefore, the magnitude of the difference between area means in each planned comparison was calculated for each benthic metric where a significant difference was detected. The magnitude of the difference was expressed as the number of reference mean SDs as follows:

magnitude of difference = (exposure mean – reference mean) / SD of the reference mean

If a significant difference between areas was not detected for a benthic metric, then the minimum effect size that could have been detected (had a large enough effect existed) was calculated using the mean square error generated from the ANOVA as an estimate of variability, with alpha and beta equal to 0.10. The minimum detectable effect size was based on the minimum number of reference area SDs, according to the following equation:

$$\delta = [(t_\alpha + t_\beta)(\sqrt{MSE})(\sqrt{2/n})]/SDref$$

where, δ = minimum detectable effect size,

MSE = mean square error,
n = sample size per area (in this case = 5), and
SDref = standard deviation of the reference area mean.

Possible relationships among the significant benthic invertebrate community indices and the supporting physical and chemical data observed were then examined using correlation analysis. A Bonferroni-type correction was applied to minimize the risk of declaring false positive correlations since at least 5% of derived correlations would be expected to occur by chance alone. Any significant correlations found at the adjusted p-value and/or at a p-level <0.05 were further investigated using scatter plots to determine if a continuous distribution of data was realized (possible causal relationships) or if these relationships were “leveraged” by outlying points (or groups of points).

2.6 Fish Survey

In accordance with the approved study design, a traditional lethal EEM fish population survey was undertaken in the effluent-exposed area of Pinewood River (PinR-EXP) and one reference area: Sturgeon Creek (StuC-REF; Figure 2.1). Following initial fish catches and consultation with Environment Canada during the field survey, it was determined that the sentinel species targeted would be brook stickleback and central mudminnow.

2.6.1 Sample Collection

Brook stickleback and central mudminnow were targeted from the effluent-exposed area on the Pinewood River and the Sturgeon Creek reference using backpack electrofishing, fine-mesh seine nets and minnow traps. All fishing was conducted under a License to Collect Fish for Scientific Purposes obtained from the Ontario Ministry of Natural Resources and Forestry (1086615; Appendix E). Supporting information recorded for each seine haul, backpack electrofishing pass, and minnow trap set included deployment and retrieval time (minnow traps), seine haul distance, electrofishing seconds, water depth, GPS coordinates and habitat description. Upon net retrieval, all fish were identified, counted, and recorded on the appropriate field sheets. Twenty adult male and 20 adult female brook stickleback and central mudminnow were targeted in each area for the survey. All captured fish not utilized in the fish health assessment were identified, enumerated, and released.

2.6.2 Sample Processing

Sentinel species collected were held in aerated buckets and processed in an offsite laboratory. Sampled fish were individually sacrificed in a strong clove oil solution immediately prior to dissection. Lengths were measured using electronic calipers (to the nearest 0.01 mm) and weight was measured with a Scout Pro Balance (Model PSE-123) to the nearest 0.001 g with ± 1% precision. Both measures were recorded on data sheets. The presence of any external lesions, tumours, parasites or other abnormalities was also noted. Fish were opened using dissecting scissors and any internal abnormalities were noted. Processing involved removal of gonads and livers using dissecting tweezers and scissors, and measurement of gonad and liver weight to the nearest 0.001 g using an electronic balance surrounded by a draft shield. Whole female gonads were then preserved in 10% buffered formalin in containers labelled with the fish identification. Following processing, fish heads were frozen separately in labelled whirl-pak™ bags, for later extraction of otoliths for ageing (see Section 2.6.3 below).

Ovary samples were subsequently shipped to Zaranko Environmental Assessment Services (ZEAS) Laboratory in Nobleton, Ontario, for determination of fecundity and egg weight. All samples retained for ageing were shipped (frozen) to AAE Tech Services (Winnipeg, Manitoba), where otoliths were extracted for age determination using the crack and burn methodology.

2.6.3 Laboratory Analysis

2.6.3.1 Fecundity and Egg Weight

At ZEAS Laboratory in Nobleton, Ontario, whole ovary samples were drained into an 18-µm sieve to remove the preservative and then weighed to the nearest 0.001 g to determine the preserved gonad sample weight. Three sub-samples, each consisting of at least 100 eggs, were then removed and weighed. The weights of each subsample were recorded and the numbers of eggs in each sub-sample were counted under a microscope. The remainder of each sample was re-preserved and archived. Ten percent of egg samples were recounted to verify the precision of fecundity estimates. The number of eggs in the whole gonad was calculated as follows (for each sample):

$$gonad\ \ fecundity = \frac{total\ \ weight\ \ of\ \ preserved\ \ gonad\ \ sample}{weight\ \ of\ \ preserved\ \ sample}\ x\ number\ \ of\ \ eggs\ \ in\ \ preserved\ \ sample$$

The final fecundity estimate for each female was calculated as an average of the fecundity estimates from the three sub-samples.

Individual egg weights for each female were calculated as follows:

$$individual\ egg\ weight = \frac{weight\ of\ unpreserved\ gonad}{total\ \ fecundity}$$

2.6.3.2 Aging

AAE Tech Services Inc. estimated fish age by analyses of otoliths. Preparation of the otoliths for ageing was done using a Crack and Burn methodology. Briefly, the otoliths were mounted in epoxy resin and, after the epoxy hardened, sliced into micro-sections using a low-speed isomet diamond saw. Micro-sections were mounted onto glass slides using a mounting medium and read under a compound microscope using transmitted light. For each otolith, the age and edge condition was recorded along with the confidence rating for the age determination.

2.6.4 Data Analysis

Raw fish survey data collected in the field were transcribed from field sheets into electronic spreadsheets. The data were then checked by a separate individual for entry errors as part of the routine QA/QC procedures. Methods of data analysis recommended for EEM (Environment Canada 2012) were employed in the fish survey. Tabulated catch data were used to calculate catch-per-unit-effort (CPUE) for each area and fish collection method. Fish population data were summarized by separately calculating the mean, standard deviation, standard error, minimum, maximum and sample size of each measured variable by area, species, and gender.

Eight endpoints were used to evaluate the health of central mudminnow populations from the effluent-exposed (Pinewood River) and the reference area (Sturgeon Creek). Age was used as an indicator of survival. Weight-at-age, length-at-age, relative gonad weight, relative egg weight, and relative fecundity were used as indicators of energy use. Condition and relative liver weight were used as indicators of energy storage. The same endpoints (with the exception of the endpoints containing age) were used to evaluate the health of brook stickleback populations from the effluent-exposed and the reference area. All health endpoints were analyzed separately for males and females. Prior to statistical analyses, the raw body weight for each fish was adjusted to account for the gonad and liver weights of each fish (i.e., adjusted body weight = raw body weight – gonad weight – liver weight). Of the endpoints assessed, EEM effect endpoints for a lethal fish survey include weight-at-age, relative gonad weight, condition, and relative liver weight, while the remaining comparisons are considered supporting endpoints (Environment Canada 2012).

Statistical comparisons of age between areas were conducted using the two-sample t-test when residuals for the assumption of normality or homogeneity of variances were met (Shapiro-Wilks' test and Levene's test, respectively ($\alpha = 0.05$). When the assumption of equal variances was not met but the assumption of normality was met, the t-test for unequal variances was used (Ruxton 2006). Data were log_{10}-transformed as necessary to meet the assumptions. When the assumptions of normality could not be met, then the Mann-Whitney test was used. Area comparisons were assessed using a significance level ($\alpha = 0.1$).

Statistical comparisons of weight-at-age and length-at-age between areas were conducted using analysis of covariance (ANCOVA) with log_{10}-transformed body size as the response, area as a factor, and log_{10}-transformed age as a covariate. Few fish were aged greater than 2 years old for central mudminnow so the analysis was conducted using age 1 and 2 fish only so the ANCOVA was equivalent to a two-way analysis of variance (ANOVA) with age as the second factor.

Statistical comparisons of relative liver weight, relative gonad weight, relative egg weight, and relative fecundity between areas were conducted using ANCOVA with log_{10}-transformed response variables and adjusted body weight (log_{10}-transformed) as a covariate. Condition was analyzed using ANCOVA with log_{10}-transformed adjusted body weight (log_{10}-transformed) as the response and fork length (log_{10}-transformed) as a covariate.

Significant interactions between the area and the covariate (i.e. the assumption of homogeneity of regression slopes between areas) in the ANCOVA were assessed using $\alpha = 0.05$. When the interaction term was significant, the coefficients of determination (R^2) of the interaction model and parallel slope model were compared to assess whether the slopes were practically significant. If the R^2 was > 0.8 and within 0.002 between the two models, the conclusion was that the interaction model and parallel slope models were practically the same (Environment Canada 2012) and the ANCOVA proceeded with the parallel slope model. Influence was also assessed using Cook's distance statistic when a significant interaction was detected. If the interaction was driven by influential points, these were removed from the analysis (Environment Canada 2012). When the interaction could not be removed by comparison of R^2 values or removal of influential points, the conclusion was that the difference in the response variable between areas was dependent on the covariate values. When the interaction term was not significant, the interaction term was removed from the model and the parallel slope ANCOVA model was fit. When the covariate was not a significant predictor of the response variable in the parallel slope ANCOVA model, the analysis proceeded as a t-test or Mann-Whitney test (as described for age). Area comparisons in the ANCOVA analyses were assessed using a significance level ($\alpha = 0.1$).

The data were plotted using individual value plots for univariate endpoints and scatterplots for bivariate endpoints prior to analysis. Statistical outliers were defined to be observations with

Studentized residuals with magnitude > 4 (Environment Canada 2012). Statistical analyses were reported for comparisons with and without the outliers to assess the influence of the outlier on statistical significance and the magnitude of difference. All statistical analyses were conducted using Minitab 18 software (Minitab 2017).

A magnitude of difference between the effluent-exposed area and reference area was calculated for each endpoint as a percentage of the reference area as:

$$\text{Magnitude of Difference} = (\text{Exp} - \text{Ref})/\text{Ref} \times 100\%$$

using either medians (Mann-Whitney), means (t-test), or the covariate-adjusted means (ANCOVA, without interaction). When an interaction was observed, the magnitude of difference was estimated for small and large fish at the minimum and maximum values of the overlap in covariate values between areas using the predicted values of the response variables from the interaction ANCOVA regression model (Environmental Canada 2012). When response variables are $\log_{10}$-transformed, the means are reported in the original data units (i.e. anti-logged), equivalent to geometric means.

An estimated minimum detectable difference (MDD) using $\alpha=\beta=0.1$ was calculated for each endpoint using either the coefficient of variation (pooled standard deviation divided by reference mean) for untransformed data or the pooled standard deviation of regression residuals for $\log_{10}$-transformed data, and reported as a percentage difference relative to the reference mean. The MDD percentage was reported as both a percentage increase, and a percentage decrease because MDD differs with respect to the direction of $\log_{10}$-transformed measures. The MDD calculations for the M-W test were estimated based on a two-sample t-test using sample sizes multiplied by 0.864 and rounded up to the nearest integer. The 0.864 is the lower bound of the asymptotic relative efficiency of the Mann-Whitney test and the two-sample t-test (Hodges and Lehmann 1956). The MDD calculations were conducted using the two-sample t-test power analysis function in Minitab 18 software (Minitab 2017).

An *a priori* power analysis was conducted for each endpoint using the observed variability from the 2017 data analyses to estimate the sample sizes required to detect a range of effect sizes. The analyses were conducted using the two-sample t-test power analysis function in Minitab 18 software (Minitab 2017) using the same estimates of variability and assumptions for the M-W test as described for the MDD calculations.

3 EFFLUENT SUBLETHAL TOXICITY

3.1 Toxicity Test Results

Sublethal toxicity tests conducted on grab samples of RRP final effluent at Final Discharge Point 2 (FDP2) and Final Discharge Point 3 (FDP3) over the Phase 1 EEM period (2016 to 2017) indicated that effluent was generally of high quality with the lowest reported effects occurring at effluent concentrations of 37% and 95% for FDP2 and FDP3 respectively.

FDP2 sublethal toxicity tests did not elicit effects on fathead minnow survival or on growth of the green algae *Pseudokerchneriella subcapitata* (*P. subcapitata*) at any point during the Phase 1 EEM (Table 3.1). However, FDP2 effluent impaired the survival and growth of the invertebrate *Ceriodaphnia dubia* in 2016 (92% and 72% effluent, respectively; Table 3.1), but not in 2017. This same pattern was observed for the growth of fathead minnow and duckweed (*Lemna minor*) frond size (i.e. weight) with impairment occurring in 2016 (37% and 76%, respectively, Table 3.1) but not 2017. Conversely, frond production for *L. minor* was consistently impaired by FDP2 effluent in both years of the Phase 1 EEM (55% and 64%, respectively; Table 3.1).

FDP3 effluent was of excellent quality with virtually no impairment for any of the test organisms (Table 3.1). It is noteworthy that *P. subcapitata*, usually being the most sensitive species, was not affected by exposure to effluent from either FDP (Table 3.1).

3.2 Predicted Receiving Environment Influence

When sublethal effects are reported at effluent concentrations lower than 30% it is recommended that mines calculate the implied geographic extent of the effect (Environment Canada 2012). Since the geometric mean effect concentrations for effluent sublethal toxicity tests were above 30% in the Phase 1 EEM period, this was not required.

Generally, adverse effects on resident aquatic biota would not be predicted in the Pinewood River based on the lowest effluent concentration effect occurring at 37% (fathead minnow growth), since effluent concentrations in the receiving environment have been estimated to be ≤14% (Minnow 2016).

Table 3.1: Sublethal Toxicity Test Results for RRP Effluent (as % effluent)

a) FDP2 (Sump 3, 6)

Date	*Ceriodaphnia dubia*		Fathead Minnow		*Lemna minor*		*Pseudokerchneriella subcapitata*
	Survival LC50 [a]	Reproduction IC25 [b]	Survival LC50 [a]	Growth IC25 [b]	Frond Increase IC25 [b]	Dry Weight IC25[b]	Growth IC25 [b]
25-Jul-16	91.7 (30 - DNC[c])	71.4 (43.6 - 100)	> 100	37.1 (22.5 - 53.7)	55 (33.1 - 80.0)	76.22 (38 - 100)	> 90.9
28-Aug-17	> 100	> 100	>100	>100	63.7 (50.8 - 75.3)	> 97.0	> 90.9
Cycle 1 Geometric Mean	**96**	**84**	**>100**	**61**	**59**	**86**	**>91**

b) FDP3 (Sump 4)

Date	*Ceriodaphnia dubia*		Fathead Minnow		*Lemna minor*		*Pseudokerchneriella subcapitata*
	Survival LC50 [a]	Reproduction IC25 [b]	Survival LC50 [a]	Growth IC25 [b]	Frond Increase IC25 [b]	Dry Weight IC25[b]	Growth IC25 [b]
27-Sep-16	> 100	> 100	> 100	> 100	95.3 (26.4 - 96.7)	> 97.0	> 90.9
20-Jun-17	> 100	> 100	Indeterminate[d]	Indeterminate[e]	>97.0	> 97.0	> 90.9
Cycle 1 Geometric Mean	**>100**	**>100**	**>100**	**>100**	**96**	**>97**	**>91**

[a] Effluent concentration causing 50% mortality among exposed organisms.

[b] Effluent concentration at which a 25% inhibition/reduction in endpoint was observed among effluent-exposed organisms relative to control group.

[c] Range could not be calculated.

[d] A statistically reasonable estimate could not be calculated. However, according to Equal Variance t two-sample Test (CETIS), there was no significant reduction in growth between the control and the 100% test concentration.

[e] A statistically reasonable estimate could not be calculated. However, according to Fisher Exact Test (CETIS), mortality in the 100% effluent concentration (0%) was not significantly higher than in control (10%).

4 RECEIVING WATER QUALITY

4.1 Water Quality during the EEM

Physico-chemical measurements taken in April showed that water quality was generally similar in the effluent-exposed and reference sampling areas with the exception of higher specific conductivity and pH in the effluent-exposed area (Table 4.1; Appendix Table C.1).

Table 4.1: In Situ Surface Water Quality Data Collected during the Fish Survey for RRP Phase 1 EEM, 2017

Area Idenifier	Date	Temperature (°C)	pH	Dissolved Oxygen		Specific Conductivity (µS/cm)
				(mg/L)	(% sat)	
StuC-REF	24-Apr-17	5.9	6.90	11.86	94.3	153
PinR-EXP	24-Apr-17	5.6	7.46	11.86	93.6	303

In situ water quality measurements were also taken in September at all benthic community survey stations and indicated significant differences in temperature and specific conductance between areas (Figure 4.1; Appendix Tables C.1, and C.2). Differences observed in temperature likely reflect the time of day the measurements were taken (e.g., early morning versus mid-afternoon). Whereas the difference in specific conductance was likely due to mine effluent (Figure 4.1; Appendix Tables C.1, and C.2).

Laboratory analysis of water samples indicated that chromium and iron were slightly elevated in the reference area compared to effluent-exposed area and Provincial Water Quality Objectives (PWQO; Table 4.2). Hardness, calcium, potassium, and sodium, were elevated in the effluent-exposed area relative to reference area concentrations (Table 4.2) and likely contributed to observed elevations in specific conductance in the effluent-exposed area (Figure 4.1). Lastly, aluminum was elevated compared to PWQO both in the effluent-exposed and reference areas indicative of naturally elevated background concentrations of this substance (Table 4.2).

4.2 Routine Water Quality Monitoring

RRP collects water samples and supporting measures a minimum of four times per year at locations upstream (SW20) and downstream (SW22A) of the mine effluent discharge in the Pinewood River (Figure 2.1).

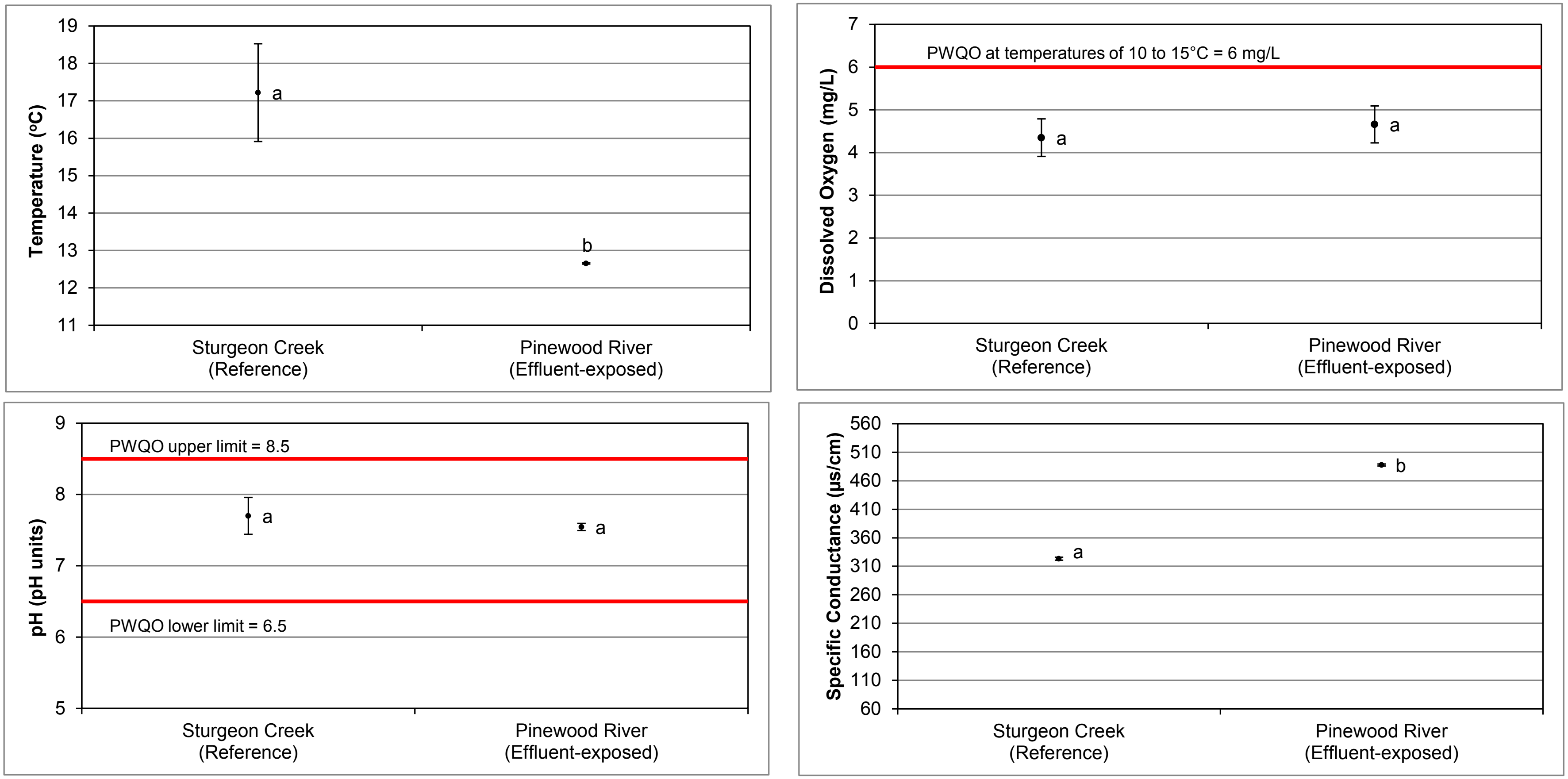


Figure 4.1: ***In Situ*** **Water Quality Measures at Benthic Sampling Stations, RRP Phase 1 EEM, September 2017**

Notes: Area mean ± standard deviation (n=5) are shown. Same letters above error bars indicate no significant difference.

Table 4.2: **Total Metal Concentrations in Sturgeon Creek and Pinewood River, RRP Phase 1 EEM, 2017**

Parameter	Units	PWQO	Sturgeon Creek (Reference)		Pinewood River (Effluent-exposed)	
			StuC-REF	StuC-REF	PinR-EXP	PinR-EXP
			24-Apr-17	13-Sep-17	24-Apr-17	13-Sep-17
Physical Tests						
Hardness	mg/L	-	98.1	174	191	257
Total Suspended Solids	mg/L	-	9.4	14.5	<2.0	4.6
Total Dissolved Solids	mg/L	-	225	239	236	308
Anions and Nutrients						
Alkalinity, Total (as $CaCO_3$)	mg/L	-	83.1	166	190	260
Ammonia, Total (as N)	mg/L	10.25	<0.020	0.097	0.077	0.027
Chloride (Cl)	mg/L	-	6.19	6.26	10.9	12.5
Fluoride (F)	mg/L	-	0.041	0.073	0.070	0.081
Nitrate and Nitrite (as N)	mg/L	-	<0.040	-	0.913	-
Nitrate (as N)	mg/L	-	<0.020	0.078	0.890	0.102
Nitrite (as N)	mg/L	-	<0.010	<0.010	0.023	<0.010
Total Phosphorus (P)	mg/L	0.30	0.040	0.107	0.019	0.032
Sulphate (SO_4)	mg/L	-	9.38	1.33	16.8	1.79
Cyanide, Weak Acid Diss	mg/L	0.0050[a]	<0.0020	<0.0020	<0.0020	<0.0020
Cyanide, Total	mg/L	0.0050[a]	<0.0020	<0.0020	<0.0020	<0.0020
Dissolved Organic Carbon	mg/L	-	28.3	35.7	16.6	28.7
Total Organic Carbon	mg/L	-	28.8	37.3	16.7	29.1
Dissolved Metals						
Calcium	mg/L	-	22.0	39.9	43.5	56.4
Magnesium	mg/L	-	10.5	18.0	19.9	28.2
Total Metals						
Aluminum	mg/L	0.075	0.552	0.435	0.062	0.092
Antimony	mg/L	0.020	<0.00010	0.00017	0.00121	0.00017
Arsenic	mg/L	0.0050	0.00086	0.00217	0.00076	0.00145
Barium	mg/L	-	0.0171	0.0237	0.0223	0.0220
Beryllium	mg/L	11	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth	mg/L	-	<0.000050	<0.000050	<0.000050	<0.000050
Boron	mg/L	0.20	0.011	0.016	0.026	0.015
Cadmium	mg/L	0.00050	0.000015	0.000009	0.000006	0.000006
Calcium	mg/L	-	22.7	40.9	42.0	58.4
Cesium	mg/L	-	0.000075	0.000054	0.000013	0.000011
Chromium	mg/L	0.0010	0.00124	0.00091	0.00023	0.00032
Cobalt	mg/L	0.00090	0.00044	0.00065	0.00015	0.00025
Copper	mg/L	0.0050	0.0019	0.0011	0.0010	<0.00050
Iron	mg/L	0.30	0.83	0.87	0.20	0.20
Lead	mg/L	0.0050	0.00037	0.00037	0.00006	0.00007
Lithium	mg/L	-	0.0043	0.0072	0.0097	0.0115
Magnesium	mg/L	-	10.7	18.9	18.5	28.5
Manganese	mg/L	-	0.050	0.220	0.028	0.084
Mercury	mg/L	0.00020	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum	mg/L	0.040	0.00041	0.00052	0.00263	0.00019
Nickel	mg/L	0.025	0.0021	0.0024	0.0012	0.0011
Phosphorus	mg/L	0.30	0.051	0.150	<0.050	0.053
Potassium	mg/L	-	1.83	1.78	3.08	2.13
Rubidium	mg/L	-	0.0022	0.0020	0.0019	0.0016

[a] Guideline for free cyanide. Applied to weak acid dissociable and total cyanide as a conservative limit.

Indicates concentration was greater than the PWQO (Provincial Water Quality Objective) Lowest Effect Level (LEL).

Table 4.2: Total Metal Concentrations in Sturgeon Creek and Pinewood River, RRP Phase 1 EEM, 2017

Parameter	Units	PWQO	Sturgeon Creek (Reference)		Pinewood River (Effluent-exposed)	
			StuC-REF	StuC-REF	PinR-EXP	PinR-EXP
			24-Apr-17	13-Sep-17	24-Apr-17	13-Sep-17
Selenium	mg/L	0.1	0.00019	0.00024	0.00017	0.00018
Silicon	mg/L	-	2.98	2.92	1.40	2.66
Silver	mg/L	0.00010	<0.000010	<0.000010	<0.000010	<0.000010
Sodium	mg/L	-	4.00	5.63	8.92	9.17
Strontium	mg/L	-	0.06	0.11	0.16	0.12
Sulphur	mg/L	-	3.38	1.01	6.06	1.20
Tellurium	mg/L	-	<0.00020	<0.00020	<0.00020	<0.00020
Thallium	mg/L	0.00030	<0.000010	<0.000010	<0.000010	<0.000010
Thorium	mg/L	-	0.00011	<0.00010	<0.00010	<0.00010
Tin	mg/L	-	0.00011	<0.00010	<0.00010	<0.00010
Titanium	mg/L	-	0.0162	0.0127	0.0022	0.0028
Tungsten	mg/L	0.030	<0.00010	<0.00010	<0.00010	<0.00010
Uranium	mg/L	0.0050	0.00089	0.00152	0.00184	0.00053
Vanadium	mg/L	0.0060	0.0023	0.0024	0.00079	0.00079
Zinc	mg/L	0.020	0.009	0.004	<0.0030	0.004
Zirconium	mg/L	0.0040	0.00065	0.00052	0.00024	0.00017
Radiological Parameters						
Ra-226	Bq/L	1.0	<0.010	<0.010	<0.010	<0.010

[a] Guideline for free cyanide. Applied to weak acid dissociable and total cyanide as a conservative limit.

Indicates concentration was greater than the PWQO (Provincial Water Quality Objective) Lowest Effect Level (LEL).

Mean concentrations of aluminum and iron were elevated above PWQOs for the protection of aquatic life at routine water quality monitoring stations located both upstream and downstream of the RRP effluent outfall (Table 4.3). Downstream concentrations of nitrite were elevated relative to both upstream levels and PWQOs, indicative of mine influence (Table 4.3; Appendix Table C.4). However, nitrite was only elevated substance relative to PWQO downstream of the RRP Mine effluent in 2016 and is likely indicative of use of explosives from active blasting during the construction phase of the mine (Table 4.3). As seen in the water samples collected during the EEM study, aluminum and iron are elevated at relative to PWQO at effluent-exposed and reference areas, indicating these substances are naturally elevated within the Pinewood River.

Overall, the RRP Mine effluent is detectable in Pinewood River, through elevated conductivity, hardness, calcium, potassium, and sodium in the effluent-exposed area relative to upstream.

Table 4.3: Summary of Routine Water Quality Data [a], RRP Phase 1 EEM, 2015 to 2017

	Parameters	Units	PWQO [b]	Pinewood River Reference (SW20)			Pinewood River Effluent-exposed (SW22A)		
				2015	2016	2017	2015	2016	2017
Non-metals	Alkalinity	mg/L $CaCO_3$	-	115	113	133	-	159	211
	pH	units	6.5 - 8.5	7.17	7.17	7.25	-	7.64	7.43
	Conductivity	µS/cm	-	254	256	305	-	328	415
	TSS	mg/L	-	3.63	3.40	3.32	-	3.30	4.0
	Nitrite (NO_2)	as N mg/L	0.06	0.001	0.002	0.002	-	0.95 [d]	0.011
	Ammonia (NH_3+NH_4)	as N mg/L	-	0.013	0.054	0.040	-	0.048	0.118
	Mercury (Hg)	mg/L	0.0002	0.000002	0.000003	0.000003	-	0.000003	0.000003
	Hardness	mg/L $CaCO_3$	-	124	127	140	-	172	209
ICP Scan	Aluminium (Al)	mg/L	0.075 [c]	0.177	0.278	0.158	-	0.134	0.122
	Arsenic (As)	mg/L	0.005	0.0011	0.0008	0.0009	-	0.0012	0.0012
	Cadmium (Cd)	mg/L	0.0001 [c]	0.00001	0.00001	0.00001	-	0.00001	0.00001
	Cyanide (CN)	mg/L	0.005			0.001	-	<0.001	0.001
	Cobalt (Co)	mg/L	0.0009	0.0002	0.0004	0.0003	-	0.0004	0.0003
	Copper (Cu)	mg/L	0.005 [c]	0.0008	0.0011	0.0008	-	0.0009	0.0009
	Iron (Fe)	mg/L	0.3	0.55	0.83	0.53	-	0.59	0.44
	Molybdenum (Mo)	mg/L	0.04	0.0003	0.0004	0.0003	-	0.0009	0.0013
	Nickle (Ni)	mg/L	0.025	0.0016	0.0014	0.0014	-	0.0015	0.0015
	Lead (Pb)	mg/L	0.003 [c]	0.0001	0.0002	0.0001	-	0.0001	0.0001
	Selenium (Se)	mg/L	0.001 [a]	0.0002	0.0002	0.0002	-	0.0002	0.0002
	Thallium (Tl)	mg/L	0.0003	0.000003	0.000004	0.000006	-	0.000005	0.000005
	Zinc (Zn)	mg/L	0.02	0.003	0.003	0.010	-	0.002	0.005
Other	Radium-226	Bq/L	1	-	-	<0.01	-	<0.01	<0.01

Concentration exceeds PWQO. (shaded cells)

[a] Mean of monthly samples collected during discharge (n=8 in 2015, n=10 in 2016, and n=11 in 2017).
[b] All guidelines reference Provincial Water Quality Objectives. Ministry of Environment and Energy, July 1994, re-issued in 1999 (OMOEE 1994), with the exception of nitrite and selenium which reference Canadian Water Quality Guidelines for the protection of aquatic life. Canadian Council of Ministers of the Environment, http://st-ts.ccme.ca/, accessed February 2018 (CCME 2018).
[c] Aluminum guideline depends on pH; cadmium, copper and lead guidelines depend on hardness; guidelines in table assume: pH = 7, temperature = 15°C, hardness = 130 mg/L as $CaCO_3$ based on the average background concentration at reference station SW20 (see Appendix Table C.4).
[d] All values but one (March 23, 2016; 5.66 mg/L) are < PWQO, with 3 below the lowest reported level.

5 SEDIMENT QUALITY

5.1 Overview

Sediment samples were collected in the effluent-exposed area of the Pinewood River and the Sturgeon Creek reference area concurrent with benthic invertebrate sampling (Figure 2.1). A total of five stations were sampled within each area as described in Section 2.

5.2 Sediment Composition

The inorganic sediment fraction was composed predominantly of silt (37-69%) and clay (25-41%), with some sand (2-31%; Figure 5.1, and Table 5.1; Appendix Table C.5). There were significant differences between the effluent-exposed and reference areas for total organic carbon, as well as the silt and clay fractions, with significantly more TOC and silt in the effluent-exposed area, and significantly less clay when compared to the reference area (Table 5.1 and Figure 5.1; Appendix Table C.3). All stations had a low proportion of gravel <5% (Table 5.1; Appendix Table C.5).

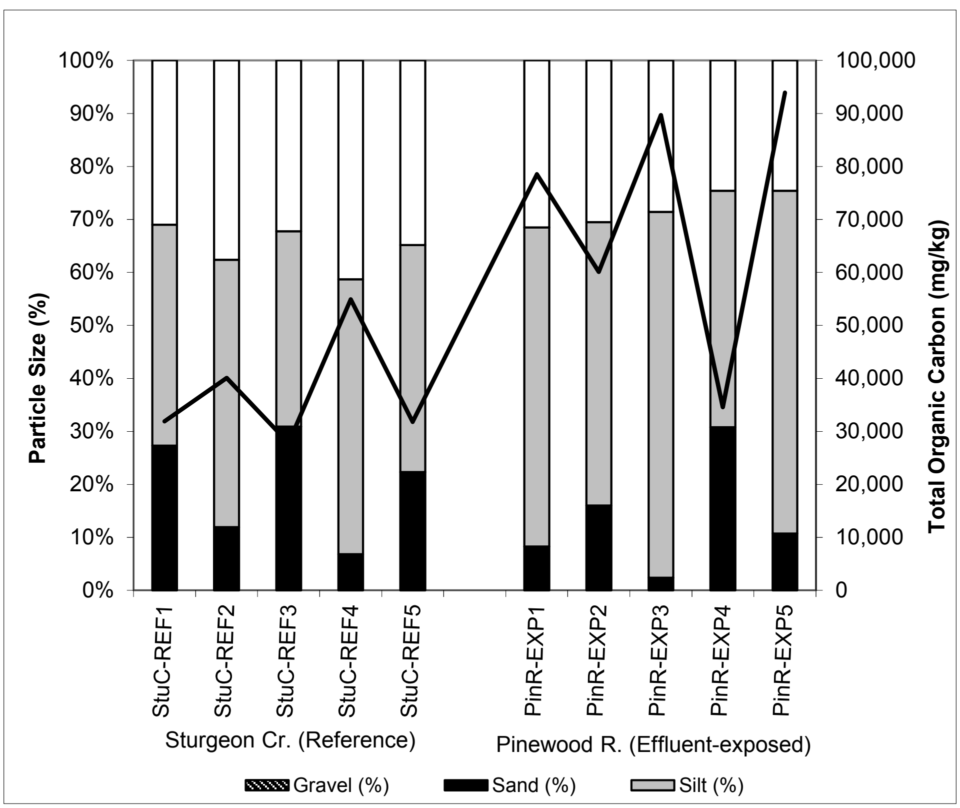


Figure 5.1: Particle Size and Total Organic Carbon Content in Sediments, RRP Phase 1 EEM, September 2017

Table 5.1: **Summary of Sediment Quality (Mean ± Standard Deviation), RRP Phase 1 EEM, 2017**

Parameter	PSQG		Units	Sturgeon Creek (Reference)		Pinewood River (Effluent-exposed)	
	LEL	SEL		Mean	Standard Deviation	Mean	Standard Deviation
Inorganics							
% Moisture	-	-	%	62.7	8.8	74.0	12.5
Total Kjeldahl Nitrogen	0.055	0.48	%	0.276	0.1	0.523	0.2
Total Organic Carbon	10,000	100,000	mg/kg	37,300	10,808	71,360	24,359
% Gravel	-	-	%	<1.0	0.0	<1.0	0.0
% Sand	-	-	%	19.8	10.2	13.6	10.8
% Silt	-	-	%	44.8	6.3	58.4	9.6
% Clay	-	-	%	35.4	4.2	28.0	3.2
Metals							
Aluminum	-	-	mg/kg	13,620	1,675	13,310	2,683
Antimony	-	-	mg/kg	0.11	0.02	0.15	0.03
Arsenic	6	33	mg/kg	2.63	0.48	3.60	1.07
Barium	-	-	mg/kg	87	17	103	27
Beryllium	-	-	mg/kg	0.53	0.06	0.56	0.08
Bismuth	-	-	mg/kg	<0.20	0.0	<0.20	0.0
Boron	-	-	mg/kg	8.2	0.8	9.5	1.9
Cadmium	0.6	10	mg/kg	0.27	0.08	0.35	0.09
Calcium	-	-	mg/kg	6,952	681	14,840	4,343
Chromium	26	110	mg/kg	33.8	7.2	30.6	6.3
Cobalt	-	-	mg/kg	9.9	1.3	9.6	2.5
Copper	16	110	mg/kg	11.6	2.0	15.3	3.7
Iron	20,000	40,000	mg/kg	15,540	2,123	16,920	2,952
Lead	31	250	mg/kg	7.60	1.1	7.72	0.9
Lithium	-	-	mg/kg	16.6	2.3	15.6	2.6
Magnesium	-	-	mg/kg	5,294	551	8,010	2,331
Manganese	460	1,100	mg/kg	346	62	476	151
Mercury	0.2	2	mg/kg	0.048	0.009	0.055	0.006
Molybdenum	-	-	mg/kg	0.84	0.42	0.96	0.42
Nickel	16	75	mg/kg	20.7	4.4	21.7	4.7
Phosphorus	600	2,000	mg/kg	519	42	676	117
Potassium	-	-	mg/kg	1,634	240	1,494	325
Selenium	-	-	mg/kg	0.35	0.1	0.50	0.1
Silver	-	-	mg/kg	<0.10	0.0	<0.10	0.0
Sodium	-	-	mg/kg	96	11	132	29
Strontium	-	-	mg/kg	25.4	3.1	31.8	6.2
Sulphur	-	-	mg/kg	1,100	212	1,620	435
Thallium	-	-	mg/kg	0.159	0.019	0.160	0.029
Tin	-	-	mg/kg	<1.0	0.0	<1.0	0.0
Titanium	-	-	mg/kg	152	6.6	128	20.3
Tungsten	-	-	mg/kg	<0.50	0.0	<0.50	0.0
Uranium	-	-	mg/kg	1.7	0.3	1.7	0.4
Vanadium	-	-	mg/kg	37.0	5.2	36.4	7.2
Zinc	120	820	mg/kg	72	13.4	74	18.0
Zirconium	-	-	mg/kg	6.0	1.0	4.7	0.6

Indicates concentration greater than the PSQG (Provincial Sediment Quality Guideline) Lowest Effect Level (LEL).
Indicates concentration greater than the PSQG (Provincial Sediment Quality Guideline) Severe Effect Level (SEL).

5.3 Sediment Quality

Sediment concentrations of chromium, and nickel were elevated in both the effluent-exposed and reference areas, compared to Provincial Sediment Quality Guideline (PSWQG) Lowest Effect Levels (LEL; Table 5.1; Appendix Table C.5). Additionally, effluent-exposed sediment concentrations of manganese and phosphorus were elevated compared to reference area concentrations and the PSQG LEL (Table 5.1 and Appendix Table C.5). Total organic carbon (TOC) was above the PSQG LEL in both areas, there were no Severe Effects Level (SEL) exceedances except for total Kjeldahl nitrogen (TKN) at the effluent-exposed area, TKN was also greater than LEL at the reference area (Table 5.1).

Principal Components Analysis (PCA) identified arsenic, barium, beryllium, boron, copper, iron, molybdenum, nickel, titanium, vanadium, and zinc as the main analytes distinguishing the effluent-exposed sediment chemistry from that of the reference area along PC-Axis 1 (Appendix Tables C.5 and C.6). Sediment PC-Axis 2 scores were compared between the effluent-exposed and reference areas and largely described the higher sediment concentrations of antimony, calcium, magnesium, phosphorus, selenium, sodium, strontium, and sulphur in the effluent-exposed area, and higher zirconium concentrations in the in the reference area (Appendix Tables C.5 and C.6).

Overall, sediment chemistry was very similar between the effluent-exposed and reference areas, with slightly elevated concentrations of TOC, TKN, manganese, and phosphorus in the effluent-exposed sediments relative to both reference and provincial sediment quality guidelines.

6 BENTHIC INVERTEBRATE COMMUNITY

6.1 Overview

The benthic invertebrate community of the effluent-exposed area on Pinewood River (PinR-EXP) was compared to that of one reference area: on the Sturgeon Creek (StuC-REF; Figure 2.1).

6.2 Primary Metrics

Organism density, taxon richness, and Simpson's evenness (E) did not differ between areas (Table 6.1 and Figure 6.1). Bray-Curtis (B-C) index (distance) at the effluent-exposed area was significantly greater that at the reference area (Table 6.1; Figure 6.1), suggesting community composition differences that are investigated further in the following section.

Table 6.1: Summary of Benthic Invertebrate Community Characteristics and Statistical Comparisons Between Areas, RRP Phase 1 EEM, 2017

Type	Benthic Community Metric	Significantly Different? (effect size expressed as # reference area standard deviations) [a]
		StuC Reference vs PinR Effluent-exposed
Metrics for evaluating effect under MMER (Family Level)	Density (Ind./m^2)	No
	Number of Taxa	No
	Simpson's E	No
	B-C Distance	**Yes (6.7)**
Supporting Metrics	Oligochaeta (%)	No
	Ephemeroptera (%)	No
	Tichoptera (%)	No
	Chaoboridae (%)	**Yes (-1.8)**
	Chironomids (%)	No
	Bivalvia (%)	No
	CA Axis-1 (26.5%)	**Yes (2.8)**
	CA Axis-2 (25.6%)	No
	CA Axis-3 (17.9%)	No

[a] Where a statistically significant difference was found, the value represents the number of standard deviations and direction of change (positive or negative) by which the exposure area differed from reference.

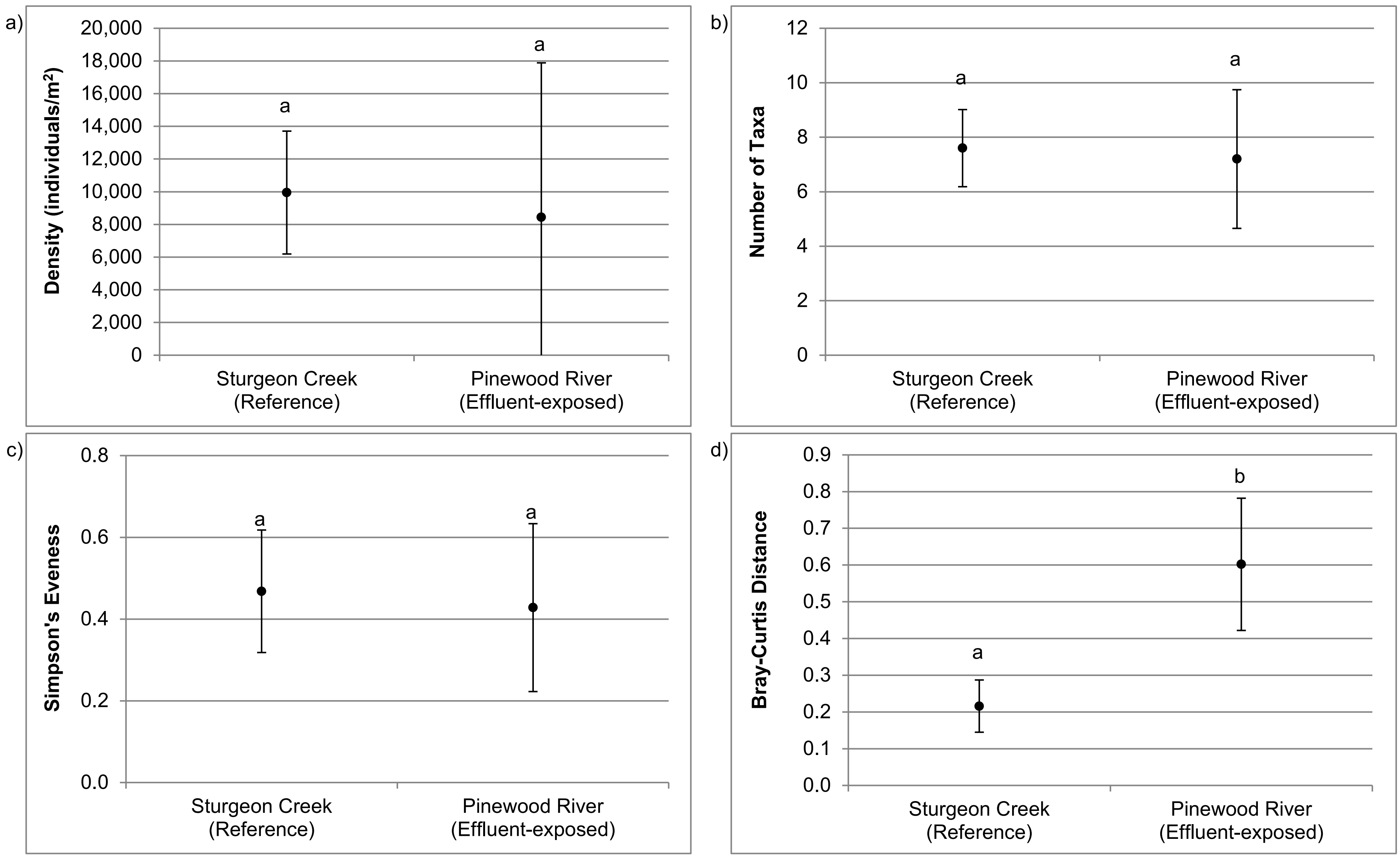


Figure 6.1: Comparison of: a) Benthic Invertebrate Density, b) Number of Taxa, c) Simpson's Evenness and d) Bray-Curtis Distance to Reference Median, RRP Phase 1 EEM, 2017

Data Represent Area Means and 95% Confidence Intervals (n=5 in all areas). Areas with the Same Letter do not Differ Significantly (p>0.1).

6.3 Taxon Group Composition

Benthic community composition was assessed based on percent representation of major taxon groups to highlight any differences between exposed and reference areas and their environmental significance. Chironomids and Oligochaeta showed comparable percent abundances between areas (Figure 6.2 and Table 6.1; Appendix Tables D.3 to D.5). The pollution-intolerant EPT (Ephemeroptera, Plecoptera[3], and Trichoptera) taxa were found in very low abundances in both the reference and effluent-exposed areas which is likely a result of the nature of the habitat found in these areas (i.e. low flow depositional areas; Table 6.1; Appendix Table D.4). Overall, community composition of the effluent-exposed area was similar to reference with no compelling evidence of an effluent-related effect.

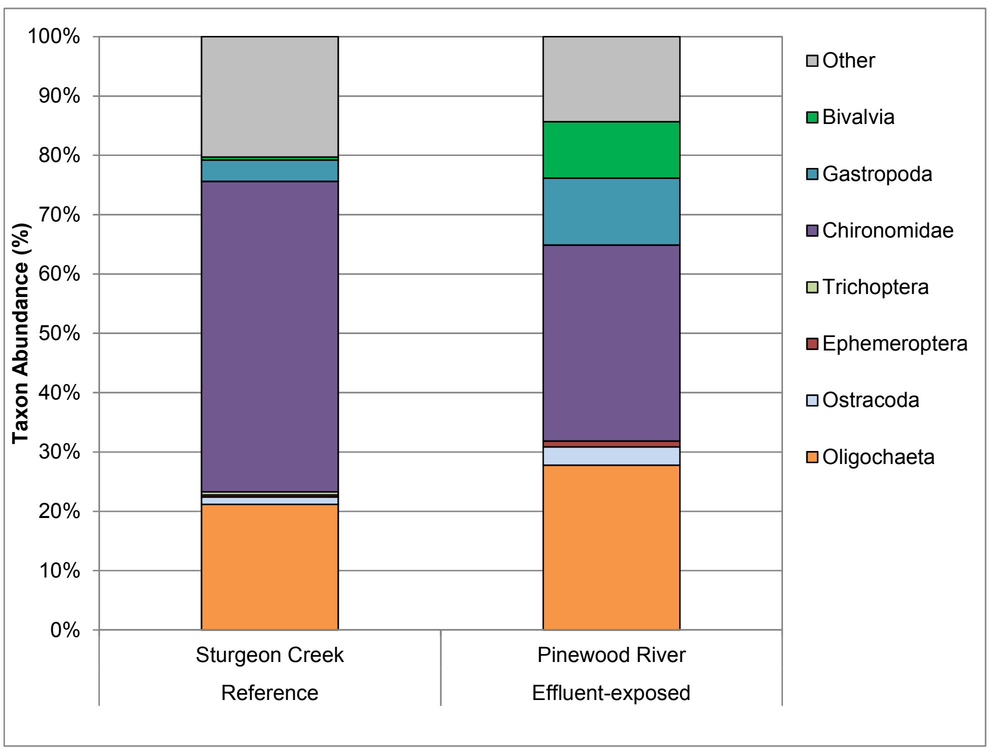


Figure 6.2: Percent Composition of Dominant Benthic Groups, RRP Phase 1 EEM, 2017

Correspondence Analysis (CA) was also used to examine community composition. Unlike the B-C distance metric and Simpson's Indices, this multivariate technique can identify the individual taxa that most contribute to community variation. In the present study, CA explained 52.1% of the total community variance in the first two CA axes and differed between areas (Figure 6.3 and

[3] Plecoptera (stoneflies), were not found at either area.

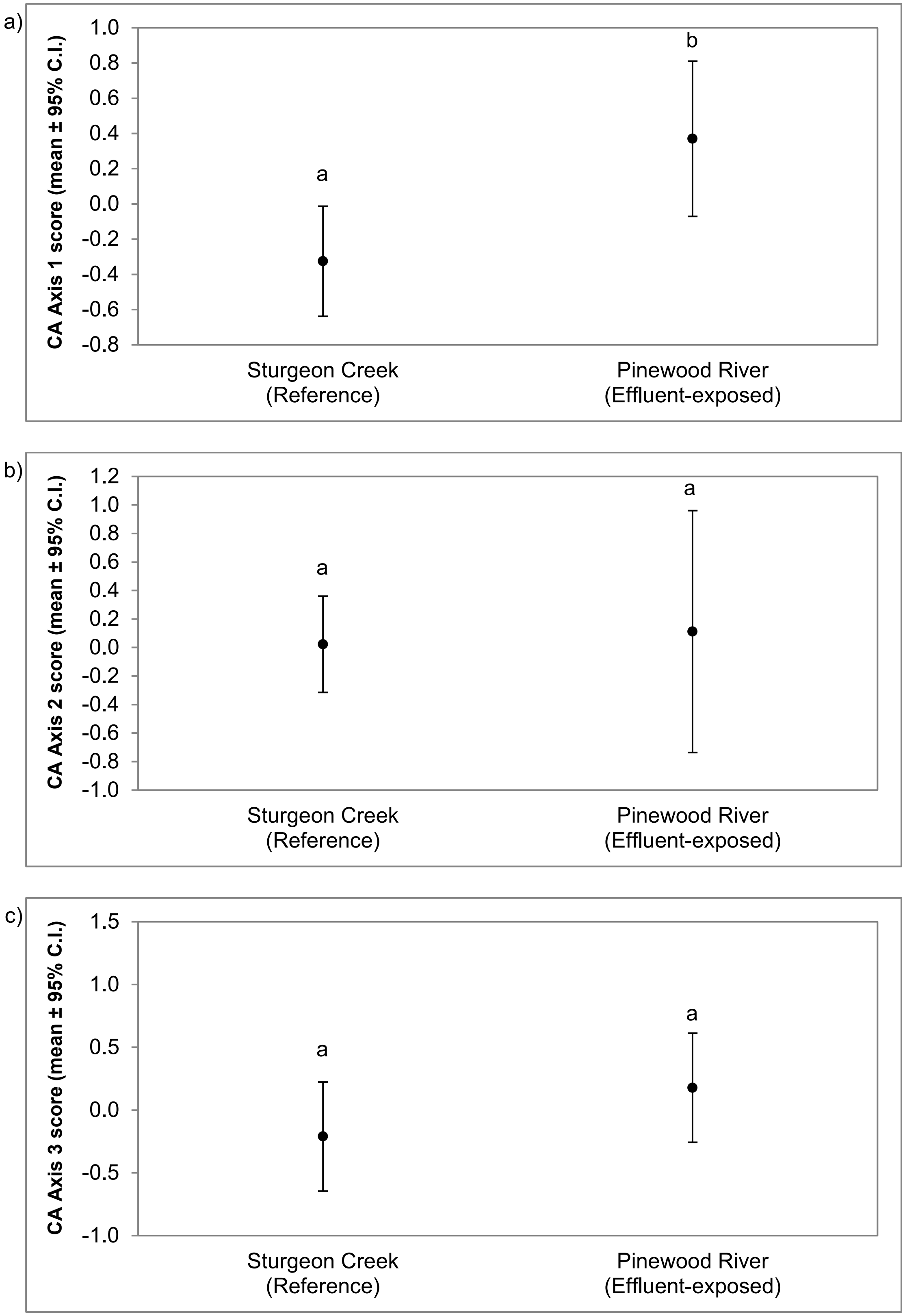


Figure 6.3: Results of Correspondence Analysis of Benthic Invertebrate Communities, RRP Phase 1 EEM, 2017

Note: Areas with the same letter do not differ significantly.

Table 6.1; Appendix Tables D.6 and D.7). CA axis-2 and -3 showed no difference between areas, (Figure 6.3 and Table 6.1). This was largely due to the presence of harpacticoids[4] in the reference area, but absence from the effluent-exposed area, as well as the presence of the snail family Hydrobiidae and bivalve Sphaeriidae at the effluent-exposed area, and absence from the reference area (Figure 6.4 and Appendix Table D.7).

In general, the Sturgeon Creek reference area demonstrated less within area variability relative to the Pinewood River effluent-exposed area (Figure 6.4). The effluent-exposed area and Sturgeon Creek reference area had a statistically different community structure as defined by CA axis-1.

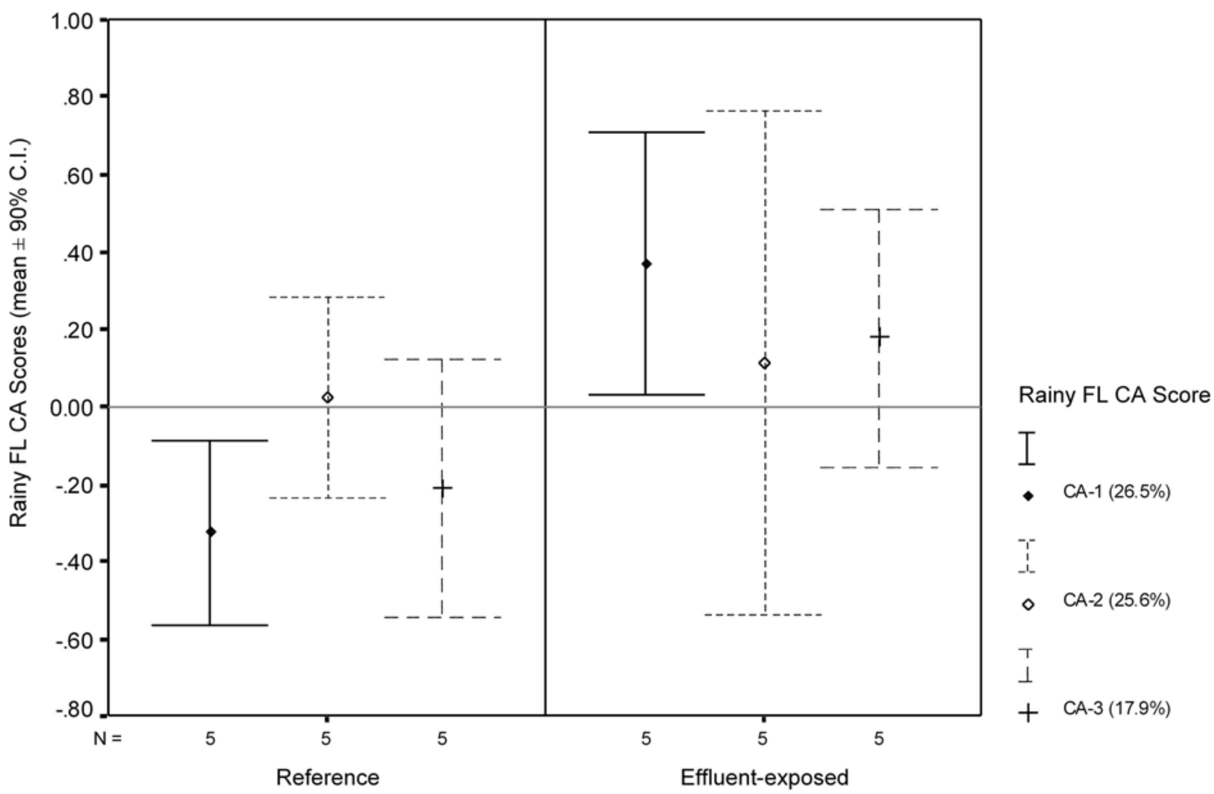


Figure 6.4: **Family Level (FL) Correspondence Analysis (CA) Scores at RRP Phase 1 EEM, 2017**

[4] Due to their small size harpacticoids can sometimes be lost in the screening process, and because they are commonly found attached to algae or other organic material organism retention can vary with substrate type. Substrate type and volumes of organic material in samples did not vary between exposure and reference areas and therefore it is unlikely that any variation in harpacticoid abundances between areas is the result of loss during screening.

6.4 Influence of Physico-Chemical Variables

Correlation analysis was performed between benthic indices and supporting physico-chemical variables that demonstrated statistically significant differences between areas. A statistically significant correlation between two variables may, but does not necessarily, indicate a cause-and-effect relationship. Three correlations were significant at an adjusted p-level that accounted for the number of comparisons made ($p = 0.05/70 = 0.00071$; Table 6.2). After inspection of data distributions in scatter plots (Appendix Figure D.1a, b, and c), the significant correlations appear to be due to spatial autocorrelation of replicates within areas and is likely not a function of effluent related effects.

6.5 Summary

In summary, the effluent-exposed area was similar to the reference area concerning three EEM metrics for the current EEM Phase, these are density, Simpson's evenness, and taxon richness. The sole EEM benthic endpoint that differed significantly between the effluent-exposed and reference areas is the Bray-Curtis Index. In addition, the community structure as defined by CA differed significantly between the effluent exposed and reference areas. This difference may be attributed to variations between the sampling areas such as stream width: the Sturgeon Creek reference area is much smaller compared to that of the effluent-exposed area, as well as extensive beaver activity in the vicinity of the effluent-exposed area, these habitat differences may result in certain families being present in one area but not in the other (i.e. Chaoboridae), as they are found in the reference area in relatively high abundances, but have very little representation in the effluent-exposed area (Appendix Table D.2).Therefore these differences are likely a result of dissimilarities in habitat between the effluent-exposed and reference areas, rather than a direct effluent effect.

Table 6.2: Correlations Between Benthic Metrics that were Significantly ($p < 0.05$) Different Between Areas with Environmental Supporting Measurements that were also Significantly ($p < 0.05$) Different Between Areas, RRP Phase 1 EEM, 2017

		Temperature (°C; bottom)	pH (bottom)	Conductivity (µS/cm; bottom)	Specific Conductance (µS/cm; bottom)	Total Kjeldahl Nitrogen (%)	FOC (log10 [mg/g])	Total Organic Carbon (%)	% Silt (%)	% Clay (%)	Sediment Metal PC-2 (16.2%)
LPL BC Dissimilarity	Pearson Correlation	-0.85440	-0.49703	0.90509	0.88954	0.50572	0.51802	0.49685	0.52204	-0.64874	-0.84160
	Sig. (2-tailed)	0.00164	0.14387	0.00032	0.00057	0.13590	0.12508	0.14404	0.12167	0.04243	0.00227
LPL CA-1 (29.0%)	Pearson Correlation	-0.63709	-0.26911	0.70681	0.68104	0.57110	0.53488	0.52611	0.61917	-0.40359	-0.63151
	Sig. (2-tailed)	0.04758	0.45213	0.02229	0.03015	0.08463	0.11115	0.11827	0.05628	0.24745	0.05018
FL BC Dissimilarity	Pearson Correlation	-0.84069	-0.45257	0.89404	0.87508	0.45838	0.46050	0.44692	0.47844	-0.67752	-0.83840
	Sig. (2-tailed)	0.00231	0.18907	0.00048	0.00091	0.18274	0.18046	0.19535	0.16187	0.03135	0.00244
FL CA-1 (26.5%)	Pearson Correlation	-0.75944	-0.39454	0.74536	0.73859	0.31493	0.32570	0.33601	0.35219	-0.69490	-0.76675
	Sig. (2-tailed)	0.01083	0.25920	0.01335	0.01469	0.37544	0.35843	0.34249	0.31824	0.02572	0.00967
% Chaoboridae	Pearson Correlation	0.74903	0.47442	-0.80052	-0.79027	-0.45897	-0.48096	-0.45935	-0.43950	0.57467	0.75556
	Sig. (2-tailed)	0.01266	0.16594	0.00540	0.00652	0.18211	0.15936	0.18170	0.20377	0.08227	0.01149

correlation suggestive; $p < 0.05$ (NOT adjusted for False Discovery Rate)

correlation scatterplot inspected: $p < 0.0100$

significant; $p < 0.00071$ ($p = 0.05$ adjusted for 70 comparisons)

Note: n = 10 for all correlations

7 FISH COMMUNITY SURVEY

7.1 Overview

Fish were sampled from the effluent-exposed area on the Pinewood River, as well as a reference area on Sturgeon Creek (Figure 2.1). Brook stickleback and central mudminnow were sampled from both the reference and effluent-exposed areas. Detailed data are provided in Appendix E.

7.2 Fish Community

Fish communities were evaluated in two areas: the effluent-exposed area of the Pinewood River, and the Sturgeon Creek reference area (Figure 2.1). A total of eleven species were caught in the two areas, with the greatest diversity found in the effluent-exposed area (Table 7.1; Appendix Tables E.1 to E.3).

Table 7.1: Summary of Fish Caught in the Sturgeon Creek Reference and the Effluent-exposed Areas, RRP Phase 1 EEM, 2017

Species	Sturgeon Creek (Reference)	Pinewood River (Effluent-exposed)
Total No. of Species	**7**	**11**
Sentinel Species		
Brook stickleback	224	1,757
Central mudminnow	100	81
Other		
Brown bullhead	-	1
Brassy minnow	6	91
Creek chub	11	-
Dace spp.	-	104
Finescale dace	2	3
Johnny darter	-	2
Lake chub	3	10
Pearl dace	-	4
Northern redbelly dace	48	27
White sucker	-	9
Total Fish Caught	**394**	**2,089**

Pinewood River supports a variety of fish species, ranging from the large-bodied species such as northern pike (*Esox lucius*), walleye (*sander vitreus*), and white sucker (*Catostomus* *commersonii*), to a number of small-bodied species (Table 7.1). During the spring sampling, brook stickleback were the most abundant species found in both sampling areas (Table 7.1). Brown bullhead (*Ameiurus natalis*), johnny darter (*Etheostoma nigrum*), pearl dace (*Margariscus margarita*), and white sucker were only observed in the Pinewood River whereas creek chub (*Semotilus atromaculatus*) were only found in Sturgeon Creek. Overall, species composition was similar between areas, with the fish community predominantly being made up of brook stickleback, central mudminnow, and northern redbelly dace (*Chrosomus eos*).

Overall catch-per-unit-effort (CPUE) for seines (# fish/m^3), minnow traps (# fish/trap day) and backpack electrofishing (#fish/ minute) were highest in the Pinewood River effluent-exposed area (Table 7.2). Minnow trapping was the most effective method employed during the spring survey (Table 7.2).

Brook stickleback CPUE for minnow trapping was highest in the effluent-exposed and central mudminnow CPUE was highest at the reference area (Table 7.2).

Overall, no major differences in community composition were observed among areas although the effluent-exposed area of the Pinewood River supported the highest species diversity.

7.3 Brook Stickleback

Twenty three female brook stickleback from the Pinewood River (effluent-exposed) and 23 from Sturgeon Creek reference area were collected during the Phase 1 spring fish survey (Appendix Tables E.4 and E.5). In addition, 21 male brook stickleback from the Pinewood River (effluent-exposed), and 22 from the Sturgeon Creek reference area were collected (Appendix Tables E.6 and E.7). All collected brook stickleback were subject to measurements needed to calculate the required EEM metrics, which were summarized by sex and area (Appendix Tables E.4 to E.7).

7.3.1 Female Brook Stickleback

Female brook stickleback from the Pinewood River effluent-exposed and Sturgeon Creek reference areas were of similar age (Figure 7.1a and Table 7.3). Females captured in both areas were predominantly one year old (Figure 7.1a; Appendix Tables E.4 and E.5). Accordingly, there was insufficient age distribution for analysis of body weight at age (Appendix Tables E.4 and E.5).

Gonad size relative to adjusted body weight was significantly larger in female brook stickleback captured in the Pinewood River than in those from Sturgeon Creek, with the magnitude of difference greater than the applicable critical effect size (CES) of ±25% (Table 7.3 and Figure 7.2; Appendix Tables E.4 and E.5). Egg weight relative to adjusted body weight was significantly smaller in effluent-exposed females compared to reference females, however the magnitude of difference was very small (0.13%) and is not ecologically meaningful. These data indicated that

Table 7.2: Catch-per-unit-effort (CPUE) Summary for Sentinel Fish Caught during the RRP Phase 1 EEM, Arpil 2017

a) CPUE by Seine [a]

Location	Total Effort (Area m^2)	Brook Stickleback CPUE	Central Mudminnow CPUE	Total Sentinel Species	
				Catch	CPUE
Sturgeon Creek Reference	0	0	0	0	0
Pinewood River Effluent-exposed	221	1.70	0.06	389	1.76

b) CPUE by Minnow Trap [b]

Location	Effort (Trap Days)	Brook Stickleback CPUE	Central Mudminnow CPUE	Total Sentinel Species	
				Catch	CPUE
Sturgeon Creek Reference	22	10.20	4.55	324	14.73
Pinewood River Effluent-exposed	80	17.30	0.60	1,429	17.91

c) CPUE by Backpack Electrofishing [c]

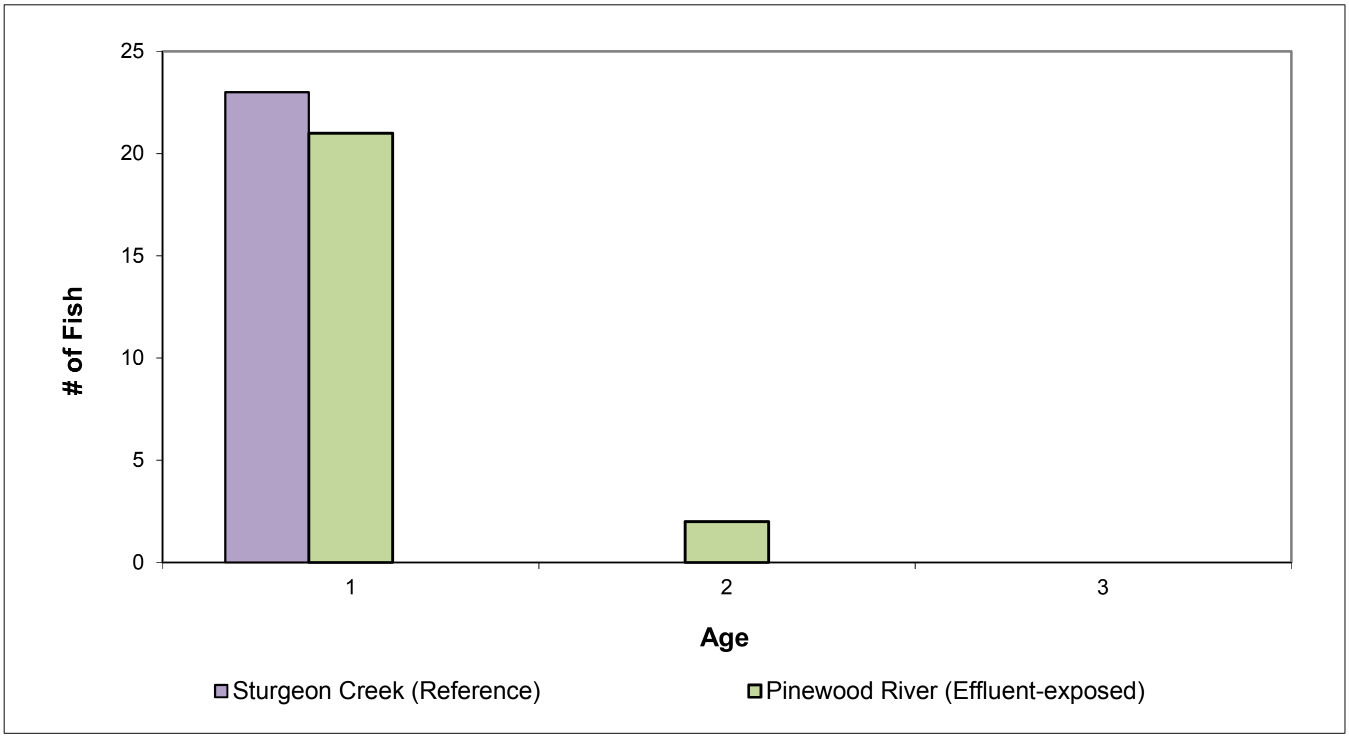
Location	Effort (Seconds)	Brook Stickleback CPUE	Central Mudminnow CPUE	Total Sentinel Species	
				Catch	CPUE
Sturgeon Creek Reference	0	0	0	0	0
Pinewood River Effluent-exposed	756	0	1.60	20	1.59

[a] Seine netting CPUE based on number of fish caught per area seined (m^2) (# of fish/m^2).

[b] Minnow trapping CPUE based on number of fish caught per trap day (24 hours) per trap (# of fish/trap/day).

[c] Backpack electrofishing CPUE based on number of fish caught per minute (# of fish/minute).

a)



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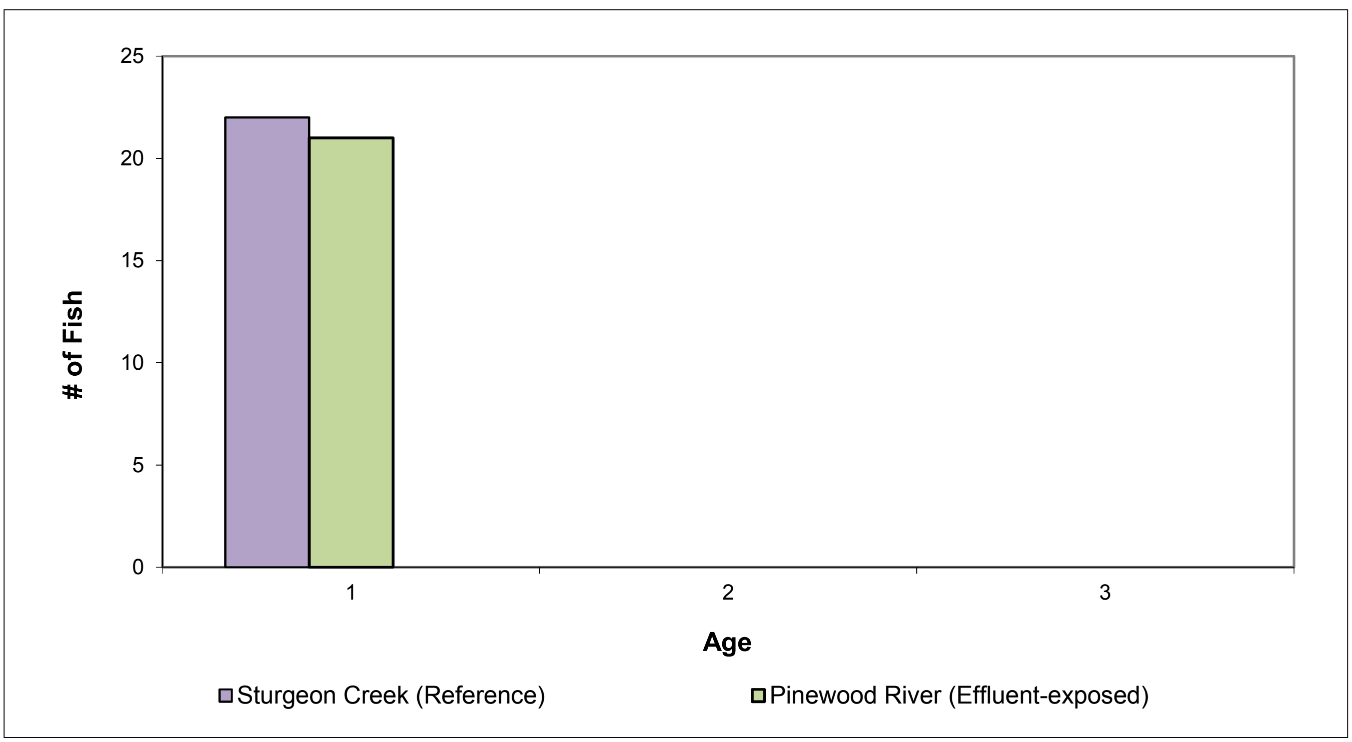


Figure 7.1: Age frequency Distributions of a) Female and b) Male Brook Stickleback in Sturgeon Creek and Pinewood River, RRP Phase 1 EEM, April 2017

Table 7.3: Statistical Comparisons For Brook Stickleback Health Endpoints For Pinewood River (Effluent-exposed) Compared to Sturgeon Creek (Reference) Areas,RRP Phase 1 EEM, 2017

Sex	Indicator	Endpoint	Variables: Response	Variables: Covariate	Sample Size: Reference (Sturgeon)	Sample Size: Effluent-exposed (Pinewood)	Test	ANCOVA Model Statistics: Interaction Model (Interaction p-value)	ANCOVA Model Statistics: Parallel Slope Model (Covariate p-value)	ANCOVA Model Statistics: Covariate Value for Comparisons[a]	Summary Statistics[b]: Statistic	Summary Statistics[b]: Reference Area	Summary Statistics[b]: Effluent-exposed Area	Test P-value (Location)	Magnitude of Difference (%)[c]: Effluent-exposed	Estimated Minimum Detectable Difference (% Relative to Reference) with α=β=0.1: Decrease	Estimated Minimum Detectable Difference (% Relative to Reference) with α=β=0.1: Increase
Female	Energy Usage	Relative Gonad Weight	log[Gonad Weight (g)]	log[Adjusted Body Weight (g)]	23	22	ANCOVA	0.962	<0.001	0.797	Adjusted Mean	0.0308	0.0892	<0.001	190	-28	39
		Egg Weight	log[Egg Weight (mg)]	log[Adjusted Body Weight (g)]	23	22	$\text{T-test}_{unequal}$	0.639	0.109	-	Geometic Mean	0.989	0.990	<0.001	0.13	-0.072	0.072
					23	18[d]	$\text{T-test}_{unequal}$	0.995	0.086	-	Geometic Mean	0.989	0.990	<0.001	0.10	-0.046	0.046
		Relative Fecundity	log[Fecundity]	log[Adjusted Body Weight (g)]	23	22	ANCOVA	0.524	0.035	0.797	Adjusted Mean	1,914	1,599	0.197	-16	-33	50
					23	18[d]	ANCOVA	0.899	<0.001	0.788	Adjusted Mean	1,908	2,051	0.274	7.5	-19	23
	Energy Storage	Relative Liver Weight	log[Liver Weight (g)]	log[Adjusted Body Weight (g)]	23	22	ANCOVA	0.068	<0.001	0.797	Adjusted Mean	0.0291	0.0708	<0.001	144	-18	22
		Condition	log[Adjusted Body Weight (g)]	log[Total Length (mm)]	23	22	ANCOVA	0.856	<0.001	46.8	Adjusted Mean	0.745	0.856	<0.001	15	-6.6	7.1
Male	Energy Usage	Relative Gonad Weight	log[Gonad Weight (g)]	log[Adjusted Body Weight (g)]	22	21	ANCOVA	0.378	0.004	0.882	Adjusted Mean	0.00305	0.00286	0.679	-6.3	-35	54
	Energy Storage	Relative Liver Weight	log[Liver Weight (g)]	log[Adjusted Body Weight (g)]	22	21	ANCOVA	0.827	<0.001	0.882	Adjusted Mean	0.0245	0.0380	<0.001	55	-26	34
		Condition	log[Adjusted Body Weight (g)]	log[Total Length (mm)]	22	21	ANCOVA	0.487	<0.001	47.2	Adjusted Mean	0.800	0.977	<0.001	22	-7.2	7.8

Location P-value < 0.1 or Interaction P-value < 0.05

Magnitude of Difference > 25% (or > 10% for Condition), EEM effect endpoints only.

Covariate P-value > 0.05

Note: Three large fish had high leverage on the regressions so these observations were removed from the ANCOVAs

[a] The mean value of the covariate (that corresponds to the adjusted means for the response variable) for the parallel slope ANCOVA model or the minimum and maximum values of the overlap in covariate values for the interaction ANCOVA model.

[b] The median, mean, and adjusted mean are reported for Mann-Whitney, t-test and ANCOVA, respectively, and the predicted values of the regression line equations for minimum and maximum values of the covariate (where the data sets overlap) for ANCOVAs where a significant interaction (i.e., different slopes) occurs.

[c] The magnitude of difference calculated as: [(exposed area mean - reference area mean) /reference area mean] x 100. When there is a significant interaction in the ANCOVA, the magnitude of difference is calcaulated at the minimum and maximum values of overlap in covariate values as as: [(exposed area predicted value - reference area predicted value) / reference area predicted value] x 100.

[d] Four fish from Pinewood River had large egg weights and lower fecundity. The results of the analyses for egg weight and fecundity are shown for the datasets that include and exclude these four fish.

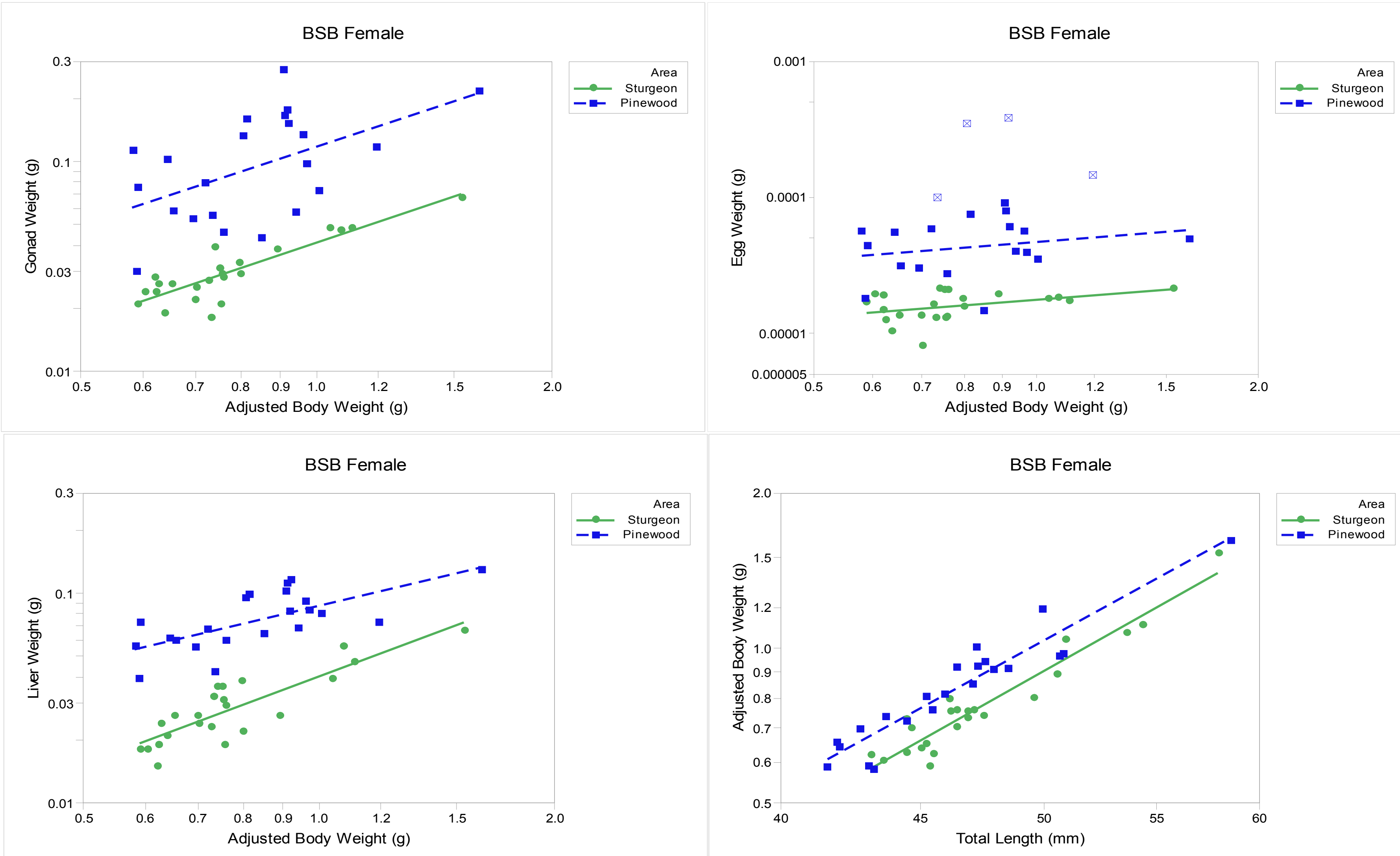


Figure 7.2: Scatterplot and Linear Regressions For Female Brook Stickleback Health Endpoints For Pinewood River (Effluent-exposed) Compared to Sturgeon Creek (Reference), RRP Phase 1 EEM, 2017

Notes: outliers are plotted as open symbols with an × through them

Pinewood River females had proportionately larger ovaries compared to those at Sturgeon Creek, suggesting greater energy allocation towards reproduction in the Pinewood River female brook stickleback population. Relative liver size and body condition of female brook stickleback from the Pinewood River were both significantly greater than those captured at Sturgeon Creek, with the magnitude of difference for both endpoints outside of the applicable CES (± 25% for liver weight and ±10% for condition; Table 7.3 and Figure 7.2). There were low incidences of abnormalities noted for both areas. These data indicate that Pinewood River females devote more resources to energy storage than those from the Sturgeon Creek, possibly indicative that food resources available to brook stickleback at Pinewood River differed from resources available at Sturgeon Creek.

Overall, female brook stickleback collected at Pinewood River effluent-exposed area showed no difference in age, but significantly larger relative gonad size, larger relative liver weight, and higher condition compared to those captured at Sturgeon Creek.

7.3.2 Male Brook Stickleback

Male brook stickleback from the Pinewood River effluent-exposed area did not differ in age relative to those from the Surgeon Creek reference (Figure 7.1b). Males captured in both areas were all one year old (Figure 7.1b; Appendix Tables E.6 and E.7).

Gonad weight relative to adjusted body weight was similar between effluent-exposed male brook stickleback and Sturgeon Creek reference males (Table 7.3; Appendix Tables E.6 and E.7). Relative liver size and body condition of male brook stickleback were both significantly greater than those captured at Sturgeon Creek, with the magnitude of difference for both endpoints outside the CES (Table 7.3 and Figure 7.3; Appendix Tables E.6 and E.7). Similar to the female brook stickleback, there was a very low occurrence of abnormalities noted.

Overall, male brook stickleback collected at Pinewood River showed no difference in age, but significantly larger livers and body condition compared to those captured at Sturgeon Creek. The survival (age) and energy storage responses of male brook stickleback were very similar to those of females between Pinewood River and Sturgeon Creek. These responses may have reflected differences of food resources/assemblages, and/or differential energy allocation between Pinewood River and the Sturgeon Creek reference area.

7.4 Central Mudminnow

Twenty-one female central mudminnow from Pinewood River (effluent-exposed) and 22 from the Sturgeon Creek were collected during the Phase 1 spring fish survey (Appendix Tables E.8 and E.9). In addition, 22 male central mudminnow from Pinewood River (effluent-exposed) and 22 males from Sturgeon Creek were collected (Table 7.4; Appendix Tables E.10 to E.11). All

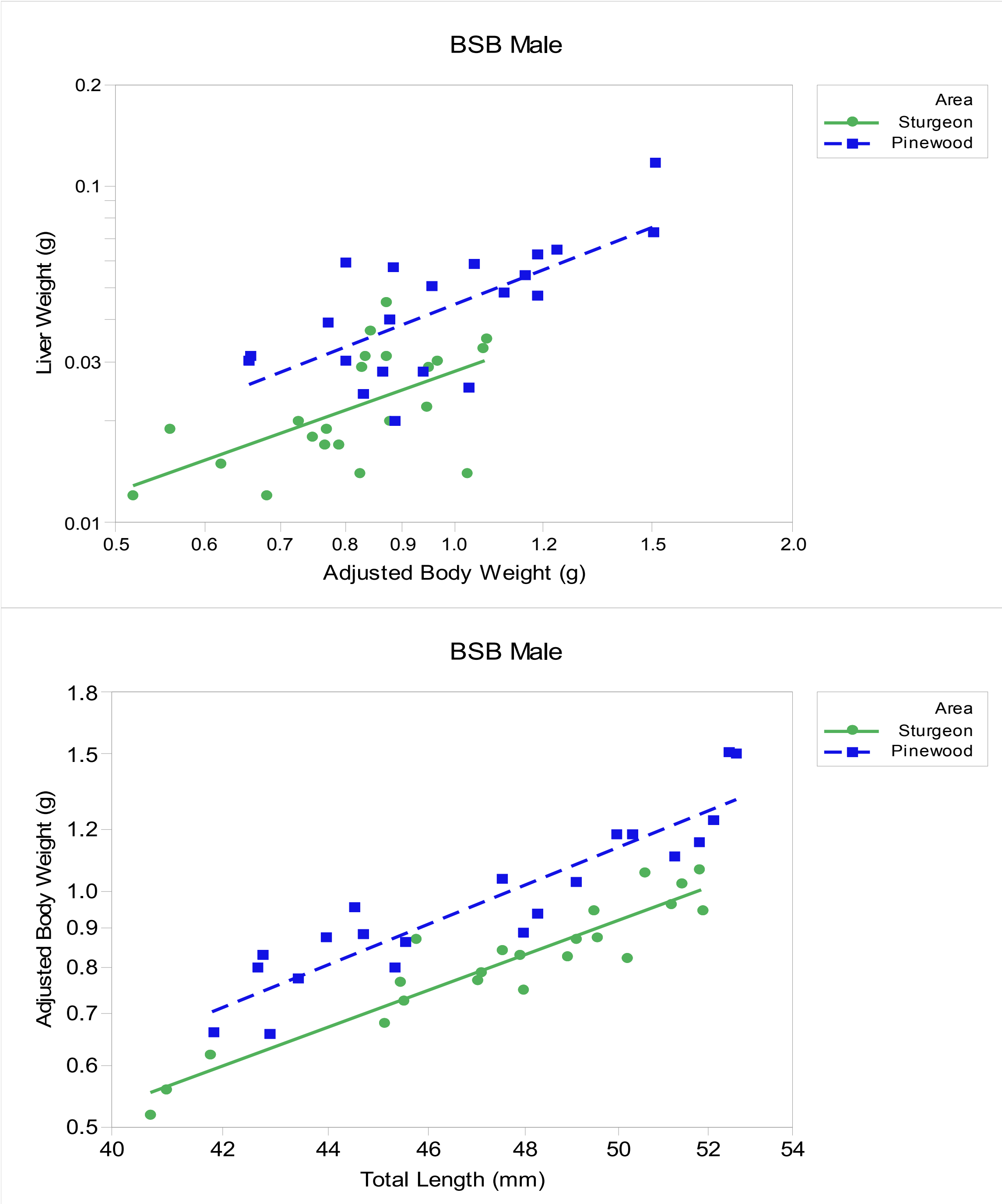


Figure 7.3: Scatterplot and Linear Regressions For Male Brook Stickleback Health Endpoints For Pinewood River (Effluent-exposed) Compared to Sturgeon Creek (Reference), RRP Phase 1 EEM, 2017

Notes: outliers are plotted as open symbols with an × through them

Table 7.4: Statistical Comparisons For Central Mudminnow Health Endpoints For Pinewood River (Effluent-exposed) Compared to Sturgeon Creek (Reference) Areas, RRP Phase 1 EEM, 2017

Sex	Indicator	Endpoint	Variables		Sample Size		Test	ANCOVA Model Statistics			Summary Statistics[b]			Test P-value (Location)	Magnitude of Difference (%)[c]	Estimated Minimum Detectable Difference (% Relative to Reference) with α=β=0.1	
			Response	Covariate	Reference Sturgeon	Effluent-exposed Pinewood		Interaction Model Interaction P-value	Parallel Slope Model Covariate p-value	Covariate Value for Comparisons[a]	Statistic	Reference Area	Effluent-exposed Area		Effluent-exposed	Decrease	Increase
Female	Survival	Age	Age (years)	-	22	21	M-W	-	-	-	Median	2	2	0.978	0	-38	38
	Energy Usage	Weight-at-age (Age 1 and 2 fish)	log[Adjusted Body Weight (g)]	Age	20	19	ANCOVA	0.052	<0.001	1	Predicted Mean	2.418	3.687	0.043	53	-33	50
										2		6.589	5.853		-11.2		
		Length-at-age (Age 1 and 2 fish)	log[Total Length (mm)]	Age	20	19	ANCOVA	0.038	<0.001	1	Predicted Mean	70.44	70.03	0.892	-0.6	-12	13
										2		90.64	90.12		-0.6		
		Relative Gonad Weight	log[Gonad Weight (g)]	log[Adjusted Body Weight (g)]	22	21	ANCOVA	0.955	<0.001	5.15	Adjusted Mean	0.496	0.677	0.016	37	-31	45
		Egg Weight	log[Egg Weight (mg)]	log[Adjusted Body Weight (g)]	22	21	ANCOVA	0.991	0.001	5.15	Adjusted Mean	0.993	0.994	0.004	0.038	-0.037	0.037
		Relative Fecundity	log[Fecundity]	log[Adjusted Body Weight (g)]	22	21	ANCOVA	0.901	<0.001	5.15	Adjusted Mean	460	428	0.292	-7.0	-18	22
	Energy Storage	Relative Liver Weight	log[Liver Weight (g)]	log[Adjusted Body Weight (g)]	22	21	ANCOVA	0.301	<0.001	5.15	Adjusted Mean	0.139	0.158	0.022	14	-15	18
		Condition	log[Adjusted Body Weight (g)]	log[Total Length (mm)]	22	21	ANCOVA	0.382	<0.001	84.3	Adjusted Mean	4.92	5.40	<0.001	9.7	-6.8	7.3
Male	Survival	Age	Age (years)	-	22	22	M-W	-	-	-	Median	1	1	0.356	0	-31	31
	Energy Usage	Weight-at-age (Age 1 and 2 fish)	log[Adjusted Body Weight (g)]	Age	20	19	ANCOVA	0.969	<0.001	1	Predicted Mean	2.102	2.257	0.618	7	-34	51
										2		5.051	5.423		7.3		
		Length-at-age (Age 1 and 2 fish)	log[Total Length (mm)]	Age	20	19	ANCOVA	0.908	<0.001	1	Predicted Mean	62.07	61.77	0.913	-0.48	-12	14
										2		82.38	81.98		-0.48		
		Relative Gonad Weight	log[Gonad Weight (g)]	log[Adjusted Body Weight (g)]	22	22	ANCOVA	0.895	<0.001	3.17	Adjusted Mean	0.0460	0.0429	0.554	-6.7	-29	42
	Energy Storage	Relative Liver Weight	log[Liver Weight (g)]	log[Adjusted Body Weight (g)]	22	22	ANCOVA	0.282	<0.001	3.17	Adjusted Mean	0.0454	0.0703	<0.001	55	-24	31
		Condition	log[Adjusted Body Weight (g)]	log[Total Length (mm)]	22	22	ANCOVA	0.126	<0.001	69.8	Adjusted Mean	3.01	3.35	<0.001	11	-5.9	6.3

Location P-value < 0.1 or Interaction P-value < 0.05

Magnitude of Difference > 25% (or > 10% for Condition), EEM effect endpoints only.

Covariate P-value > 0.05

[a] The mean value of the covariate (that corresponds to the adjusted means for the response variable) for the parallel slope ANCOVA model or the minimum and maximum values of the overlap in covariate values for the interaction ANCOVA model.

[b] The median, mean, and adjusted mean are reported for Mann-Whitney, t-test and ANCOVA, respectively, and the predicted values of the regression line equations for minimum and maximum values of the covariate (where the data sets overlap) for ANCOVAs where a significant interaction (i.e., different slopes) occurs.

[c] The magnitude of difference calculated as: [(exposed area mean - reference area mean) /reference area mean] x 100. When there is a significant interaction in the ANCOVA, the magnitude of difference is calcaulated at the minimum and maximum values of overlap in covariate values as as: [(exposed area predicted value - reference area predicted value) / reference area predicted value] x 100.

collected central mudminnow were subject to measurements needed to calculate the required EEM metrics, which were summarized by sex and area (Appendix Tables E.8 to E.11).

7.4.1 Female Central Mudminnow

Female central mudminnow from the effluent-exposed area did not differ in age relative to those from Sturgeon Creek (Figure 7.4a and Table 7.4). Effluent-exposed female central mudminnow ranged from age 1 to 4 years and the Sturgeon Creek females ranged from 1 to 3 years (Figure 7.4a; Appendix Tables E.8 and E.9).

Growth, as assessed using adjusted body weight-at-age was significantly greater for females captured at Pinewood River when comparing one year olds, but two year old females were slightly smaller and therefore the results are equivocal (Table 7.4 and Figure 7.5).

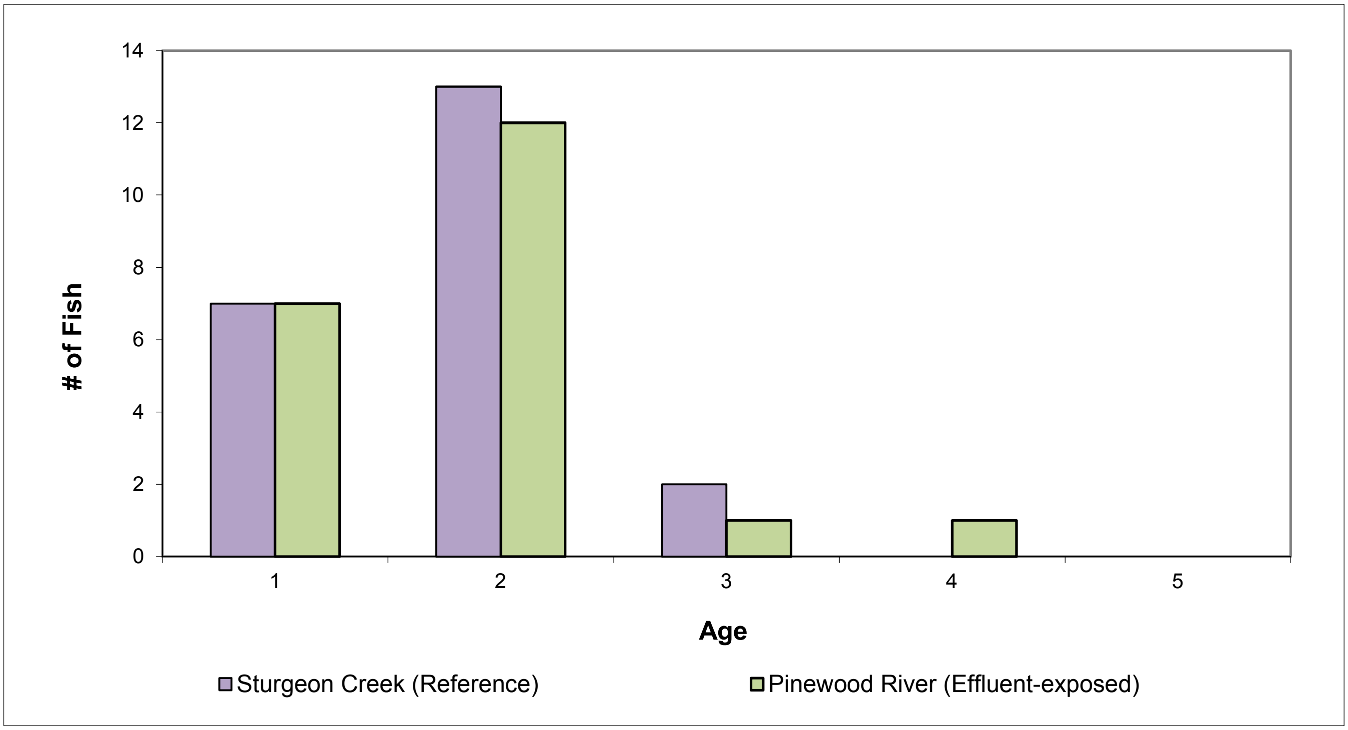
Relative gonad size and egg weight were both significantly larger in female central mudminnow captured in the Pinewood River than at Sturgeon Creek, with the magnitude of difference outside of applicable CES for overall gonad weight but not for egg weight, with egg weights being effectively identical (Table 7.4 and Figure 7.5; Appendix Tables E.8 and E.9). These data indicated that Pinewood River females possessed proportionally larger ovaries at a given body weight compared to those at Sturgeon Creek, suggesting greater energy allocation towards reproduction. Relative liver size and body condition of female central mudminnow captured at Pinewood River were both significantly greater than those captured at Sturgeon Creek, however the magnitude of difference for both were within the applicable CES suggesting that they may not be ecologically meaningful (Table 7.4 and Figure 7.5; Appendix Tables E.8 and E.9).

Overall, female central mudminnow collected at Pinewood River showed no difference in age, significantly larger relative gonad size, larger relative liver size, and greater body condition compared to those captured at Sturgeon Creek. The survival, reproductive, and energy storage responses in female central mudminnow were very similar to those of brook stickleback between Pinewood River and Sturgeon Creek. As indicated previously, the responses shown in female central mudminnow may have reflected differing food resources/assemblages and/or differential energy allocation between the Pinewood River and the Sturgeon Creek reference area.

7.4.2 Male Central Mudminnow

Male central mudminnow from the effluent-exposed area were of similar age to those from the reference area (Figure 7.4b and Table 7.4). Male central mudminnow ranged from 1 to 4 years at the effluent-exposed area and 1 to 3 years at the reference area (Figure 7.4b; Appendix Tables E.10 and E.11).

a)



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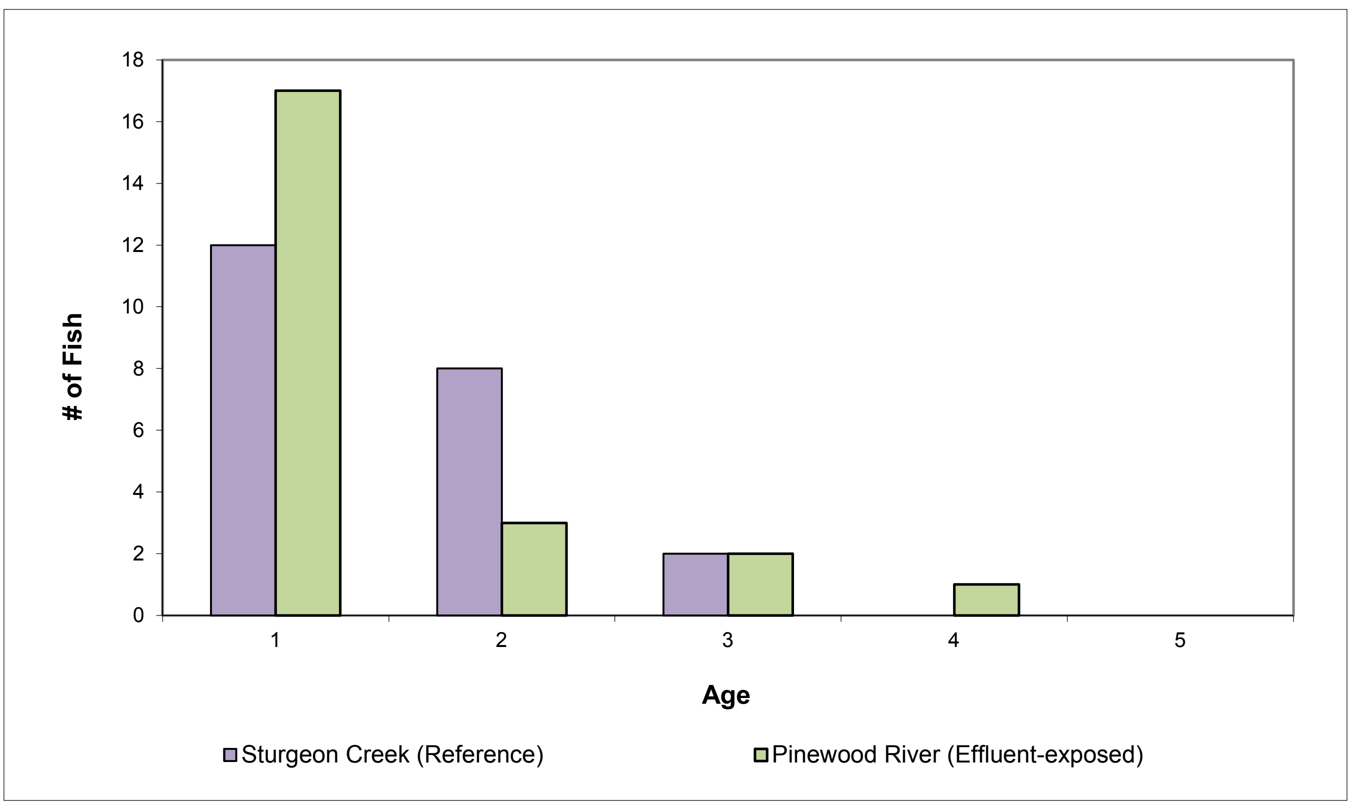


Figure 7.4: Age frequency Distributions of a) Female and b) Male Central Mudminnow in Sturgeon Creek and Pinewood River, RRP Phase 1 EEM, April 2017

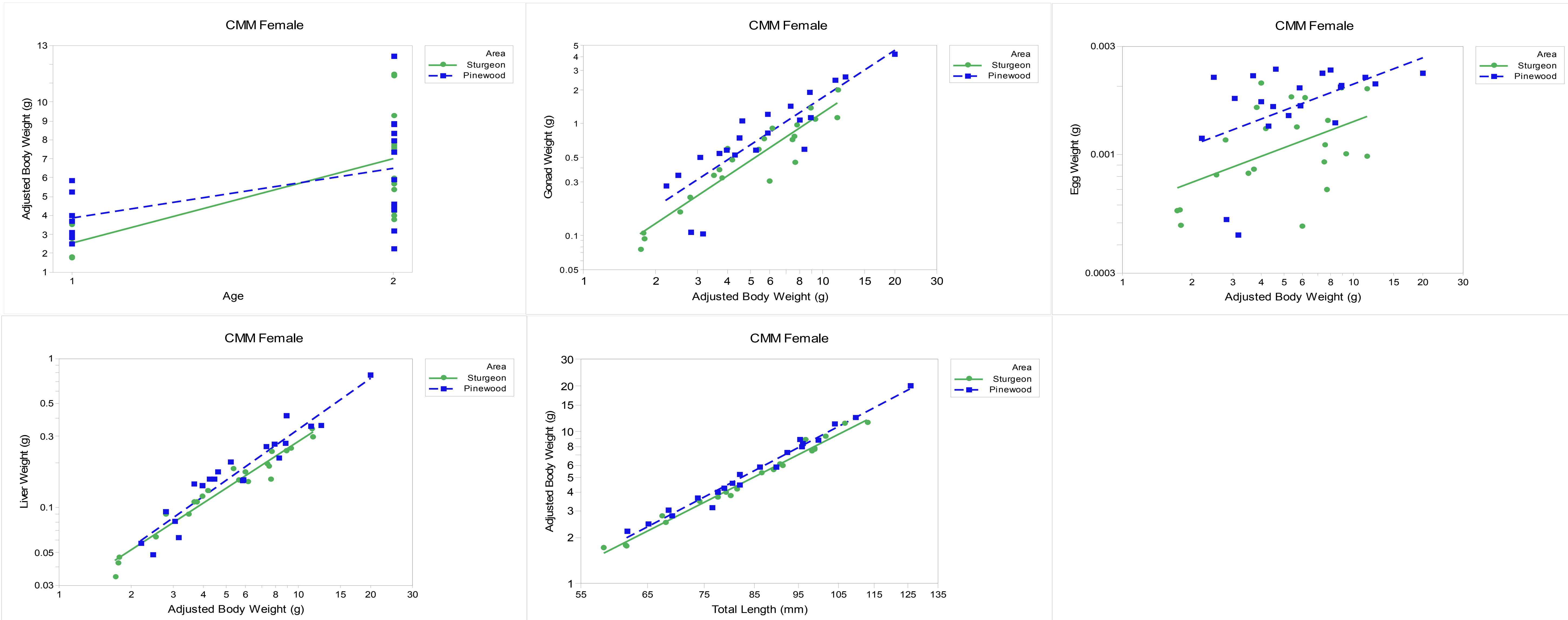


Figure 7.5: Scatterplot and Linear Regressions For Female Central Mudminnow Health Endpoints For Pinewood River (Effluent-exposed) Compared to Sturgeon Creek (Reference), RRP Phase 1 EEM, 2017

Notes: outliers are plotted as open symbols with an × through them

Relative gonad size was not significantly different for male central mudminnow from the Pinewood River compared to those from the reference area (Table 7.4). Relative liver size and body condition of male central mudminnow were both significantly greater than those captured at Sturgeon Creek, with the magnitude of difference for both endpoints outside the applicable CES (Table 7.4 and Figure 7.6; Appendix Tables E.10 and E.11). No abnormalities were observed in the male central mudminnow during the spring survey.

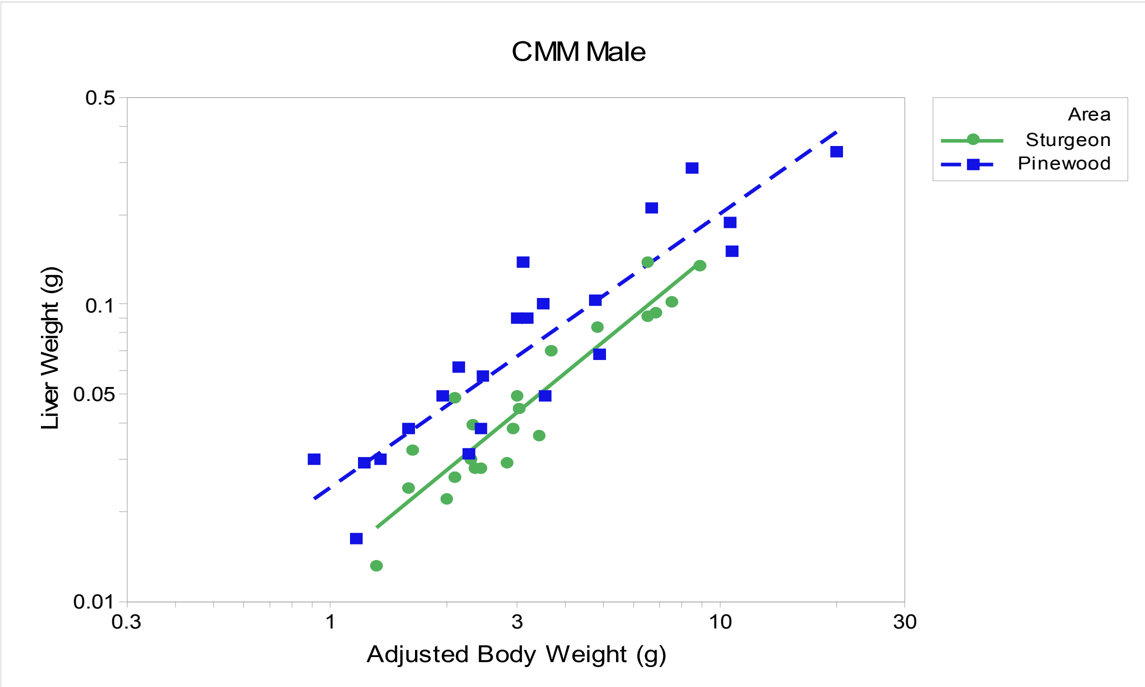
Overall, male central mudminnow collected at the Pinewood River showed no difference in age, but significantly larger livers and body condition compared to those captured at Sturgeon Creek. The survival (age) and energy storage responses shown in male central mudminnow were very similar to those shown in female central mudminnow and both sexes of brook stickleback between Pinewood River and Sturgeon Creek. As indicated previously, the responses shown in male central mudminnow may have reflected differences of food resources/assemblages, and/or differential energy allocation between Pinewood River and the Sturgeon Creek reference area.

7.5 Summary

No major differences in community composition were observed between the two fishing areas, although the effluent-exposed area on the Pinewood River supported the highest species diversity.

Female brook stickleback downstream of the RRP differed significantly from reference female brook stickleback on the basis of relative gonad size, relative live size, and body condition, with the magnitude of differences exceeding the applicable CES. A similar pattern was observed for effluent-exposed female central mudminnow with significant differences in relative gonad size, relative liver size, and body condition; however only relative gonad size was outside of the applicable CES. Effluent-exposed male brook stickleback differed significantly from males captured at the Sturgeon Creek reference on the basis of larger relative liver size and body condition, with the magnitude of difference exceeding the applicable CES for both endpoints. Similarly, male effluent-exposed central mudminnow showed the exact same pattern as the male brook stickleback in terms of significance and magnitude of difference outside of applicable CES.

Overall, fish downstream of the RRP site during the Phase 1 EEM generally showed a similar pattern of survival, reproductive, and energy storage responses when compared to fish captured at the Sturgeon Creek reference area that is suggestive of greater food resource availability.



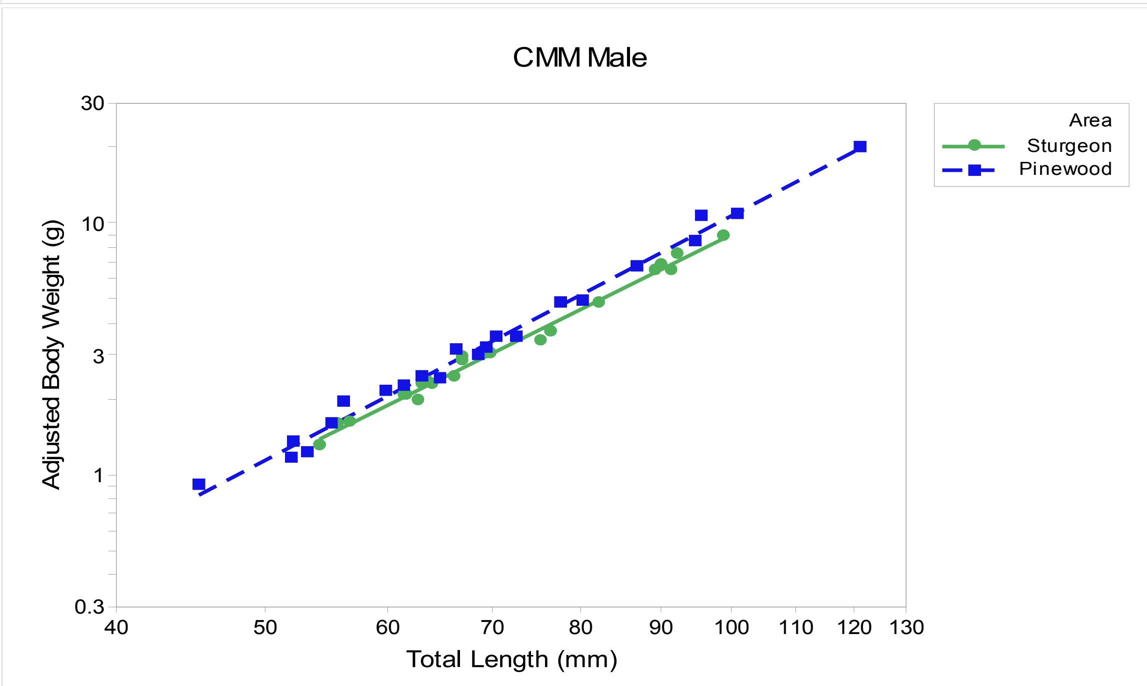


Figure 7.6: Scatterplot and Linear Regressions For Male Central Mudminnow Health Endpoints For Pinewood River (Effluent-exposed) Compared to Sturgeon Creek (Reference), RRP Phase 1 EEM, 2017

Notes: outliers are plotted as open symbols with an × through them

8 SUMMARY AND CONCLUSIONS

8.1 Conclusions

The RRP Phase 1 EEM field study was implemented in April and September 2017 and provided an integrated assessment of the influence of effluent discharge on the chemical and biological condition of the aquatic receiving environment. The effluent-exposed area on Pinewood River was compared to a reference area located on the Sturgeon Creek, south east of the mine.

Sublethal toxicity tests conducted on grab samples of RRP final effluent at Final Discharge Point 2 (FDP2), and Final Discharge Point 3 (FDP3) over the Phase 1 EEM period (2016 to 2017) indicated that effluent was generally of high quality with the lowest reported effects occurring at effluent concentrations of 37% and 95% for FDP2 and FDP3 respectively, which is above calculated effluent concentrations in the Pinewood River.

Routine water quality monitoring data show that the mine effluent is detectable in Pinewood River, particularly through higher hardness, conductivity, calcium, potassium, and sodium in the effluent-exposed area relative to upstream. Effects on water quality during the field surveys followed a similar pattern that was observed during the routine water quality.

The inorganic sediment fraction was composed predominantly of silt and clay with some sand. There were significant differences between the effluent-exposed and reference area sediments on the basis of total organic carbon, as well as the silt and clay fractions, with significantly more TOC and silt in the effluent-exposed area, and significantly less clay. Sediment chemistry showed two analytes were greater in the effluent-exposed area than in both the reference area and PSQG LEL values (manganese and phosphorus) however this maybe a natural difference between the two areas rather than a mine-related effect. Concentrations of TKN, chromium, and nickel were similar between both areas as well as being elevated compared to PSQG values indicating that these substances are also naturally elevated in these two watercourses.

The benthic invertebrate community in the effluent-exposed area was similar to the reference area for all EEM metrics (mean organism density, number of taxa, and Simpson's Evenness) except Bray-Curtis. Also, Chironomids and Oligochaeta showed comparable percent abundances and were not significantly different among areas. The proportion of pollution-intolerant EPT (Ephemeroptera, Plecoptera, Tricoptera) were similar in percent abundance in the effluent-exposed area compared to the Surgeon Creek, however they were in low abundances for both areas. Correspondence Analysis showed a difference in the Pinewood River effluent-exposed area compared to the community in Sturgeon Creek. The subtle differences observed in the community structure between the areas were most likely related to differences in natural habitat factors between watersheds (i.e., factors not controlled for in this study) rather than mine-related impacts.

The fish survey showed no major differences in community composition between the two areas although the effluent-exposed area on Pinewood River supported the highest diversity. Female brook stickleback downstream of the RRP differed significantly from reference female brook stickleback for relative gonad size, relative liver size, and body condition, with the magnitude of differences outside of the applicable CES. A similar pattern was observed for effluent-exposed female central mudminnow with significant differences in relative gonad size, relative liver size, and body condition, however only relative gonad size was outside of the applicable CES. Effluent-exposed male brook stickleback were significantly different from male brook stickleback captured at the Sturgeon Creek reference based on larger relative liver size and body condition, with the magnitude of difference outside of the applicable CES for both endpoints. Similarly, male effluent-exposed central mudminnow showed the exact same pattern as the male brook stickleback (larger relative liver size and body condition) in terms of significance and magnitude of difference outside of applicable CES. Although significant differences for several endpoints for both sexes and species were outside of the applicable CES, these differences may be a result of differing food resources/assemblages between the Pinewood River and Sturgeon Creek and not a result of mine-effluent.

8.2 Recommendations

Based on the findings of the Phase 1 RRP EEM study conducted in April and September 2017, it is recommended that the mine implements the Phase 2 EEM biological study (“periodic monitoring - surveillance”) three years after Phase 1. A specific recommendation for RRP’s Phase 2 EEM is to use the same sentinel fish species and reference areas used in the Phase 1 EEM. This will allow for consistent Phase to Phase comparisons. Additionally, once a permanent final discharge point has been established, the effluent plume should be fully characterized to determine the magnitude and extent of the effluent within the Pinewood River.

9 REFERENCES

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APPENDIX A
CORRESPONDENCE RELATED TO THE PHASE 1 EEM STUDY DESIGN

APPENDIX B

DATA QUALITY ASSESSMENT

APPENDIX B DATA QUALITY ASSESSMENT

B1 INTRODUCTION

B1.1 Overview

Data Quality Assessment (DQA) was conducted on data collected as part of Phase 1 Environmental Effects Monitoring study implemented for the New Gold Rainy River Project. The objective of DQA is to define the overall quality of the data presented in the report, and, by extension, the confidence with which the data can be used to derive conclusions

B1.2 Background

A variety of factors can influence the chemical and biological measurements made in an environmental study and thus affect the accuracy and/or precision of the data. Inconsistencies in sampling or laboratory methods, use of instruments that are inadequately calibrated or which cannot measure to the desired level of accuracy or precision, and contamination of samples in the field or laboratory are just some of the potential factors that can lead to the reporting of data that do not accurately reflect actual environmental conditions. Depending on the magnitude of the problem, inaccuracy or imprecision have the potential to affect the reliability of any conclusions made from the data. Therefore, it is important to ensure that monitoring programs incorporate appropriate steps to control the non-natural sources of data variability (i.e., minimize the variability that does not reflect natural spatial and temporal variability in the environment) and thus assure the quality of the data.

Data quality as a concept is meaningful only when it relates to the intended use of the data. That is, one must know the context in which the data will be interpreted in order to establish a relevant basis for judging whether or not the data set is adequate. DQA involves comparison of actual field and laboratory measurement performance to data quality objectives (DQOs) established for a particular study, such as evaluation of lowest detection limits, and data precision (based on field duplicate samples), along with proper scrutiny of all laboratory data reports.

DQOs were established at the outset of the field program that reflect reasonable and achievable performance expectations (Appendix Table B.1). Programs involving a large amount of samples and analytes usually result in some results that exceed the DQOs. This is particularly so for multi-element scans (e.g., ICP scans for metals) since the analytical conditions are not necessarily optimal for every element included in the scan. Generally, scan results may be considered acceptable if no more than 20% of the parameters fail to meet the DQOs. Overall, the intent of comparing data to DQOs was not to reject any measurement that did not meet the DQO, but to ensure any questionable data received more scrutiny to determine what effect, if any, this had on interpretation of results within the context of this project.

B1.3 Types of Quality Control Samples

Several types of quality control (QC) samples were assessed based on samples collected (or prepared) in the field and laboratory. These samples, and a description of each, include the following:

- **Blanks** are samples of de-ionized water and/or appropriate reagent(s) that are handled and analyzed the same way as regular samples. These samples will reflect any contamination of samples occurring in the laboratory (in the case of laboratory or method blanks). Analyte concentrations should be non-detectable although a data quality objective of twice the method detection limit allows for slight "noise" around the detection limit.
- **Field Duplicates** are replicate samples collected from a randomly selected field station using identical collection and handling methods or by splitting the same sample which are then analyzed separately in the laboratory. The duplicate samples are handled and analyzed in an identical manner in the laboratory. The data from field replicate samples reflect natural variability, as well as the variability associated with sample collection methods, and therefore provide a measure of field precision.
- **Laboratory Duplicates** are replicate sub-samples created in the laboratory from randomly selected field samples which are sub-sampled and then analyzed independently using identical analytical methods. For fish tissue, laboratory duplicates represent separate aliquots of material collected after sample homogenization. The laboratory duplicate sample results reflect any variability introduced during laboratory sample handling and analysis and thus provide a measure of laboratory precision.
- **Spike Recovery Samples** are created in the laboratory by adding a known amount/concentration of a given analyte (or mixture of analytes) to a randomly selected test sample previously divided to create two sub-samples. The spiked and regular sub-samples are then analyzed in an identical manner. The spike recovery represents the difference between the measured spike amount (total amount in spiked sample minus amount in original sample) relative to the known spike amount (as a percentage). Two types of spike recovery samples are commonly analyzed. Spiked blanks (or blank spikes) are created using laboratory control materials whereas matrix spikes are created using field-collected samples. The analysis of spiked samples provides an indication of the accuracy of analytical results.

- **Certified Reference Materials and QC Standards** are samples containing known chemical concentrations that are processed and analyzed along with batches of environmental samples. The sample results are then compared to target results to provide a measure of analytical accuracy. The results are reported as the percent of the known amount that was recovered in the analysis.

Two types of QC were applied to benthic invertebrate community samples as follows:

- **Organism Recovery** Checks for benthic invertebrate community samples involve the re-processing of previously sorted material from a randomly selected sample to determine the number of invertebrates that were not recovered during the original sample processing. The reprocessing is conducted by an analyst not involved during the original processing to reduce any bias. This check allows the determination of accuracy through assessment of recovery efficiency.
- **Sub-Sampling Error** is assessed for studies in which benthic invertebrate community samples require sub-sampling (due to excessive sample volume and/or invertebrate density). By comparing the numbers of benthic invertebrates recovered between at least two sub-samples, this measure provides an evaluation of how effective the sub-sampling method was in evenly dividing the original sample. Therefore, sub-sampling error provides a measure of analytical accuracy and precision. The processing of entire benthic invertebrate community samples in representative sample fractions also allows an evaluation of sub-sampling accuracy.

One additional types of QC measures was applied to the fish fecundity samples as follows:

- **Egg Re-count** for collected fish gonad tissue involves the reprocessing of previously counted eggs to ensure that the initial count was accurate. The re-count is completed on a randomly selected sample and reprocessing is conducted by an analyst not involved during the original count to reduce any bias.

B2 WATER SAMPLES

B2.1 Lowest Detection Limits

Target laboratory lowest detection limits (LDL) for water sample analyses were established at levels below all potentially applicable water quality guidelines (Appendix Table B.2). All reported LDLs were at or below the applicable water quality guidelines meaning that sample data for this project could be reliably interpreted relative to the guidelines.

B2.2 Field Duplicate Samples

Two sets of duplicate water samples were collected in the field (one in April and one in the September), which showed good agreement in analyte concentrations (Appendix Table B.3). In the April sample, one analyte that did not achieve the DQO, this was total dissolved solids. In the September sample, four analytes did not achieve the DQO; total ammonia, nitrate, sulfate, and sulfur. Although total dissolved solids, total ammonia, sulfate, and sulfur did not achieve the DQO, the absolute difference in concentration between the duplicate samples was very low. Nitrate also failed to meet the DQO and had relatively high absolute differences in concentration; this is possibly because the duplicate sample was not fully preserved, therefore microbial action continued, leading to continued nitrogen fixation (i.e. increased nitrate). Overall, the data suggest that reported sample data were reasonably precise representations of conditions at the time of sampling.

B3 SEDIMENT SAMPLES

B3.1 Lowest Detection Limits

Target laboratory lowest detection limits (LDL) for sediment sample analyses were established at levels below all potentially applicable sediment quality guidelines (Appendix Table B.4). None of the reported LDLs were at or above the target concentrations meaning that sample data for this project could be reliably interpreted relative to the guidelines (Sediment Quality Guidelines; Appendix Table B.4).

B3.2 Field Duplicate Samples

One field duplicate sediment sample was collected for this project. All parameters achieved close agreement indicating good precision (Appendix Table B.5).

B4 BENTHIC MACROINVERTEBRATE SAMPLES

B4.1 Subsampling Accuracy and Precision

Three samples were fractioned and sorted in its entirety for QC purposes. The DQO of 20% was met for both precision and accuracy for two of the three samples, the lab indicated that the probability of meeting the accuracy criteria is reduced, due to the low organism densities. (Appendix Table B.6a and Table B.6c). Overall, the number of organisms in each fraction showed close agreement.

B4.2 Organism Recovery

The data quality objective for percent organism recovery was met for both samples that were re-sorted (Appendix Table B.6b).

B5 FISH SAMPLES

B5.1 Fecundity

The relative percent differences between original and resorted fecundity estimates, based on five brook stickleback and four central mudminnow ovaries, were good (Appendix Table B.7). All but three samples achieved the DQO. Overall, the duplicate results indicated good precision.

B6 DATA QUALITY STATEMENT

The quality of data for this project was adequate to serve the project objective.

Table B.1: Data Quality Objectives for Environmental Samples Collected for the RRP Phase 1 EEM, 2017

Quality Control Measure	Quality Control Sample Type	Study Component			
		Water Quality	Sediment Quality	Benthic Invertebrate Community	Fish Fecundity
Lowest Detection Limits (LDL)	Comparison actual LDL versus target LDL	LDL for each variable should be at least as low as applicable guidelines, ideally ≤1/10th guideline valuea	LDL for each variable should be at least as low as applicable guidelines, ideally ≤1/10th guideline valuea	n/a	n/a
Field Precision	Field Duplicates	≤25% RPD[b]	≤40% RPD	n/a	n/a
Laboratory Precision	Sub-Sampling Precision	n/a	n/a	≤20% difference between sub-samples	n/a
	Fecundity Estimate	n/a	n/a	n/a	±5% RPD
Accuracy	Sub-Sampling Accuracy	n/a	n/a	Subsample estimate is within 20% of total abundance	n/a
	Organism Recovery	n/a	n/a	≥ 90%	n/a

[a] or below predictions, if applicable and no guideline exists for the substance.
[b] RPD - Relative Percent Difference
Note: n/a - not applicable

Table B.2: Laboratory Lowest Detection Limits (LDLs) Relative to Targets and to Water Quality Guidelines

	Analytes	Units	Lowest Detection Limit Achieved	Water Quality Criteria: Ontario Water Quality Objective[a]
Non-Metals	Radium-226	Bq/L	0.010	1.0
	Hardness ($CaCO_3$)	mg/L	0.5	-
	Total Ammonia-N	mg/L	0.02	10.25
	Total Dissolved Solids	mg/L	10	-
	Total Suspended Solids	mg/L	2	-
	Alkalinity (Total as $CaCO_3$)	mg/L	2	-
	Strong Acid Dissoc. Cyanide (CN)	mg/L	0.0020	0.005
	Nitrate (N)	mg/L	0.020	-
	Nitrate plus Nitrite (N)	mg/L	0.040	-
	Nitrite (N)	mg/L	0.010	-
	Phosphorus (P)	mg/L	0.050	0.30
ICP Metals	Total Aluminum (Al)	mg/L	0.003	0.075
	Total Antimony (Sb)	mg/L	0.0001	0.020
	Total Arsenic (As)	mg/L	0.0001	0.005
	Total Barium (Ba)	mg/L	0.00005	-
	Total Beryllium (Be)	mg/L	0.0001	11
	Total Bismuth (Bi)	mg/L	0.00005	-
	Total Boron (B)	mg/L	0.01	0.20
	Total Cadmium (Cd)	mg/L	0.00001	0.00050
	Total Chromium (Cr)	mg/L	0.0001	0.0010
	Total Cobalt (Co)	mg/L	0.00010	0.00090
	Total Copper (Cu)	mg/L	0.0005	0.0050
	Total Iron (Fe)	mg/L	0.01	0.30
	Total Lead (Pb)	mg/L	0.0001	0.0050
	Total Lithium (Li)	mg/L	0.001	-
	Total Manganese (Mn)	mg/L	0.0001	-
	Total Mercury (Hg)	mg/L	0.00001	0.00020
	Total Molybdenum (Mo)	mg/L	0.0001	0.040
	Total Nickel (Ni)	mg/L	0.0005	0.025
	Total Selenium (Se)	mg/L	0.00005	0.1
	Total Silicon (Si)	mg/L	0.1	-
	Total Silver (Ag)	mg/L	0.00001	0.00010
	Total Strontium (Sr)	mg/L	0.0002	-
	Total Thallium (Tl)	mg/L	0.00001	0.00030
	Total Tin (Sn)	mg/L	0.0001	-
	Total Titanium (Ti)	mg/L	0.0003	-
	Tungsten (W)	mg/L	0.00010	0.030
	Total Uranium (U)	mg/L	0.00001	0.0050
	Total Vanadium (V)	mg/L	0.0005	0.0060
	Total Zinc (Zn)	mg/L	0.003	0.020
	Total Zirconium (Zr)	mg/L	0.00006	0.0040
	Total Calcium (Ca)	mg/L	0.05	-
	Total Magnesium (Mg)	mg/L	0.005	-
	Total Potassium (K)	mg/L	0.05	-
	Total Sodium (Na)	mg/L	0.05	-
	Total Sulphur (S)	mg/L	0.5	-

Note: Highlighted Values Indicate LDLs that were Above the Water Quality Guideline.

[a] PWQO (Ontario Provincial Water Quality Objective).

Table B.3: Field Duplicate Results for Analysis of Water Samples

	Analytes	Units	ALS Job Number L1917630 Station: PinR-EXP (Apr. 24, 2017)			ALS Job Number L1991701 Station: PinR-EXP (Sept. 13, 2017)		
			Replicate 1	Replicate 2	RPD[a,b]	Replicate 1	Replicate 2	RPD[a,b]
Non-Metals	Alkalinity, Total (as CaCO3)	mg/L	190	187	2	260	245	6
	Ammonia, Total (as N)	mg/L	0.077	0.078	1	0.027	0.053	65
	Chloride (Cl)	mg/L	10.9	10.7	2	12.5	12.4	1
	Fluoride (F)	mg/L	0.07	0.07	4	0.081	0.08	0
	Nitrate (as N)	mg/L	0.89	0.88	2	0.102	2.95	187
	Nitrite (as N)	mg/L	0.023	0.023	0	<0.010	<0.010	0
	Phosphorus (P)-Total	mg/L	0.0185	0.0163	13	0.0324	0.0337	4
	Sulfate (SO4)	mg/L	16.8	16.5	2	1.79	2.44	31
	Hardness (as CaCO3)	mg/L	191	182	5	257	262	2
	Total Suspended Solids	mg/L	<2.0	2	0	4.6	4.3	7
	Total Dissolved Solids	mg/L	236	163	37	308	305	1
	Cyanide, Weak Acid Diss	mg/L	<0.0020	<0.0020	0	<0.0020	<0.0020	0
	Cyanide, Total	mg/L	<0.0020	<0.0020	0	<0.0020	<0.0020	0
	Dissolved Organic Carbon	mg/L	16.6	16.3	2	28.7	29.3	2
	Total Organic Carbon	mg/L	16.7	17.0	2	29.1	29.5	1
	Radium	Bq/L	<0.010	<0.010	0	<0.010	<0.010	0
ICP Metals	Aluminum (Al)-Total	mg/L	0	0	0	0	0	3
	Antimony (Sb)-Total	mg/L	0.0012	0.0013	4	0.0002	0.0002	6
	Arsenic (As)-Total	mg/L	0.001	0.001	5	0.001	0.002	5
	Barium (Ba)-Total	mg/L	0.02	0.02	3	0.02	0.02	3
	Beryllium (Be)-Total	mg/L	<0.00010	<0.00010	0	<0.00010	<0.00010	0
	Bismuth (Bi)-Total	mg/L	<0.000050	<0.000050	0	<0.000050	<0.000050	0
	Boron (B)-Total	mg/L	0.026	0.027	4	0.015	0.015	0
	Cadmium (Cd)-Total	mg/L	0.000	0.000	24	0.0000056	<0.0000050	6
	Calcium (Ca)-Total	mg/L	42.0	42.7	2	58.4	57.9	1
	Cesium (Cs)-Total	mg/L	0.000013	0.000013	0	0.000011	0.000013	17
	Chromium (Cr)-Total	mg/L	0.00023	0.00024	4	0.00032	0.00034	6
	Cobalt (Co)-Total	mg/L	0.00015	0.00015	0	0.00025	0.00027	8
	Copper (Cu)-Total	mg/L	0.001	0.001	3	<0.00050	<0.00050	0
	Iron (Fe)-Total	mg/L	0.196	0.2	3	0.201	0.2	9
	Lead (Pb)-Total	mg/L	0.000059	0.000052	13	0.000074	0.000068	8
	Lithium (Li)-Total	mg/L	0.0097	0.0101	4	0.0115	0.0119	3
	Magnesium (Mg)-Total	mg/L	18.500	19.700	6	28.500	29.700	4
	Manganese (Mn)-Total	mg/L	0.028	0.029	1	0.084	0.092	9
	Mercury (Hg)-Total	mg/L	<0.0000050	<0.0000050	0	<0.0000050	<0.0000050	0
	Molybdenum (Mo)-Total	mg/L	0.0026	0.0026	0	0.000185	0.000187	1
	Nickel (Ni)-Total	mg/L	0.00117	0.00122	4	0.00111	0.00114	3
	Phosphorus (P)-Total	mg/L	<0.050	<0.050	0	0.1	0.1	19
	Potassium (K)-Total	mg/L	3.080	3.130	2	2.130	2.190	3
	Rubidium (Rb)-Total	mg/L	0.0019	0.00195	3	0.00158	0.00156	1
	Selenium (Se)-Total	mg/L	0.0002	0.0002	7	0.00018	0.00017	3
	Silicon (Si)-Total	mg/L	1.40	1.43	2	2.66	2.79	5
	Silver (Ag)-Total	mg/L	<0.000010	<0.000010	0	<0.000010	<0.000010	0
	Sodium (Na)-Total	mg/L	8.92	9.15	3	9.17	9.45	3
	Strontium (Sr)-Total	mg/L	0.158	0.155	2	0.124	0.124	0
	Sulfur (S)-Total	mg/L	6.06	5.75	5	1.20	1.67	33
	Tellurium (Te)-Total	mg/L	<0.00020	<0.00020	0	<0.00020	<0.00020	0
	Thallium (Tl)-Total	mg/L	<0.000010	<0.000010	0	<0.000010	<0.000010	0
	Thorium (Th)-Total	mg/L	<0.00010	<0.00010	0	<0.00010	<0.00010	0
	Tin (Sn)-Total	mg/L	<0.00010	<0.00010	0	<0.00010	<0.00010	0
	Titanium (Ti)-Total	mg/L	0.00217	0.0026	18	0.00279	0.00303	8
	Tungsten (W)-Total	mg/L	<0.00010	<0.00010	0	<0.00010	<0.00010	0
	Uranium (U)-Total	mg/L	0.00184	0.00187	2	0.000525	0.000516	2
	Vanadium (V)-Total	mg/L	0.00079	0.00078	1	0.00079	0.00082	4
	Zinc (Zn)-Total	mg/L	<0.0030	<0.0030	0	0.0038	<0.0030	12
	Zirconium (Zr)-Total	mg/L	0.00024	0.000243	1	0.00017	0.000165	3

Note: Highlighted Values did not Meet the Data Quality Objective of ≤ 25% Relative Percent Difference.

[a] Relative Percent Difference = [absolute (replicate1-replicate2)/average (replicate1,replicate2)]*100

[b] The lowest detection limit (LDL) value was used in instances where values less than the LDL were reported.

Table B.4: Laboratory Lowest Detection Limits (LDL) for Sediment Samples Relative to Targets and to Guidelines

Analytes		Units	Achieved LDL	Sediment Quality Guidelines Ontario[a] LEL[b]	Sediment Quality Guidelines Ontario[a] SEL[c]
Non-Metals	Moisture	%	0.1	-	-
	Total Organic Carbon	%	0.05	1.0	10.0
	Gravel	%	1.0	-	-
	Sand	%	1.0	-	-
	Silt	%	1.0	-	-
	Clay	%	1.0	-	-
ICP Metals	Aluminum (Al)	µg/g	50	-	-
	Antimony (Sb)	µg/g	0.1	-	-
	Arsenic (As)	µg/g	0.1	6	33
	Barium (Ba)	µg/g	0.5	-	-
	Beryllium (Be)	µg/g	0.1	-	-
	Bismuth (Bi)	µg/g	0.2	-	-
	Boron (B)	µg/g	5	-	-
	Cadmium (Cd)	µg/g	0.02	0.6	10
	Calcium (Ca)	µg/g	50	-	-
	Chromium (Cr)	µg/g	0.5	26	110
	Cobalt (Co)	µg/g	0.1	-	-
	Copper (Cu)	µg/g	0.5	16	110
	Iron (Fe)	µg/g	50	20,000	40,000
	Lead (Pb)	µg/g	0.5	31	250
	Lithium (Li)	µg/g	2	-	-
	Magnesium (Mg)	µg/g	20	-	-
	Manganese (Mn)	µg/g	1	460	1,100
	Mercury (Hg)	µg/g	0.005	0.2	2
	Molybdenum (Mo)	µg/g	0.1	-	-
	Nickel (Ni)	µg/g	0.5	16	75
	Phosphorus (P)	µg/g	50	600	2,000
	Potassium (K)	µg/g	100	-	-
	Selenium (Se)	µg/g	0.2	-	-
	Silver (Ag)	µg/g	0.1	-	-
	Sodium (Na)	µg/g	50	-	-
	Strontium (Sr)	µg/g	0.5	-	-
	Sulfur (S)	µg/g	1,000	-	-
	Thallium (Tl)	µg/g	0.05	-	-
	Tin (Sn)	µg/g	1.0	-	-
	Titanium (Ti)	µg/g	1	-	-
	Tungsten (W)	µg/g	0.5	-	-
	Uranium (U)	µg/g	0.05	-	-
	Vanadium (V)	µg/g	0.2	-	-
	Zinc (Zn)	µg/g	2	120	820
	Zirconium (Zr)	µg/g	1	-	-

Note: Highlighted Values Indicate Target LDL was not Achieved.

[a] Ontario Provincial Sediment Quality Criteria (PSQG)

[b] Lowest effect level (LEL)

[c] Severe effect level (SEL)

Table B.5: Field Duplicate Results for Analysis of Sediment Samples

	Analytes	Units	ALS Job Number L1995196 Station ID PinR-EXP-4 (September 14, 2017) Replicate 1	Replicate 2	RPD[a,b]
Non-Metals	Moisture	%	54	60	11
	Total Organic Carbon	mg/kg	3.46	3.26	6
	Gravel	%	<1.0	<1.0	0
	Sand	%	31	32	5
	Silt	%	45	41	9
	Clay	%	25	27	8
ICP Metals	Aluminum (Al)	µg/g	9,350	9,590	3
	Antimony (Sb)	µg/g	0.11	0.10	10
	Arsenic (As)	µg/g	2.2	2.1	6
	Barium (Ba)	µg/g	61	62	1
	Beryllium (Be)	µg/g	0.44	0.40	10
	Bismuth (Bi)	µg/g	<0.20	<0.20	0
	Boron (B)	µg/g	7	6	17
	Cadmium (Cd)	µg/g	0.20	0.19	7
	Calcium (Ca)	µg/g	11,600	9,080	24
	Chromium (Cr)	µg/g	21	21	0
	Cobalt (Co)	µg/g	7	7	2
	Copper (Cu)	µg/g	10	10	2
	Iron (Fe)	µg/g	12,600	12,500	1
	Lead (Pb)	µg/g	6	6	7
	Lithium (Li)	µg/g	12	12	4
	Magnesium (Mg)	µg/g	6,770	6,100	10
	Manganese (Mn)	µg/g	315	303	4
	Mercury (Hg)	µg/g	0.05	0.03	40
	Molybdenum (Mo)	µg/g	0.35	0.29	19
	Nickel (Ni)	µg/g	15	15	0
	Phosphorus (P)	µg/g	496	469	6
	Potassium (K)	µg/g	1,040	1,060	2
	Selenium (Se)	µg/g	0.34	0.28	19
	Silver (Ag)	µg/g	<0.10	<0.10	0
	Sodium (Na)	µg/g	96	84	13
	Strontium (Sr)	µg/g	22	20	10
	Sulfur (S)	µg/g	<1,000	<1,000	0
	Thallium (Tl)	µg/g	0.12	0.11	10
	Tin (Sn)	µg/g	<1.0	<1.0	0
	Titanium (Ti)	µg/g	137	128	7
	Tungsten (W)	µg/g	<0.50	<0.50	0
	Uranium (U)	µg/g	1	1	12
	Vanadium (V)	µg/g	25	26	2
	Zinc (Zn)	µg/g	50	48	4
	Zirconium (Zr)	µg/g	5	4	7

Note: Highlighted Values did not Meet the Data Quality Objective of ≤ 40% Relative Percent Difference.

[a] Relative Percent Difference = [absolute (replicate1-replicate2)/average (replicate1,replicate2)]*100

[b] The laboratory detection limit (LDL) value was used in instances where values less than the LDL were reported.

Table B.6a: Calculation of Subsampling Error for Benthic Macroinvertebrate Samples

Station ID	Whole Organisms	Number of Organisms in Fraction 1	Number of Organisms in Fraction 2	Number of Organisms in Fraction 3	Number of Organisms in Fraction 4	Actual Density	Precision % range		Accuracy	
									min	max
StuC-REF-2	0	36	38	0	0	74	5.3	-	2.7	2.7
StuC-REF-3	0	24	31	0	0	55	22.6	-	12.7	12.7
PinR-EXP-5	0	14	24	0	0	38	41.7	-	26.3	26.3

Note: Highlighted Values did not Meet the Data Quality Objective of ≤ 20% Difference.
min = minimum absolute % error; max = maximum absolute % error.

Table B.6b: Percent Recovery of Benthic Macroinvertebrates

Station ID	Number of Organisms Recovered (initial sort)	Number of Organisms in Re-sort	Percent Recovery
StuC-REF-4	42	42	100.0%
PinR-EXP-2	89	94	94.7%
		Average % Recovery	97.4%

Note: Highlighted Values did not Meet the Data Quality Objective of 90% Recovery.

Table B.6c: Sample Fractions Sorted from RRP Phase 1 EEM Samples

Station ID	Fraction Sorted	Station	Fraction Sorted
StuC-REF-1	1/16	PinR-EXP-1	1/16
StuC-REF-2	1/8[a]	PinR-EXP-2	1/16
StuC-REF-3	1/8[a]	PinR-EXP-3	1/16
StuC-REF-4	1/16	PinR-EXP-4	1/16
StuC-REF-5	1/16	PinR-EXP-5	1/8[a]

[a] three eighths sorted for subsampling error calculations.

QA/QC Notes

Reported fractions averaged 4 hours to sort due to high quantities of organic matter. ZEAS has shown that subsampling precision and accuracy are density dependent (Zaranko and Keene 2005). Specifically, small absolute differences between subsampled fractions become increasingly large, when expressed as a percentage of total organisms, as organism densities decline. Therefore, the probability of meeting precision and accuracy criteria is reduced in samples with low organism densities (i.e., <150 organisms/subsample). It would take an extaordinary effort (>20 hours) to report accuracy on 1/8ths or smaller fractions. Based on the low densities, there would be a low probability of attaining the accuracy criteria.

Zaranko, D.T. and J. Keene. 2005. Are the costs to meet environmental effects monitoring (EEM) benthic sample precision and accuracy criteria justified? In Dixon, D.G., S. Munro and A.J. Niimi (eds). Proceedings of the 32nd Annual Aquatic Toxicity Workshop: October 3 to 5, 2005, Waterloo, Ontario. Can. Tech. Rep. Fish. Aquat. Sci: 2617. 120p.

Table B.7: Relative Percent Difference Between Original Egg Count and Recount Values

Sample	Egg Count (min. 100 eggs counted)			Egg Re-count			Relative Percent Difference[a]		
	1	2	3	1	2	3	1	2	3
PinR-BSB-03	124	130	103	121	125	101	2	4	2
PinR-BSB-21	142	114	122	146	108	114	3	5	7
StuC-BSB-01	167	101	109	154	103	114	8	2	4
StuC-BSB-16	122	102	101	117	100	97	4	2	4
StuC- BSB-32	111	108	122	114	109	119	3	1	2
PinR-CMM-14	388	-	-	390	-	-	1	-	-
PinR-CMM-23	123	101	101	124	101	100	1	0	1
StuC-CMM-17	646	-	-	652	-	-	1	-	-
StuC-CMM-31	694	-	-	690	-	-	1	-	-

Note: Highlighted Values did not Meet the Data Quality Objectives of ≤ 5% Relative Percent Difference.

[a] Relative Percent Difference = [absolute (replicate1-replicate2)/average (replicate1,replicate2)]*100

APPENDIX C
WATER AND SEDIMENT QUALITY DATA

Laboratory Reports

Table C.1: *In Situ* Surface Water Quality Data Collected during the Fish Survey for RRP Phase 1 EEM, 2017

Station ID	Date	Time	Latitude (dd mm ss.s) [a]	Longitude (dd mm ss.s) [a]	Temperature (°C)	pH	Dissolved Oxygen		Specific Conductivity (µS/cm)
							(mg/L)	(% sat)	
StuC-REF	24-Apr-17	14:30	48 43 16.6	-93 57 38.3	5.9	6.90	11.86	94.3	153
PinR-EXP	24-Apr-17	13:00	48 49 46.6	-94 03 53.0	5.6	7.46	11.86	93.6	303

[a] d-degrees, m-minutes, s-seconds
Note: Map Datum (NAD) 83

Table C.2: Supporting Water Characteristics at Reference and Effluent-exposed Stations, RRP Phase 1 EEM, September 2017

Medium	Parameter	Reference Stations					Effluent-exposed Stations				
		StuC-REF1	StuC-REF2	StuC-REF3	StuC-REF4	StuC-REF5	PinR-EXP1	PinR-EXP2	PinR-EXP3	PinR-EXP4	PinR-EXP5
Habitat Parameters	Depth (m)	0.96	0.98	0.94	0.94	0.98	0.96	0.82	0.98	0.98	0.82
	Velocity (m/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water (Surface)	Temperature (ºC)	18.70	18.60	16.30	16.20	16.30	12.65	12.65	12.63	12.67	12.68
	pH	8.03	7.92	7.59	7.45	7.51	7.57	7.58	7.59	7.48	7.50
	D.O. (% sat)	45.9	46.2	42.3	37.9	49.9	41.1	47.3	49.4	41.3	40.9
	D.O (mg/L)	4.48	4.53	4.14	3.72	4.88	4.35	5.01	5.24	4.37	4.33
	Specific Conductance (µS/cm)	321	321	327	324	324	488	488	485	489	488
Water (Bottom)	Temperature (ºC)	17.70	17.10	16.20	15.90	16.30	12.08	12.22	12.59	12.67	12.66
	pH	7.77	7.57	7.44	7.33	7.50	7.02	7.30	7.36	7.31	7.26
	D.O. (% sat)	38.2	42.0	41.1	34.6	43.2	25.2	29.4	44.6	38.5	38.8
	D.O (mg/L)	3.74	4.11	4.02	3.39	4.23	2.70	3.11	4.73	4.08	4.11
	Specific Conductance (µS/cm)	327	326	329	326	324	524	495	506	486	490

Table C.3: Benthic Analyses and Supporting Measures - ANOVA results, Rainy River Phase 1 EEM, 2017

Dependent Variable	Mean Square	F (ANOVA)	P-value	Observed Power
Density (Ind./m2)	5,661,058	0.1691	0.6917	0.1240
LPL Number of Taxa	19.6000	1.2366	0.2984	0.2694
LPL Simpson's D	0.0063	0.9682	0.3539	0.2341
LPL Simpson's E	0.0137	0.4250	0.5328	0.1600
LPL BC Dissimilarity	0.4840	34.3750	0.0004	0.9999
Rainy LPL CA-1 (29.0%)	1.8332	6.8400	0.0309	0.7706
Rainy LPL CA-2 (17.0%)	0.8106	2.1204	0.1834	0.3789
Rainy LPL CA-3 (16.4%)	0.0129	0.0423	0.8422	0.1060
Rainy LPL CA-4 (12.0%)	0.4422	2.2569	0.1714	0.3948
FL Number of Taxa	0.4000	0.1455	0.7128	0.1207
FL Simpson's D	0.0137	2.3502	0.1638	0.4055
FL Simpson's E	0.0040	0.1907	0.6738	0.1271
FL BC Dissimilarity	0.3725	30.6576	0.0005	0.9996
Rainy FL CA-1 (26.5%)	1.2090	12.7705	0.0073	0.9458
Rainy FL CA-2 (25.6%)	0.0199	0.0735	0.7931	0.1105
Rainy FL CA-3 (17.9%)	0.3771	3.0832	0.1172	0.4849
Rainy FL CA-4 (14.4%)	0.0232	0.1729	0.6885	0.1246
% Oligochaeta	306.4730	0.7179	0.4214	0.2004
% Ostracoda	10.4244	0.8873	0.3738	0.2233
% Ephemeroptera	1.1628	0.4750	0.5102	0.1669
% Trichoptera	0.3312	1.0000	0.3466	0.2383
% Chaoboridae	1,232.5440	13.2452	0.0066	0.9520
% Chironomidae	122.0105	0.2673	0.6191	0.1379
% Metal Sensitive Chironomidae	0.8880	0.1743	0.6873	0.1248
% Gastropoda	168.0180	0.9757	0.3522	0.2351
% Bivalvia	193.9522	1.4200	0.2676	0.2931
% Collector Gatherers	745.4596	1.8525	0.2106	0.3469
% Filterers	223.4453	1.8252	0.2137	0.3436
% Scrapers	153.4289	0.8913	0.3728	0.2238
% Shredders	206.5703	7.0070	0.0294	0.7792
% Clingers	6.8393	0.0267	0.8743	0.1038
% Sprawlers	1,749	9.8036	0.0140	0.8863
% Burrowers	639	1.7130	0.2269	0.3298
Station Depth (m)	0.0058	1.5319	0.2509	0.1942
Temperature (°C; bottom)	44.0160	141.2060	0.0000	1.0000
Dissolved Oxygen (mg/L; bottom)	0.0578	0.1460	0.7123	0.0632
Dissolved Oxygen (% sat.; bottom)	51.0760	1.3922	0.2719	0.1808
pH (bottom)	0.1850	8.2627	0.0207	0.7122
Conductivity (µS/cm; bottom)	43,047	449.1754	0.0000	1.0000
Specific Conductance (µS/cm; bottom)	75,847	639.5005	0.0000	1.0000
Moisture (%)	318.0960	2.7368	0.1367	0.3084
Total Kjeldahl Nitrogen (%)	0.1520	7.5777	0.0250	0.6753
FOC (log10 [mg/g])	0.1810	8.0061	0.0222	0.6988
Total Organic Carbon (%)	29.0021	8.1675	0.0212	0.7073
% Gravel (%)	0.0000	.	.	.
% Sand (%)	96.1000	0.8730	0.3775	0.1312
% Silt (%)	463.7610	7.0049	0.0294	0.6416
% Clay (%)	137.6410	9.8685	0.0138	0.7853
Rainy River Sediment Metal PC-1 (69.7%)	1.0119	1.0134	0.3436	0.1445
Rainy River Sediment Metal PC-2 (16.2%)	7.4188	37.5344	0.0003	0.9996
Rainy River Sediment Metal PC-3 (6.2%)	0.0176	0.0157	0.9034	0.0514

P-value < 0.1.

Table C.4: Surface Water Quality at SW20 (Pinewood River reference area) and SW22A (Pinewood River Effluent-exposed area), 2015 to 2017

Analytes		Field pH	Field Temperature (°C)	Field Dissolved Oxygen (mg/L)	Colour	Conductivity	Hardness	Lab pH	TSS	TDS	Turbidity	Alkalinity (Total as $CaCO_3$)	Acidity (as $CaCO_3$)	Total Ammonia-N	Unionized Ammonia	Chloride (Cl)	Fluoride (F-)	Nitrate (N)
Location	Sample Date				TCU	µS/cm	mg/L		mg/L	mg/L	NTU	mg/L	mg/L	mg/L	mg/L		mg/L	mg/L
SW20 (Reference)	14-May-15	6.79	6.7	33	120	217	100	7.8	5	160	5		4.6	0.024			0.035	0.015
	09-Jun-15	6.85	14.16	64	187	176	84	7.5	5	250	5	79	3.6	0.010			0.040	0.010
	21-Jul-15	7.24	18	46	247	203	104	7.4	2	170	4	92	5.8	0.022			0.039	0.015
	25-Aug-15	7.39	13.24	34	155	295	156	7.7	2	225	3	147	7.6	0.014			0.050	0.005
	15-Sep-15	7.14	13.2	8	124	299	154	7.4	5	225	3	151	6.2	0.004			0.043	0.010
	27-Oct-15	7.13	4.2	63	79	343	159	7.6	6	225	7	149	5.0	0.008	0.0010	17.8	0.033	0.040
	18-Nov-15	7.38	5.9	76	104	280	128	7.5	4	195	7	99	5.0	0.006	0.0010	23.6	0.022	0.145
	17-Dec-15	7.42	0.1	71	101	220	103	7.5	2	165	4	90	6.0	0.016	0.0010	10.1	0.028	0.030
	27-Jan-16	7.25	0.8	29	118	306	157	7.4	1	220	9	142	8.8	0.068	0.0010	7.9	0.032	0.060
	29-Feb-16	7.40	0.6	26	76	319	166	7.5	4	210	11	160	10.0	0.118	0.0010	6.5	0.035	0.085
	23-Mar-16	7.47	20.0		108	189	94	7.5	6	135	6	77	5.8	0.022		11.1	0.033	0.060
	18-Apr-16	6.59	3.0		87	196	91	7.6	5	130	7	77	4.6	0.034	0.0010	9.9	0.037	0.055
	18-May-16	7.12	7.9		89	269	127	7.7	2	160	3	110	4.8	0.027	0.0010	14.8	0.045	0.005
	25-Jan-17	6.71	1.0	6	79	305	141	7.2	3	200	7	148	14.6	0.068	<0.001	11.0	0.029	0.075
	15-Feb-17	7.60	0.3	8	89	368	181	7.4	8	235	9	180	11.2	0.098	<0.001	14.3	0.032	0.065
	29-Mar-17	7.26	0.1	6	82	161	71	7.3	7	120	7	72	4.6	0.038	<0.001	7.4	0.025	0.045
	26-Apr-17	7.55	1.0	14	99	251	117	7.6	2	170	4	104	4.8	0.008	<0.001	17.2	0.043	0.015
	24-May-17	7.35	10.0	7	116	302	145	7.9	3	210	3	127	1.0	0.034	<0.001	19.8	0.059	<0.005
	21-Jun-17	7.25	15.0	2	116	345	154	7.4	2	220	1	177	13.8	0.008	<0.001	27.3	0.050	<0.005
	18-Jul-17	7.14	16.0	1	122	313	154	7.3	3	235	1	135	13.6	0.026	<0.001	23.3	0.043	<0.005
	16-Aug-17	6.65	18.0	1	99	351	164	7.4	5	215	3	164	8.0	0.024	<0.001	23.7	0.051	0.005
	26-Sep-17	7.06	13.0	2	89	434	179	7.8	2	275	2	158	8.6	0.060	<0.001	34.4	0.055	0.010
	30-Oct-17	7.57	3.0	6	81	250	111	7.6	1	175	3	93	6.0	0.014	<0.001	18.5	0.030	<0.005
	20-Nov-17	7.65	0.8	7	87	278	124	7.4	2	185	3	104	5.2	0.060	<0.001	19.3	0.026	0.010
SW22 (Effluent-exposed)	27-Jan-16	7.35	0.7		91	380	200	7.4	4	265	7	190	13.0	0.084	<0.001	5.8	0.041	0.055
	29-Feb-16	7.22	1.4		96	405	219	7.4	4	260	9	210	19.6	0.130	<0.001	5.6	0.050	0.090
	23-Mar-16	7.59	20.0		85	202	97	7.6	8	145	11	99	5.6	0.014	0.1000	4.4	0.041	0.001
	18-Apr-16	7.38	6.8	80	70	267	136	7.8	5	170	5	123	4.2	0.032	<0.001	7.4	0.059	0.110
	18-May-16	7.85	14.0	6	84	293	158	7.9	4	180	2	142	4.0	<0.020	<0.001	2.5	0.062	<0.005
	22-Jun-16	7.32	17.0	4	145	235	145	7.8	1	185	3	122	4.2	0.018	<0.001	5.0	0.059	0.025
	15-Jul-16	6.18	21.0	5	147	240	131	7.7	1	180	2	123	3.8	0.044	<0.001	3.3	0.065	0.020
	16-Aug-16	6.77	22.0	1	97	343	177	7.7	3	250	2	172	11.4	0.056	<0.001	8.2	0.060	<0.005
	19-Sep-16	7.36	14.0	3		501	248		2			216		0.034	<0.001			0.355
	21-Sep-16	7.38	14.0	4	65	418	207	7.6	4	290	3	198	8.2	0.020	<0.001	9.5	0.076	0.150
	25-Jan-17	6.99	0.5	4	82	451	228	7.3	5	285	7	247	15.0	0.214	<0.001	12.2	0.055	0.310
	15-Feb-17	7.93	0.1	10	57	580	287	7.4	6	355	5	279	23.8	0.676	0.0050	16.9	0.060	0.745
	29-Mar-17	7.32	0.2	6	54	193	92	7.6	9	130	10	95	4.8	0.058	<0.001	4.0	0.032	0.145
	26-Apr-17	7.43	1.0	14	80	317	159	7.9	4	190	2	154	3.6	0.012	<0.001	11.1	0.061	0.160
	24-May-17	7.56	15.0	9	79	347	171	7.8	3	220	2	195	<0.2	0.026	<0.001	9.1	0.076	<0.005
	21-Jun-17	7.70	17.0	7	66	423	225	7.8	5	280	4	295	6.6	0.028	<0.001	13.7	0.077	<0.005
	18-Jul-17				82	397	215	7.8	2	280	2	233	7.8	0.062		12.1	<1.0	0.010
	16-Aug-17	7.27	19.0	2	67	493	260	7.5	6	320	5	272	8.0	0.146	0.0010	9.8	0.093	0.010
	26-Sep-17	7.21	13.0	2	95	480	221	7.9	2	330	2	163	5.0	0.042	<0.001	12.1	0.066	0.245
	30-Oct-17	7.58	2.0	5	55	480	244	7.9	2	315	2	215	4.4	0.028	<0.001	14.7	0.059	1.490
	20-Nov-17	7.27	0.7	5	80	409	197	7.6	3	265	3	170	5.4	0.010	<0.001	17.3	0.044	0.105

Table C.4: Surface Water Quality at SW20 (Pinewood River reference area) and SW22A (Pinewood River Effluent-exposed area), 2015 to 2017

Analytes		Nitrite (N)	Orthophosphate (P)	Sulphate	DOC	TOC	T. Aluminum (Al)	T. Antimony (Sb)	T. Arsenic (As)	T. Barium (Ba)	T. Beryllium (Be)	T. Bismuth (Bi)	T. Boron (B)	T. Cadmium (Cd)	T. Calcium (Ca)
Location	Sample Date	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	14-May-15	0.003	0.0030	5.92	22.9	26.0	0.25	0.00005	0.0006	0.0148	0.000010	0.000020	0.006	0.0000100	22.5
	09-Jun-15	0.001	0.0088	1.18	29.2	33.3	0.24	0.00005	0.0009	0.0159	0.000020	0.000020	0.015	0.0000150	20.4
	21-Jul-15	0.001	0.0222	0.56	37.6	35.8	0.18	0.00007	0.0017	0.0175	0.000020	0.000060	0.014	0.0000150	23.8
	25-Aug-15	0.001	0.0284	2.40	30.5	32.6	0.05	0.00007	0.0018	0.0127	0.000020	0.000040	0.016	0.0000050	38.6
	15-Sep-15	0.001	0.0056	1.46	32.0	32.1	0.03	0.00006	0.0013	0.0138	0.000020	0.000020	0.017	0.0000050	37.3
	27-Oct-15	0.001	0.0137	7.92	23.3	24.1	0.18	0.00005	0.0008	0.0145	0.000020	0.000220	0.018	0.0000050	38.6
	18-Nov-15	0.001	0.0128	11.70	22.9	22.7	0.30	0.00004	0.0008	0.0172	0.000020	0.000020	0.014	0.0000100	28.2
	17-Dec-15	0.001	0.0078	5.80	24.3	23.6	0.17	0.00005	0.0006	0.0132	0.000010	0.000020	0.007	0.0000050	23.4
	27-Jan-16	0.001	0.0199	6.82	28.8	28.5	0.28	0.00011	0.0010	0.0185	0.000020	0.000020	0.016	0.0000200	39.2
	29-Feb-16	0.002	0.0166	6.18	21.6	22.3	0.31	0.00007	0.0009	0.0200	0.000020	0.000020	0.015	0.0000150	36.0
	23-Mar-16	0.001	0.0043	6.64	24.0	22.3	0.32	0.00006	0.0005	0.0155	0.000020	0.000020	0.012	0.0000100	21.8
SW20 (Reference)	18-Apr-16	0.004	0.0046	7.10	18.6	19.5	0.42	0.00006	0.0006	0.0166	0.000020	0.000020	0.012	0.0000150	21.9
	18-May-16	0.001	0.0059	5.90	22.3	25.9	0.07	0.00007	0.0008	0.0170	0.000010	0.000020	0.017	0.0000050	31.6
	25-Jan-17	0.002	0.0135	5.98	24.6	22.6	0.20	0.00008	0.0008	0.0180	0.000030	<0.00002	0.012	0.0000200	31.8
	15-Feb-17	<0.001	0.0183	8.04	22.4	24.6	0.25	0.00005	0.0008	0.0190	0.000020	<0.00002	0.014	0.0000150	42.9
	29-Mar-17	0.001	0.0053	4.62	15.1	16.1	0.54	0.00005	0.0005	0.0150	0.000020	<0.00002	0.010	0.0000150	17.1
	26-Apr-17	<0.001	<0.0030	8.24	22.0	21.9	0.31	0.00006	0.0005	0.0170	0.000030	<0.00002	0.010	0.0000100	26.8
	24-May-17	<0.001	0.0073	5.38	23.4	24.0	0.13	0.00006	0.0008	0.0176	0.000020	<0.000005	0.014	0.0000072	31.0
	21-Jun-17	0.011	0.0178	2.44	26.4	28.1	0.02	0.00006	0.0015	0.0170	0.000020	<0.00002	0.016	<0.000005	33.7
	18-Jul-17	<0.001	0.0188	2.32	28.2	28.2	0.02	0.00006	0.0016	0.0160	0.000010	<0.00002	0.016	0.0000050	36.0
	16-Aug-17	<0.001	0.0075	0.50	33.8	32.2	0.01	0.00006	0.0014	0.0160	<0.00001	<0.00002	0.018	<0.000005	40.0
	26-Sep-17	0.002	0.0135	14.60	23.6	27.5	0.07	0.00008	0.0011	0.0210	0.000010	<0.00002	0.025	<0.000005	43.5
	30-Oct-17	<0.001	0.0052	8.12	22.3	23.1	0.07	0.00005	0.0006	0.0140	<0.00001	<0.00002	0.012	0.0000050	26.7
	20-Nov-17	<0.001	0.0047	10.50	20.8	22.7	0.13	0.00006	0.0006	0.0170	0.000010	<0.00002	0.009	0.0000050	28.8
	27-Jan-16	0.001	0.0432	4.80	26.7	27.1	0.18	0.00020	0.0010	0.0230	0.000030	<0.00002	0.014	0.0000150	49.0
	29-Feb-16	0.001	0.0551	5.72	24.2	25.6	0.19	0.00014	0.0011	0.0230	0.000020	<0.00002	0.014	0.0000150	47.7
	23-Mar-16	5.660	0.0091		19.8	20.1	0.45	0.00008	0.0006	0.0180	0.000020	<0.00002	0.013	0.0000100	26.2
	18-Apr-16	0.013	0.0050	6.88	16.9	18.5	0.17	0.00021	0.0006	0.0200	0.000010	<0.00002	0.016	0.0000100	33.4
	18-May-16	<0.001	0.0095	2.84	21.9	23.8	0.05	0.00012	0.0010	0.0190	0.000010	<0.00002	0.017	0.0000200	41.3
	22-Jun-16	<0.001	0.0259	3.32	25.1	28.6	0.11	0.00006	0.0012	0.0200	0.000020	<0.00002	0.018	0.0000100	29.4
	15-Jul-16	0.001	0.0494	2.26	27.6	27.5	0.06	0.00009	0.0017	0.0180	0.000020	<0.00002	0.016	0.0000100	29.5
	16-Aug-16	<0.001	0.0343	2.52	29.6	30.9	0.02	0.00012	0.0021	0.0210	0.000010	<0.00002	0.021	<0.000005	42.0
	19-Sep-16						0.03		0.0011					<0.000005	58.5
SW22 (Effluent-exposed)	21-Sep-16	0.025	0.0101	13.90	22.4	23.0	0.09	0.00086	0.0011	0.0240	<0.00001	<0.00002	0.025	<0.000005	52.1
	25-Jan-17	0.006	0.0371	9.38	24.5	23.9	0.15	0.00060	0.0010	0.0250	0.000030	<0.00002	0.019	0.0000200	48.5
	15-Feb-17	0.023	0.0223	21.40	16.9	19.1	0.12	0.00268	0.0011	0.0310	<0.00001	0.000020	0.040	0.0000100	70.6
	29-Mar-17	0.007	0.0102	4.86	12.8	12.6	0.42	0.00019	0.0005	0.0170	0.000020	<0.00002	0.012	0.0000200	21.4
	26-Apr-17	0.003	<0.0030	11.20	19.3	19.3	0.10	0.00032	0.0007	0.0190	<0.00001	<0.00002	0.015	0.0000050	37.4
	24-May-17	<0.001	0.0140	8.08	19.7	22.1	0.05	0.00011	0.0010	0.0210	0.000010	<0.000005	0.016	0.0000036	41.4
	21-Jun-17	0.002	0.0139	14.10	18.9	21.6	0.08	0.00045	0.0014	0.0250	0.000010	<0.00002	0.025	<0.000005	47.8
	18-Jul-17	<0.001	0.0377	14.20	23.7	24.6	0.05	0.00012	0.0020	0.0210	<0.00001	<0.00002	0.019	<0.000005	49.2
	16-Aug-17	0.001	0.0523	2.50	26.8	28.8	0.13	0.00010	0.0030	0.0150	<0.00001	<0.00002	0.026	0.0000050	64.3
	26-Sep-17	0.026	0.0172	73.10	24.0	27.2	0.07	0.00031	0.0011	0.0290	<0.00001	<0.00002	0.020	0.0000100	50.7
	30-Oct-17	0.030	0.0067	36.40	19.4	19.2	0.06	0.00038	0.0008	0.0270	<0.00001	<0.00002	0.020	0.0000050	55.3
	20-Nov-17	0.001	0.0091	21.60	21.0	22.6	0.12	0.00010	0.0008	0.0250	<0.00001	<0.00002	0.014	0.0000050	46.0

Table C.4: Surface Water Quality at SW20 (Pinewood River reference area) and SW22A (Pinewood River Effluent-exposed area), 2015 to 2017

Analytes		T. Chromium (Cr)	T. Cobalt (Co)	T. Copper (Cu)	T. Iron (Fe)	T. Lead (Pb)	T. Lithium (Li)	T. Magnesium (Mg)	T. Manganese (Mn)	T. Mercury (Hg)	T. Molybdenum (Mo)	T. Nickel (Ni)	T. Potassium (K)	T. Selenium (Se)	T. Silver (Ag)	T. Sodium (Na)
Location	Sample Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SW20 (Reference)	14-May-15	0.0005	0.00018	0.0008	0.35	0.00010	0.002	9.8	0.017	0.000002	0.00042	0.0015	1.23	0.00020	0.000010	7.64
	09-Jun-15	0.0007	0.00023	0.0009	0.48	0.00016	0.003	8.3	0.025	0.000002	0.00038	0.0016	0.88	0.00020	0.000010	4.74
	21-Jul-15	0.0006	0.00032	0.0014	0.79	0.00017	0.003	9.2	0.052	0.000004	0.00042	0.0019	0.97	0.00020	0.000010	5.14
	25-Aug-15	0.0004	0.00023	0.0004	0.79	0.00008	0.004	15.9	0.044	0.000002	0.00026	0.0020	1.44	0.00020	0.000010	7.46
	15-Sep-15	0.0003	0.00021	0.0004	0.42	0.00001	0.006	15.7	0.052	0.000002	0.00024	0.0017	1.40	0.00020	0.000010	8.76
	27-Oct-15	0.0004	0.00020	0.0007	0.53	0.00010	0.008	16.2	0.039	0.000002	0.00034	0.0014	2.09	0.00020	0.000010	10.00
	18-Nov-15	0.0006	0.00023	0.0011	0.56	0.00015	0.005	13.1	0.030	0.000002	0.00044	0.0014	2.14	0.00020	0.000010	10.10
	17-Dec-15	0.0004	0.00016	0.0006	0.47	0.00009	0.003	10.4	0.034	0.000002	0.00022	0.0010	1.23	0.00020	0.000010	5.16
	27-Jan-16	0.0006	0.00068	0.0008	1.57	0.00025	0.006	15.9	0.309	0.000002	0.00028	0.0016	1.76	0.00020	0.000010	6.00
	29-Feb-16	0.0007	0.00067	0.0012	1.35	0.00021	0.007	16.0	0.263	0.000002	0.00032	0.0014	1.91	0.00020	0.000010	6.12
	23-Mar-16	0.0006	0.00024	0.0012	0.46	0.00017	0.003	10.0	0.037	0.000004	0.00036	0.0012	1.85	0.00020	0.000010	6.08
	18-Apr-16	0.0008	0.00025	0.0012	0.48	0.00020	0.003	9.7	0.029	0.000004	0.00048	0.0014	1.60	0.00020	0.000010	5.70
	18-May-16	0.0003	0.00016	0.0009	0.29	0.00004	0.005	13.4	0.042	0.000002	0.00042	0.0014	1.37	0.00020	0.000010	8.64
	25-Jan-17	0.0011	0.00044	0.0010	0.88	0.00020	0.006	14.8	0.138	0.000004	0.00030	0.0015	1.70	<0.0002	<0.00001	6.36
	15-Feb-17	0.0007	0.00057	0.0009	1.19	0.00020	0.007	18.3	0.204	0.000002	0.00030	0.0017	1.91	<0.0002	<0.00001	8.28
	29-Mar-17	0.0008	0.00033	0.0010	0.55	0.00020	0.003	7.9	0.073	0.000002	0.00030	0.0011	2.17	<0.0002	<0.00001	4.74
	26-Apr-17	0.0006	0.00019	0.0020	0.41	0.00020	0.004	12.0	0.020	0.000002	0.00040	0.0014	1.49	<0.0002	<0.00001	8.90
	24-May-17	0.0004	0.00019	0.0009	0.37	0.00008	0.006	14.0	0.045	0.000004	0.00038	0.0015	1.21	0.00015	0.000001	9.87
	21-Jun-17	0.0003	0.00035	0.0005	0.54	0.00005	0.006	15.7	0.169	0.000002	0.00030	0.0016	1.01	<0.0002	<0.00001	13.10
	18-Jul-17	0.0003	0.00039	0.0004	0.45	0.00003	0.006	14.7	0.339	0.000004	0.00030	0.0017	0.85	0.00020	<0.00001	11.70
	16-Aug-17	0.0003	0.00031	0.0002	0.53	0.00002	0.006	17.0	0.147	0.000002	0.00010	0.0012	0.41	<0.0002	<0.00001	12.60
	26-Sep-17	0.0008	0.00021	0.0008	0.35	<0.00001	0.008	18.3	0.041	0.000004	0.00060	0.0017	2.45	<0.0002	<0.00001	19.00
	30-Oct-17	0.0003	0.00010	0.0006	0.21	0.00005	0.005	11.7	0.013	0.000002	0.00030	0.0010	1.70	<0.0002	<0.00001	8.74
	20-Nov-17	0.0006	0.00013	0.0007	0.34	0.00007	0.005	13.6	0.015	0.000004	0.00030	0.0011	1.27	<0.0002	<0.00001	8.52
SW22 (Effluent-exposed)	27-Jan-16	0.0005	0.00081	0.0009	1.31	0.00020	0.006	19.5	0.604	0.000002	0.00040	0.0016	1.78	<0.0002	<0.00001	4.84
	29-Feb-16	0.0005	0.00083	0.0009	1.58	0.00020	0.006	21.4	0.546	0.000002	0.00040	0.0018	1.82	<0.0002	<0.00001	5.74
	23-Mar-16	0.0008	0.00028	0.0015	0.62	0.00030	0.003	11.7	0.032	0.000004	0.00060	0.0014	2.03	<0.0002	<0.00001	3.28
	18-Apr-16	0.0005	0.00019	0.0011	0.29	0.00010	0.005	13.6	0.025	0.000004	0.00100	0.0012	1.95	<0.0002	<0.00001	4.20
	18-May-16	0.0003	0.00023	0.0009	0.29	0.00003	0.006	16.6	0.071	<0.000002	0.00070	0.0015	1.38	<0.0002	<0.00001	4.90
	22-Jun-16	0.0004	0.00022	0.0012	0.42	0.00008	0.003	13.4	0.040	<0.000002	0.00060	0.0017	1.28	0.00020	<0.00001	3.56
	15-Jul-16	0.0002	0.00023	0.0007	0.54	0.00005	0.004	14.1	0.064	0.000002	0.00060	0.0016	1.09	0.00020	<0.00001	3.22
	16-Aug-16	0.0002	0.00033	0.0004	0.37	0.00001	0.006	17.1	0.337	0.000004	0.00060	0.0015	1.20	0.00020	<0.00001	5.00
	19-Sep-16				0.20	0.00003		26.1		<0.000002	0.00260	0.0011		<0.0002		
	21-Sep-16	0.0002	0.00025	0.0004	0.28	0.00006	0.010	22.6	0.087	<0.000002	0.00160	0.0014	2.67	<0.0002	<0.00001	8.00
	25-Jan-17	0.0005	0.00056	0.0009	1.07	0.00020	0.009	21.9	0.312	0.000002	0.00090	0.0016	2.27	<0.0002	<0.00001	7.34
	15-Feb-17	0.0009	0.00045	0.0009	0.78	0.00010	0.015	29.7	0.295	<0.000002	0.00320	0.0024	3.83	<0.0002	<0.00001	12.60
	29-Mar-17	0.0008	0.00032	0.0013	0.55	0.00020	0.004	9.3	0.074	<0.000002	0.00070	0.0011	2.33	<0.0002	<0.00001	2.68
	26-Apr-17	0.0003	0.00015	0.0009	0.24	0.00006	0.008	16.4	0.022	0.000002	0.00120	0.0012	2.36	<0.0002	<0.00001	6.56
	24-May-17	0.0007	0.00021	0.0009	0.37	0.00004	0.007	18.3	0.072	<0.000002	0.00070	0.0016	1.64	0.00014	0.000001	5.87
	21-Jun-17	0.0003	0.00026	0.0007	0.29	0.00008	0.012	22.0	0.101	0.000002	0.00150	0.0015	2.01	<0.0002	<0.00001	8.58
	18-Jul-17	0.0002	0.00024	0.0003	0.24	0.00007	0.008	23.1	0.108	0.000004	0.00050	0.0014	1.52	0.00020	<0.00001	7.78
	16-Aug-17	0.0005	0.00046	0.0005	0.51	0.00010	0.010	28.1	0.947	0.000004	0.00120	0.0021	1.55	0.00020	<0.00001	8.98
	26-Sep-17	0.0003	0.00025	0.0010	0.27	<0.00001	0.009	23.0	0.034	0.000004	0.00170	0.0013	4.77	0.00040	<0.00001	9.72
	30-Oct-17	0.0004	0.00030	0.0010	0.24	0.00004	0.011	24.7	0.030	0.000002	0.00170	0.0012	4.07	<0.0002	<0.00001	10.40
	20-Nov-17	0.0004	0.00021	0.0010	0.31	0.00008	0.007	21.7	0.066	0.000002	0.00070	0.0015	2.67	<0.0002	<0.00001	8.62

Table C.4: Surface Water Quality at SW20 (Pinewood River reference area) and SW22A (Pinewood River Effluent-exposed area), 2015 to 2017

Analytes		T. Strontium (Sr)	T. Tellurium (Te)	T. Thallium (Tl)	T. Tin (Sn)	T. Titanium (Ti)	T. Tungsten (W)	T. Uranium (U)	T. Vanadium (V)	T. Zinc (Zn)	T. Zirconium (Zr)
Location	Sample Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	14-May-15	0.059	0.000010	0.0000020	0.000040	0.0066	0.000010	0.0005	0.00105	0.0015	0.00044
	09-Jun-15	0.053	0.000010	0.0000040	0.000060	0.0061	0.000010	0.0002	0.00120	0.0035	0.00050
	21-Jul-15	0.061	0.000020	0.0000060	0.000040	0.0051	0.000010	0.0002	0.00130	0.0040	0.00050
	25-Aug-15	0.097	0.000020	0.0000020	0.000080		0.000010	0.0003	0.00075	0.0020	0.00042
	15-Sep-15	0.102	0.000010	0.0000020	0.000040		0.000010	0.0003	0.00050	0.0025	0.00030
	27-Oct-15	0.104	0.000010	0.0000020	0.000040		0.000010	0.0006	0.00080	0.0030	0.00032
	18-Nov-15	0.071	0.000010	0.0000020	0.000100		0.000010	0.0006	0.00115	0.0030	0.00038
	17-Dec-15	0.057	0.000020	0.0000020	0.000020		0.000010	0.0003	0.00070	0.0015	0.00034
	27-Jan-16	0.100	0.000020	0.0000040	0.000040		0.000010	0.0005	0.00135	0.0025	0.00060
	29-Feb-16	0.100	0.000010	0.0000060	0.000020		0.000010	0.0007	0.00130	0.0040	0.00036
	23-Mar-16	0.052	0.000010	0.0000040	0.000120		0.000010	0.0005	0.00120	0.0035	0.00036
SW20 (Reference)	18-Apr-16	0.055									
	18-May-16	0.077	0.000010	0.0000020	0.000040	0.0023	0.000010	0.0005	0.00065	0.0015	0.00032
	25-Jan-17	0.087	0.000060	0.0000100	0.000200	0.0067	0.000020	0.0008	0.00095	0.0480	0.00040
	15-Feb-17	0.105	0.000020	0.0000060	0.000200	0.0072	<0.00001	0.0009	0.00120	0.0055	0.00040
	29-Mar-17	0.043	0.000010	0.0000080	0.000040	0.0153	0.000020	0.0002	0.00160	0.0035	0.00050
	26-Apr-17	0.069	0.000030	0.0000060	0.000060	0.0108	0.000010	0.0009	0.00120	0.0030	0.00050
	24-May-17	0.084	0.000040	0.0000020	0.000020	0.0042	0.000004	0.0007	0.00092	0.0016	0.00036
	21-Jun-17	0.088	0.000030	<0.000002	0.000040	0.0009	<0.00001	0.0004	0.00050	0.0225	0.00020
	18-Jul-17	0.093	0.000020	<0.000002	0.000100	0.0009	<0.00001	0.0003	0.00040	0.0040	0.00030
	16-Aug-17	0.101	0.000030	<0.000002	0.000100	0.0005	<0.00001	0.0001	0.00030	0.0055	0.00010
	26-Sep-17	0.117	0.000020	<0.000002	0.001100	0.0022	<0.00001	0.0007	0.00070	0.0025	0.00030
	30-Oct-17	0.067	0.000010	<0.000002	0.000040	0.0023	<0.00001	0.0003	0.00050	0.0020	0.00020
	20-Nov-17	0.070	<0.00001	<0.000002	0.000040	0.0035	<0.00001	0.0004	0.00070	0.0085	0.00030
	27-Jan-16	0.111	0.000020	0.0000040	0.000020		<0.00001	0.0011	0.00120	0.0050	0.00040
	29-Feb-16	0.113	<0.00001	0.0000040	0.000020		<0.00001	0.0014	0.00110	0.0050	0.00050
	23-Mar-16	0.055	<0.00001	0.0000060	0.000300		<0.00001	0.0008	0.00170	0.0035	0.00040
	18-Apr-16	0.079	0.000020	0.0000040			0.000020	0.0012	0.00095	0.0015	0.00030
	18-May-16	0.093	0.000020	<0.000002	0.000040		0.000010	0.0010	0.00070	0.0010	0.00030
	22-Jun-16	0.066	<0.00001	0.0000060	0.000040		0.000010	0.0004	0.00110	0.0030	0.00030
	15-Jul-16	0.067	0.000100	0.0000060	<0.00002		0.000020	0.0003	0.00095	0.0015	0.00030
	16-Aug-16	0.117	0.000020	<0.000002	<0.00002		<0.00001	0.0004	0.00040	<0.0005	0.00020
	19-Sep-16									0.0005	
SW22 (Effluent-exposed)	21-Sep-16	0.138	0.000020	0.0000020	0.000100		<0.00001	0.0009	0.00070	0.0005	0.00020
	25-Jan-17	0.137	0.000020	0.0000080	0.000040	0.0053	0.000020	0.0018	0.00100	0.0075	0.00050
	15-Feb-17	0.242	0.000040	0.0000060	0.000040	0.0040	0.000180	0.0024	0.00080	0.0095	0.00040
	29-Mar-17	0.056	0.000030	0.0000080	0.000060	0.0120	0.000030	0.0006	0.00150	0.0040	0.00060
	26-Apr-17	0.111	0.000020	<0.000002	0.000020	0.0033	0.000020	0.0015	0.00060	0.0015	0.00030
	24-May-17	0.105	0.000030	0.0000020	0.000030	0.0020	0.000020	0.0011	0.00072	0.0016	0.00023
	21-Jun-17	0.142	0.000030	<0.000002	0.000060	0.0025	0.000020	0.0011	0.00090	0.0035	0.00020
	18-Jul-17	0.125	0.000020	0.0000040	0.000100	0.0020	0.000010	0.0005	0.00060	0.0025	0.00030
	16-Aug-17	0.142	0.000050	0.0000040	0.000100	0.0046	<0.00001	0.0005	0.00100	0.0040	0.00050
	26-Sep-17	0.131	0.000030	<0.000002	0.000080	0.0023	<0.00001	0.0009	0.00080	0.0030	0.00020
	30-Oct-17	0.162	0.000020	0.0000020	0.000020	0.0022	0.000030	0.0036	0.00060	0.0030	0.00030
	20-Nov-17	0.113	0.000010	0.0000040	<0.00002	0.0037	<0.00001	0.0017	0.00070	0.0150	0.00030

Table C.5: Sediment Metal Concentrations in Sturgeon Creek and Pinewood River, RRP Phase 1 EEM, 2017

Parameter	PSQG		Units	Sturgeon Creek						Pinewood River					
				StuC-REF-1	StuC-REF-2	StuC-REF-3	StuC-REF-4	StuC-REF-5	Mean	PinR-EXP-1	PinR-EXP-2	PinR-EXP-3	PinR-EXP-4	PinR-EXP-5	Mean
	LEL	SEL		14-Sep-17	14-Sep-17	15-Sep-17	15-Sep-17	15-Sep-17		14-Sep-17	14-Sep-17	14-Sep-17	14-Sep-17	14-Sep-17	
Inorganics															
% Moisture	-	-	%	62.5	65.0	51.5	75.5	59.0	62.7	81.8	76.5	85.5	53.5	72.6	74.0
Total Kjeldahl Nitrogen	0.055	0.48	%	0.239	0.320	0.197	0.390	0.234	0.276	0.610	0.430	0.690	0.243	0.640	0.523
Total Organic Carbon	10,000	100,000	mg/kg	31,900	40,100	27,800	54,900	31,800	37,300	78,500	60,100	89,700	34,600	93,900	71,360
% Gravel	-	-	%	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
% Sand	-	-	%	27.3	11.9	30.9	6.8	22.3	19.8	8.3	16.0	2.4	30.8	10.7	13.6
% Silt	-	-	%	41.7	50.5	36.9	51.9	42.8	44.8	60.2	53.4	69.0	44.6	64.7	58.4
% Clay	-	-	%	31.0	37.6	32.2	41.3	34.8	35.4	31.5	30.5	28.6	24.6	24.6	28.0
Metals															
Aluminum	-	-	mg/kg	11,900	15,000	11,800	15,300	14,100	13,620	16,700	13,900	14,100	9,350	12,500	13,310
Antimony	-	-	mg/kg	<0.10	0.11	0.10	0.13	<0.10	0.11	0.14	0.19	0.16	0.11	0.15	0.15
Arsenic	-	-	mg/kg	2.47	2.87	2.13	3.34	2.32	2.63	4.36	3.75	4.83	2.23	2.85	3.60
Barium	-	-	mg/kg	71.4	98.6	68.4	106	90	87	129	120	111	61	93	103
Beryllium	-	-	mg/kg	0.45	0.56	0.51	0.62	0.53	0.53	0.62	0.65	0.56	0.44	0.52	0.56
Bismuth	-	-	mg/kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Boron	-	-	mg/kg	7.6	8.7	7.8	9.5	7.6	8.2	10.4	11.5	10.8	7.1	7.8	9.5
Cadmium	0.6	10	mg/kg	0.242	0.322	0.213	0.388	0.201	0.273	0.448	0.323	0.401	0.200	0.364	0.347
Calcium	-	-	mg/kg	6,330	7,330	6,670	7,960	6,470	6,952	13,700	20,200	18,500	11,600	10,200	14,840
Chromium	26	110	mg/kg	27.0	37.9	27.3	43.8	33.1	33.8	34.8	36.1	33.8	21.2	27.1	30.6
Cobalt	-	-	mg/kg	8.9	10.6	8.8	11.8	9.3	9.9	12.1	10.9	11.2	6.7	7.3	9.6
Copper	16	110	mg/kg	9.8	12.7	9.5	14.4	11.4	11.6	19.3	16.4	17.5	9.8	13.3	15.3
Iron	20,000	40,000	mg/kg	13,500	17,000	13,200	18,000	16,000	15,540	20,000	18,300	18,400	12,600	15,300	16,920
Lead	31	250	mg/kg	6.24	7.96	7.23	9.15	7.43	7.60	8.60	8.45	7.65	6.25	7.67	7.72
Lithium	-	-	mg/kg	14.0	19.1	14.7	18.8	16.4	16.6	18.2	16.3	17.7	12.2	13.8	15.6
Magnesium	-	-	mg/kg	4,880	5,670	4,660	6,000	5,260	5,294	7,950	10,100	10,400	6,770	4,830	8,010
Manganese	460	1,100	mg/kg	319	374	264	431	343	346	609	657	438	315	362	476
Mercury	0.2	2	mg/kg	0.039	0.051	0.041	0.061	0.048	0.048	0.063	0.051	0.059	0.049	0.054	0.055
Molybdenum	-	-	mg/kg	0.51	1.05	0.54	1.48	0.63	0.84	1.02	1.23	1.44	0.35	0.76	0.96
Nickel	16	75	mg/kg	16.9	23.4	16.5	26.8	19.8	20.7	24.8	25.2	25.0	14.9	18.8	21.7
Phosphorus	600	2,000	mg/kg	493	554	471	571	508	519	781	648	777	496	676	676
Potassium	-	-	mg/kg	1,440	1,780	1,380	1,960	1,610	1,634	1,790	1,600	1,760	1,040	1,280	1,494
Selenium	-	-	mg/kg	0.27	0.38	0.27	0.48	0.34	0.35	0.56	0.45	0.62	0.34	0.53	0.50
Silver	-	-	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium	-	-	mg/kg	88	103	85	111	95	96	148	131	171	96	113	132
Strontium	-	-	mg/kg	23.4	26.0	23.7	30.5	23.2	25.4	32.0	36.2	37.6	21.7	31.5	31.8
Sulphur	-	-	mg/kg	<1000	1,100	<1000	1,400	<1000	1100	1,700	1,400	2,400	<1000	1,600	1620
Thallium	-	-	mg/kg	0.135	0.166	0.156	0.186	0.154	0.159	0.187	0.178	0.177	0.122	0.135	0.160
Tin	-	-	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Titanium	-	-	mg/kg	155	152	162	148	145	152	118	149	138	137	98	128
Tungsten	-	-	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Uranium	-	-	mg/kg	1.4	1.8	1.6	2.2	1.6	1.7	1.9	1.5	2.1	1.1	2.1	1.7
Vanadium	-	-	mg/kg	32.4	40.2	31.8	44.1	36.6	37.0	42.9	39.8	40.5	25.0	34.0	36.4
Zinc	120	820	mg/kg	61	79	59	91	67	72	94	76	89	50	64	74
Zirconium	-	-	mg/kg	5.1	6.6	6.0	7.3	5.1	6.0	4.9	5.3	3.7	4.7	4.9	4.7

ndicates concentration was greater than the PSQG (Provincial Sediment Quality Guideline) Lowest Effect Level (LEL).

ndicates concentration was greater than the PSQG (Provincial Sediment Quality Guideline) Severe Effect Level (SEL).

Table C.6: Principal Components Analysis (PCA) of Sediment Metals at RRP Phase 1 EEM Benthic Stations, 2017

Water Chemistry Parameter	Sediment Chemistry PC-1 (69.7%)	Sediment Chemistry PC-2 (16.2%)	Sediment Chemistry PC-3 (6.2%)
Aluminum (log10 [ng/kg])	0.850	0.428	-0.126
Antimony (log10 [ng/kg])	0.752	-0.506	0.106
Arsenic (log10 [ng/kg])	0.933	-0.273	0.095
Barium (log10 [ng/kg])	0.972	0.030	-0.021
Beryllium (log10 [ng/kg])	0.905	0.230	0.091
Boron (log10 [ng/kg])	0.920	-0.082	0.351
Cadmium (log10 [ng/kg])	0.895	-0.133	-0.290
Calcium (log10 [ng/kg])	0.599	-0.697	0.352
Chromium (log10 [ng/kg])	0.806	0.566	0.023
Cobalt (log10 [ng/kg])	0.840	0.428	0.242
Copper (log10 [ng/kg])	0.965	-0.223	-0.003
Iron (log10 [ng/kg])	0.977	0.089	0.010
Lead (log10 [ng/kg])	0.864	0.306	-0.150
Lithium (log10 [ng/kg])	0.810	0.527	0.016
Magnesium (log10 [ng/kg])	0.671	-0.458	0.550
Manganese (log10 [ng/kg])	0.851	-0.182	0.261
Mercury (log10 [ng/kg])	0.812	-0.185	-0.293
Molybdenum (log10 [ng/kg])	0.947	0.176	-0.010
Nickel (log10 [ng/kg])	0.961	0.225	0.059
Phosphorus (log10 [ng/kg])	0.846	-0.477	-0.160
Potassium (log10 [ng/kg])	0.799	0.552	0.034
Selenium (log10 [ng/kg])	0.851	-0.411	-0.277
Sodium (log10 [ng/kg])	0.867	-0.455	0.070
Strontium (log10 [ng/kg])	0.893	-0.323	0.007
Sulphur (log10 [ng/kg])	0.805	-0.472	-0.166
Thallium (log10 [ng/kg])	0.881	0.368	0.186
Titanium (log10 [ng/kg])	-0.227	0.604	0.702
Uranium (log10 [ng/kg])	0.745	0.183	-0.558
Vanadium (log10 [ng/kg])	0.905	0.391	-0.063
Zinc (log10 [ng/kg])	0.947	0.245	-0.041
Zirconium (log10 [ng/kg])	-0.045	0.825	-0.131

Note: Shading Indicates Heavy Positive or Negative Weighting.

WATER AND SEDIMENT QUALITY DATA

Laboratory Reports

MINNOW ENVIRONMENTAL INC.
ATTN: Jess Tester
2 Lamb Street
Georgetown ON L7G 3M9

Date Received: 26-APR-17
Report Date: 15-MAY-17 10:26 (MT)
Version: FINAL

Client Phone: 905-873-3371

Certificate of Analysis

Lab Work Order #: L1917630
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

C. Paradis

Christine Paradis
Project Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1917630-1 TRIP BLANK Sampled By: KB, KM on 24-APR-17 @ 00:01 Matrix: Water							
Physical Tests							
Hardness (as CaCO3)	<0.50		0.50	mg/L		29-APR-17	
Total Suspended Solids	<2.0		2.0	mg/L		27-APR-17	R3710052
Total Dissolved Solids	<10		10	mg/L		28-APR-17	R3710285
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	<2.0		2.0	mg/L		28-APR-17	R3710141
Ammonia, Total (as N)	<0.020		0.020	mg/L		28-APR-17	R3709907
Chloride (Cl)	<0.10		0.10	mg/L		27-APR-17	R3709534
Fluoride (F)	<0.020		0.020	mg/L		27-APR-17	R3709534
Nitrate and Nitrite as N	<0.040		0.040	mg/L		03-MAY-17	
Nitrate (as N)	<0.020		0.020	mg/L		27-APR-17	R3709534
Nitrite (as N)	<0.010		0.010	mg/L		27-APR-17	R3709534
Phosphorus (P)-Total	<0.0030		0.0030	mg/L	27-APR-17	28-APR-17	R3709801
Sulfate (SO4)	<0.30		0.30	mg/L		27-APR-17	R3709534
Cyanides							
Cyanide, Weak Acid Diss	<0.0020		0.0020	mg/L		27-APR-17	R3709375
Cyanide, Total	<0.0020		0.0020	mg/L		27-APR-17	R3709375
Organic / Inorganic Carbon							
Dissolved Carbon Filtration Location	FIELD					27-APR-17	R3709199
Dissolved Organic Carbon	<1.0		1.0	mg/L	27-APR-17	27-APR-17	R3709687
Total Organic Carbon	<1.0		1.0	mg/L		27-APR-17	R3709678
Total Metals							
Aluminum (Al)-Total	<0.0030		0.0030	mg/L	27-APR-17	28-APR-17	R3710164
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Arsenic (As)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Barium (Ba)-Total	<0.000050		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Boron (B)-Total	<0.010		0.010	mg/L	27-APR-17	28-APR-17	R3710164
Cadmium (Cd)-Total	<0.0000050		0.0000050	mg/L	27-APR-17	28-APR-17	R3710164
Calcium (Ca)-Total	<0.050		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Cesium (Cs)-Total	<0.000010		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Chromium (Cr)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Cobalt (Co)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Copper (Cu)-Total	<0.00050		0.00050	mg/L	27-APR-17	28-APR-17	R3710164
Iron (Fe)-Total	<0.010		0.010	mg/L	27-APR-17	28-APR-17	R3710164
Lead (Pb)-Total	<0.000050		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Lithium (Li)-Total	<0.0010		0.0010	mg/L	27-APR-17	28-APR-17	R3710164
Magnesium (Mg)-Total	<0.0050		0.0050	mg/L	27-APR-17	28-APR-17	R3710164
Manganese (Mn)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Mercury (Hg)-Total	<0.0000050		0.0000050	mg/L		27-APR-17	R3709180
Molybdenum (Mo)-Total	<0.000050		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Nickel (Ni)-Total	<0.00050		0.00050	mg/L	27-APR-17	28-APR-17	R3710164

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1917630-1 TRIP BLANK Sampled By: KB, KM on 24-APR-17 @ 00:01 Matrix: Water							
Total Metals							
Phosphorus (P)-Total	<0.050		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Potassium (K)-Total	<0.050		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Rubidium (Rb)-Total	<0.00020		0.00020	mg/L	27-APR-17	28-APR-17	R3710164
Selenium (Se)-Total	<0.000050		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Silicon (Si)-Total	<0.10		0.10	mg/L	27-APR-17	28-APR-17	R3710164
Silver (Ag)-Total	<0.000010		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Sodium (Na)-Total	<0.050		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Strontium (Sr)-Total	<0.00020		0.00020	mg/L	27-APR-17	28-APR-17	R3710164
Sulfur (S)-Total	<0.50		0.50	mg/L	27-APR-17	28-APR-17	R3710164
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	27-APR-17	28-APR-17	R3710164
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Thorium (Th)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Tin (Sn)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Titanium (Ti)-Total	<0.00030		0.00030	mg/L	27-APR-17	28-APR-17	R3710164
Tungsten (W)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Uranium (U)-Total	<0.000010		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Vanadium (V)-Total	<0.00050		0.00050	mg/L	27-APR-17	28-APR-17	R3710164
Zinc (Zn)-Total	<0.0030		0.0030	mg/L	27-APR-17	28-APR-17	R3710164
Zirconium (Zr)-Total	<0.000060		0.000060	mg/L	27-APR-17	28-APR-17	R3710164
Dissolved Metals							
Dissolved Metals Filtration Location	FIELD					27-APR-17	R3709282
Calcium (Ca)-Dissolved	<0.050		0.050	mg/L	27-APR-17	28-APR-17	R3710183
Magnesium (Mg)-Dissolved	<0.0050		0.0050	mg/L	27-APR-17	28-APR-17	R3710183
Radiological Parameters							
Ra-226	<0.010		0.010	Bq/L		10-MAY-17	R3719745
L1917630-2 PINR-EXP Sampled By: KB, KM on 24-APR-17 @ 13:00 Matrix: Water							
Physical Tests							
Hardness (as CaCO3)	191		0.50	mg/L		29-APR-17	
Total Suspended Solids	<2.0		2.0	mg/L		27-APR-17	R3710052
Total Dissolved Solids	236		20	mg/L		28-APR-17	R3710285
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	190		2.0	mg/L		28-APR-17	R3710141
Ammonia, Total (as N)	0.077		0.020	mg/L		27-APR-17	R3709259
Chloride (Cl)	10.9		0.10	mg/L		27-APR-17	R3709534
Fluoride (F)	0.070		0.020	mg/L		27-APR-17	R3709534
Nitrate and Nitrite as N	0.913		0.040	mg/L		03-MAY-17	
Nitrate (as N)	0.890		0.020	mg/L		27-APR-17	R3709534
Nitrite (as N)	0.023		0.010	mg/L		27-APR-17	R3709534
Phosphorus (P)-Total	0.0185		0.0030	mg/L	27-APR-17	28-APR-17	R3709801
Sulfate (SO4)	16.8		0.30	mg/L		27-APR-17	R3709534

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1917630-2 PINR-EXP Sampled By: KB, KM on 24-APR-17 @ 13:00 Matrix: Water							
Anions and Nutrients							
Cyanides							
Cyanide, Weak Acid Diss	<0.0020		0.0020	mg/L		27-APR-17	R3709375
Cyanide, Total	<0.0020		0.0020	mg/L		27-APR-17	R3709375
Organic / Inorganic Carbon							
Dissolved Carbon Filtration Location	FIELD					27-APR-17	R3709199
Dissolved Organic Carbon	16.6		1.0	mg/L	27-APR-17	27-APR-17	R3709687
Total Organic Carbon	16.7		1.0	mg/L		27-APR-17	R3709678
Total Metals							
Aluminum (Al)-Total	0.0624		0.0030	mg/L	27-APR-17	28-APR-17	R3710164
Antimony (Sb)-Total	0.00121		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Arsenic (As)-Total	0.00076		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Barium (Ba)-Total	0.0223		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Boron (B)-Total	0.026		0.010	mg/L	27-APR-17	28-APR-17	R3710164
Cadmium (Cd)-Total	0.0000056		0.0000050	mg/L	27-APR-17	28-APR-17	R3710164
Calcium (Ca)-Total	42.0		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Cesium (Cs)-Total	0.000013		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Chromium (Cr)-Total	0.00023		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Cobalt (Co)-Total	0.00015		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Copper (Cu)-Total	0.00095		0.00050	mg/L	27-APR-17	28-APR-17	R3710164
Iron (Fe)-Total	0.196		0.010	mg/L	27-APR-17	28-APR-17	R3710164
Lead (Pb)-Total	0.000059		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Lithium (Li)-Total	0.0097		0.0010	mg/L	27-APR-17	28-APR-17	R3710164
Magnesium (Mg)-Total	18.5		0.0050	mg/L	27-APR-17	28-APR-17	R3710164
Manganese (Mn)-Total	0.0284		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Mercury (Hg)-Total	<0.0000050		0.0000050	mg/L		27-APR-17	R3709180
Molybdenum (Mo)-Total	0.00263		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Nickel (Ni)-Total	0.00117		0.00050	mg/L	27-APR-17	28-APR-17	R3710164
Phosphorus (P)-Total	<0.050		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Potassium (K)-Total	3.08		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Rubidium (Rb)-Total	0.00190		0.00020	mg/L	27-APR-17	28-APR-17	R3710164
Selenium (Se)-Total	0.000170		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Silicon (Si)-Total	1.40		0.10	mg/L	27-APR-17	28-APR-17	R3710164
Silver (Ag)-Total	<0.000010		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Sodium (Na)-Total	8.92		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Strontium (Sr)-Total	0.158		0.00020	mg/L	27-APR-17	28-APR-17	R3710164
Sulfur (S)-Total	6.06		0.50	mg/L	27-APR-17	28-APR-17	R3710164
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	27-APR-17	28-APR-17	R3710164
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Thorium (Th)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Tin (Sn)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1917630-2 PINR-EXP Sampled By: KB, KM on 24-APR-17 @ 13:00 Matrix: Water							
Total Metals							
Titanium (Ti)-Total	0.00217		0.00030	mg/L	27-APR-17	28-APR-17	R3710164
Tungsten (W)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Uranium (U)-Total	0.00184		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Vanadium (V)-Total	0.00079		0.00050	mg/L	27-APR-17	28-APR-17	R3710164
Zinc (Zn)-Total	<0.0030		0.0030	mg/L	27-APR-17	28-APR-17	R3710164
Zirconium (Zr)-Total	0.000240		0.000060	mg/L	27-APR-17	28-APR-17	R3710164
Dissolved Metals							
Dissolved Metals Filtration Location	FIELD					27-APR-17	R3709282
Calcium (Ca)-Dissolved	43.5		0.050	mg/L	27-APR-17	28-APR-17	R3710183
Magnesium (Mg)-Dissolved	19.9		0.0050	mg/L	27-APR-17	28-APR-17	R3710183
Radiological Parameters							
Ra-226	<0.010		0.010	Bq/L		10-MAY-17	R3719745
L1917630-3 PINR-DUP Sampled By: KB, KM on 24-APR-17 @ 13:00 Matrix: Water							
Physical Tests							
Hardness (as CaCO3)	182		0.50	mg/L		29-APR-17	
Total Suspended Solids	2.3		2.0	mg/L		27-APR-17	R3710052
Total Dissolved Solids	163		20	mg/L		28-APR-17	R3710285
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	187		2.0	mg/L		28-APR-17	R3710141
Ammonia, Total (as N)	0.078		0.020	mg/L		27-APR-17	R3709259
Chloride (Cl)	10.7		0.10	mg/L		27-APR-17	R3709534
Fluoride (F)	0.067		0.020	mg/L		27-APR-17	R3709534
Nitrate and Nitrite as N	0.899		0.040	mg/L		03-MAY-17	
Nitrate (as N)	0.876		0.020	mg/L		27-APR-17	R3709534
Nitrite (as N)	0.023		0.010	mg/L		27-APR-17	R3709534
Phosphorus (P)-Total	0.0163		0.0030	mg/L	27-APR-17	28-APR-17	R3709801
Sulfate (SO4)	16.5		0.30	mg/L		27-APR-17	R3709534
Cyanides							
Cyanide, Weak Acid Diss	<0.0020		0.0020	mg/L		27-APR-17	R3709375
Cyanide, Total	<0.0020		0.0020	mg/L		27-APR-17	R3709375
Organic / Inorganic Carbon							
Dissolved Carbon Filtration Location	FIELD					27-APR-17	R3709199
Dissolved Organic Carbon	16.3		1.0	mg/L	27-APR-17	27-APR-17	R3709687
Total Organic Carbon	17.0		1.0	mg/L		27-APR-17	R3709678
Total Metals							
Aluminum (Al)-Total	0.0625		0.0030	mg/L	27-APR-17	28-APR-17	R3710164
Antimony (Sb)-Total	0.00126		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Arsenic (As)-Total	0.00080		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Barium (Ba)-Total	0.0229		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1917630-3 PINR-DUP Sampled By: KB, KM on 24-APR-17 @ 13:00 Matrix: Water							
Total Metals							
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Boron (B)-Total	0.027		0.010	mg/L	27-APR-17	28-APR-17	R3710164
Cadmium (Cd)-Total	0.0000071		0.0000050	mg/L	27-APR-17	28-APR-17	R3710164
Calcium (Ca)-Total	42.7		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Cesium (Cs)-Total	0.000013		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Chromium (Cr)-Total	0.00024		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Cobalt (Co)-Total	0.00015		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Copper (Cu)-Total	0.00098		0.00050	mg/L	27-APR-17	28-APR-17	R3710164
Iron (Fe)-Total	0.201		0.010	mg/L	27-APR-17	28-APR-17	R3710164
Lead (Pb)-Total	0.000052		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Lithium (Li)-Total	0.0101		0.0010	mg/L	27-APR-17	28-APR-17	R3710164
Magnesium (Mg)-Total	19.7		0.0050	mg/L	27-APR-17	28-APR-17	R3710164
Manganese (Mn)-Total	0.0288		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Mercury (Hg)-Total	<0.0000050		0.0000050	mg/L		27-APR-17	R3709180
Molybdenum (Mo)-Total	0.00263		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Nickel (Ni)-Total	0.00122		0.00050	mg/L	27-APR-17	28-APR-17	R3710164
Phosphorus (P)-Total	<0.050		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Potassium (K)-Total	3.13		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Rubidium (Rb)-Total	0.00195		0.00020	mg/L	27-APR-17	28-APR-17	R3710164
Selenium (Se)-Total	0.000183		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Silicon (Si)-Total	1.43		0.10	mg/L	27-APR-17	28-APR-17	R3710164
Silver (Ag)-Total	<0.000010		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Sodium (Na)-Total	9.15		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Strontium (Sr)-Total	0.155		0.00020	mg/L	27-APR-17	28-APR-17	R3710164
Sulfur (S)-Total	5.75		0.50	mg/L	27-APR-17	28-APR-17	R3710164
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	27-APR-17	28-APR-17	R3710164
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Thorium (Th)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Tin (Sn)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Titanium (Ti)-Total	0.00260		0.00030	mg/L	27-APR-17	28-APR-17	R3710164
Tungsten (W)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Uranium (U)-Total	0.00187		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Vanadium (V)-Total	0.00078		0.00050	mg/L	27-APR-17	28-APR-17	R3710164
Zinc (Zn)-Total	<0.0030		0.0030	mg/L	27-APR-17	28-APR-17	R3710164
Zirconium (Zr)-Total	0.000243		0.000060	mg/L	27-APR-17	28-APR-17	R3710164
Dissolved Metals							
Dissolved Metals Filtration Location	FIELD					27-APR-17	R3709282
Calcium (Ca)-Dissolved	41.6		0.050	mg/L	27-APR-17	28-APR-17	R3710183
Magnesium (Mg)-Dissolved	19.1		0.0050	mg/L	27-APR-17	28-APR-17	R3710183
Radiological Parameters							
Ra-226	<0.010		0.010	Bq/L		10-MAY-17	R3719745

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1917630-4 STUC-REF							
Sampled By: KB, KM on 24-APR-17 @ 14:40							
Matrix: Water							
Physical Tests							
Hardness (as CaCO3)	98.1		0.50	mg/L		29-APR-17	
Total Suspended Solids	9.4		2.0	mg/L		27-APR-17	R3710052
Total Dissolved Solids	225		13	mg/L		28-APR-17	R3710285
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	83.1		2.0	mg/L		28-APR-17	R3710141
Ammonia, Total (as N)	<0.020		0.020	mg/L		27-APR-17	R3709259
Chloride (Cl)	6.19		0.10	mg/L		27-APR-17	R3709534
Fluoride (F)	0.041		0.020	mg/L		27-APR-17	R3709534
Nitrate and Nitrite as N	<0.040		0.040	mg/L		03-MAY-17	
Nitrate (as N)	<0.020		0.020	mg/L		27-APR-17	R3709534
Nitrite (as N)	<0.010		0.010	mg/L		27-APR-17	R3709534
Phosphorus (P)-Total	0.0402		0.0030	mg/L	27-APR-17	28-APR-17	R3709801
Sulfate (SO4)	9.38		0.30	mg/L		27-APR-17	R3709534
Cyanides							
Cyanide, Weak Acid Diss	<0.0020		0.0020	mg/L		27-APR-17	R3709375
Cyanide, Total	<0.0020		0.0020	mg/L		27-APR-17	R3709375
Organic / Inorganic Carbon							
Dissolved Carbon Filtration Location	FIELD					27-APR-17	R3709199
Dissolved Organic Carbon	28.3		1.0	mg/L	27-APR-17	27-APR-17	R3709687
Total Organic Carbon	28.8		1.0	mg/L		27-APR-17	R3709678
Total Metals							
Aluminum (Al)-Total	0.552		0.0030	mg/L	27-APR-17	28-APR-17	R3710164
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Arsenic (As)-Total	0.00086		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Barium (Ba)-Total	0.0171		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Boron (B)-Total	0.011		0.010	mg/L	27-APR-17	28-APR-17	R3710164
Cadmium (Cd)-Total	0.0000152		0.0000050	mg/L	27-APR-17	28-APR-17	R3710164
Calcium (Ca)-Total	22.7		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Cesium (Cs)-Total	0.000075		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Chromium (Cr)-Total	0.00124		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Cobalt (Co)-Total	0.00044		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Copper (Cu)-Total	0.00185		0.00050	mg/L	27-APR-17	28-APR-17	R3710164
Iron (Fe)-Total	0.829		0.010	mg/L	27-APR-17	28-APR-17	R3710164
Lead (Pb)-Total	0.000367		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Lithium (Li)-Total	0.0043		0.0010	mg/L	27-APR-17	28-APR-17	R3710164
Magnesium (Mg)-Total	10.7		0.0050	mg/L	27-APR-17	28-APR-17	R3710164
Manganese (Mn)-Total	0.0502		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Mercury (Hg)-Total	<0.0000050		0.0000050	mg/L		27-APR-17	R3709180
Molybdenum (Mo)-Total	0.000414		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Nickel (Ni)-Total	0.00207		0.00050	mg/L	27-APR-17	28-APR-17	R3710164

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1917630-4 STUC-REF Sampled By: KB, KM on 24-APR-17 @ 14:40 Matrix: Water							
Total Metals							
Phosphorus (P)-Total	0.051		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Potassium (K)-Total	1.83		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Rubidium (Rb)-Total	0.00224		0.00020	mg/L	27-APR-17	28-APR-17	R3710164
Selenium (Se)-Total	0.000185		0.000050	mg/L	27-APR-17	28-APR-17	R3710164
Silicon (Si)-Total	2.98		0.10	mg/L	27-APR-17	28-APR-17	R3710164
Silver (Ag)-Total	<0.000010		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Sodium (Na)-Total	4.00		0.050	mg/L	27-APR-17	28-APR-17	R3710164
Strontium (Sr)-Total	0.0580		0.00020	mg/L	27-APR-17	28-APR-17	R3710164
Sulfur (S)-Total	3.38		0.50	mg/L	27-APR-17	28-APR-17	R3710164
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	27-APR-17	28-APR-17	R3710164
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Thorium (Th)-Total	0.00011		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Tin (Sn)-Total	0.00011		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Titanium (Ti)-Total	0.0162		0.00030	mg/L	27-APR-17	28-APR-17	R3710164
Tungsten (W)-Total	<0.00010		0.00010	mg/L	27-APR-17	28-APR-17	R3710164
Uranium (U)-Total	0.000887		0.000010	mg/L	27-APR-17	28-APR-17	R3710164
Vanadium (V)-Total	0.00225		0.00050	mg/L	27-APR-17	28-APR-17	R3710164
Zinc (Zn)-Total	0.0086		0.0030	mg/L	27-APR-17	28-APR-17	R3710164
Zirconium (Zr)-Total	0.000648		0.000060	mg/L	27-APR-17	28-APR-17	R3710164
Dissolved Metals							
Dissolved Metals Filtration Location	FIELD					27-APR-17	R3709282
Calcium (Ca)-Dissolved	22.0		0.050	mg/L	27-APR-17	28-APR-17	R3710183
Magnesium (Mg)-Dissolved	10.5		0.0050	mg/L	27-APR-17	28-APR-17	R3710183
Radiological Parameters							
Ra-226	<0.010		0.010	Bq/L		10-MAY-17	R3719745

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1917630-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1917630-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1917630-1, -2, -3, -4
Matrix Spike	Total Organic Carbon	MS-B	L1917630-1, -2, -3, -4

Sample Parameter Qualifier key listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-TB	Water	Alkalinity	APHA 2320B modified
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
CL-L-IC-N-TB	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CN-T-CFA-TB	Water	Total Cyanide by CFA	ISO 14403-2:2012 (modified)
This analysis is carried out using procedures adapted from ISO Method 14403:2002 "Determination of Total Cyanide using Flow Analysis (FIA and CFA)". Total or strong acid dissociable (SAD) cyanide is determined by in-line UV digestion along with sample distillation and final determination by colourimetric analysis. Method Limitation: This method is susceptible to interference from thiocyanate (SCN). If SCN is present in the sample, there could be a positive interference with this method, but it would be less than 1% and could be as low as zero.			
CN-WAD-CFA-TB	Water	Weak Acid Dissociable Cyanide by CFA	APHA 4500-CN CYANIDE (modified)
This analysis is carried out using procedures adapted from APHA Method 4500-CN I. "Weak Acid Dissociable Cyanide". Weak Acid Dissociable (WAD) cyanide is determined by in-line sample distillation with final determination by colourimetric analysis.			
DOC-TB	Water	Dissolved Organic Carbon	APHA 5310 B modified
Water samples are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis. Analyzed by converting all carbonaceous material to carbon dioxide (CO2) by catalytic combustion at 850?C. The CO2 generated is measured by an infrared detector and is directly proportional to concentration of carbonaceous material in the sample			
ETL-N2N3-TB	Water	Calculate from NO2 + NO3	Calculation
F-IC-N-TB	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HARDNESS-CALC-TB	Water	Hardness (as CaCO3)	CALCULATION
HG-T-CVAF-TB	Water	Total Mercury in Water by CVAFS	EPA 1631E (mod)
Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAFS.			
MET-D-CCMS-TB	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
MET-T-CCMS-TB	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)
Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
NH3-COL-TB	Water	Ammonia by Discrete Analyzer	APHA 4500-NH3 G. (modified)
Ammonia in aqueous matrices is analyzed using discrete analyzer with colourimetric detection.			
NO2-IC-N-TB	Water	Nitrite in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-IC-N-TB	Water	Nitrate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
P-T-COL-TB	Water	Total Phosphorus by Discrete Analyzer	APHA 4500-P B, F, G (modified)
Phosphorus in aqueous matrices is analyzed using discrete Analyzer with colourimetric detection.			
SO4-IC-N-TB	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			

Reference Information

TDS-TB	Water	Total Dissolved Solids	APHA 2540 C (modified)

Aqueous matrices are analyzed using gravimetry and evaporation

TOC-TB	Water	Total Organic Carbon (TOC)	APHA 5310 B modified

Water samples are analyzed by converting all carbonaceous material to carbon dioxide (CO_2) by catalytic combustion at 850?C. The CO_2 generated is measured by an infrared detector and is directly proportional to concentration of carbonaceous material in the sample

TSS-TB	Water	Total Suspended Solids	APHA 2540 D (modified)

Aqueous matrices are analyzed using gravimetry

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
TB	ALS ENVIRONMENTAL - THUNDER BAY, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: MINNOW ENVIRONMENTAL INC.
2 Lamb Street
Georgetown ON L7G 3M9
Contact: Jess Tester

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-TB	**Water**							
Batch R3710141								
WG2518890-2 LCS								
Alkalinity, Total (as CaCO3)			104.5		%		85-115	28-APR-17
WG2518890-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	28-APR-17
CL-L-IC-N-TB	**Water**							
Batch R3709534								
WG2517980-3 DUP		**L1917630-2**						
Chloride (Cl)		10.9	10.8		mg/L	1.4	20	27-APR-17
WG2517980-2 LCS								
Chloride (Cl)			103.2		%		90-110	27-APR-17
WG2517980-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	27-APR-17
WG2517980-4 MS		**L1917630-2**						
Chloride (Cl)			94.8		%		75-125	27-APR-17
CN-T-CFA-TB	**Water**							
Batch R3709375								
WG2518143-3 DUP		**L1917630-2**						
Cyanide, Total		<0.0020	<0.0020	RPD-NA	mg/L	N/A	20	27-APR-17
WG2518143-2 LCS								
Cyanide, Total			89.8		%		80-120	27-APR-17
WG2518143-1 MB								
Cyanide, Total			<0.0020		mg/L		0.002	27-APR-17
WG2518143-4 MS		**L1917630-2**						
Cyanide, Total			88.4		%		75-125	27-APR-17
CN-WAD-CFA-TB	**Water**							
Batch R3709375								
WG2518143-3 DUP		**L1917630-2**						
Cyanide, Weak Acid Diss		<0.0020	<0.0020	RPD-NA	mg/L	N/A	20	27-APR-17
WG2518143-2 LCS								
Cyanide, Weak Acid Diss			108.3		%		80-120	27-APR-17
WG2518143-1 MB								
Cyanide, Weak Acid Diss			<0.0020		mg/L		0.002	27-APR-17
WG2518143-4 MS		**L1917630-2**						
Cyanide, Weak Acid Diss			104.4		%		75-125	27-APR-17
DOC-TB	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
DOC-TB	**Water**							
Batch R3709687								
WG2518230-3 DUP		**L1917630-4**						
Dissolved Organic Carbon		28.3	28.4		mg/L	0.6	20	27-APR-17
WG2518230-2 LCS								
Dissolved Organic Carbon			103.0		%		80-120	27-APR-17
WG2518230-1 MB								
Dissolved Organic Carbon			<1.0		mg/L		1	27-APR-17
WG2518230-4 MS		**L1917630-4**						
Dissolved Organic Carbon			N/A	MS-B	%		-	27-APR-17
F-IC-N-TB	**Water**							
Batch R3709534								
WG2517980-3 DUP		**L1917630-2**						
Fluoride (F)		0.070	0.068		mg/L	2.9	20	27-APR-17
WG2517980-2 LCS								
Fluoride (F)			102.1		%		90-110	27-APR-17
WG2517980-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	27-APR-17
WG2517980-4 MS		**L1917630-2**						
Fluoride (F)			86.4		%		75-125	27-APR-17
HG-T-CVAF-TB	**Water**							
Batch R3709180								
WG2518150-3 DUP		**L1917630-1**						
Mercury (Hg)-Total		<0.0000050	<0.000005(	RPD-NA	mg/L	N/A	20	27-APR-17
WG2518150-2 LCS								
Mercury (Hg)-Total			95.5		%		80-120	27-APR-17
WG2518150-1 MB								
Mercury (Hg)-Total			<0.000005(		mg/L		0.000005	27-APR-17
WG2518150-4 MS		**L1917630-2**						
Mercury (Hg)-Total			93.8		%		70-130	27-APR-17
MET-D-CCMS-TB	**Water**							
Batch R3710183								
WG2518212-3 DUP		**L1917630-2**						
Calcium (Ca)-Dissolved		43.5	43.5		mg/L	0.1	20	28-APR-17
Magnesium (Mg)-Dissolved		19.9	20.3		mg/L	1.8	20	28-APR-17
WG2518212-2 LCS								
Calcium (Ca)-Dissolved			104.7		%		80-120	28-APR-17
Magnesium (Mg)-Dissolved			109.6		%		80-120	28-APR-17
WG2518212-1 MB								
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	28-APR-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-TB	**Water**							
Batch R3710183								
WG2518212-1 MB								
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	28-APR-17
WG2518212-4 MS		**L1917630-2**						
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	28-APR-17
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	28-APR-17
MET-T-CCMS-TB	**Water**							
Batch R3710164								
WG2518004-2 LCS								
Aluminum (Al)-Total			103.8		%		80-120	28-APR-17
Antimony (Sb)-Total			101.7		%		80-120	28-APR-17
Arsenic (As)-Total			99.4		%		80-120	28-APR-17
Barium (Ba)-Total			93.9		%		80-120	28-APR-17
Beryllium (Be)-Total			105.0		%		80-120	28-APR-17
Bismuth (Bi)-Total			100.6		%		80-120	28-APR-17
Boron (B)-Total			104.0		%		80-120	28-APR-17
Cadmium (Cd)-Total			97.1		%		80-120	28-APR-17
Calcium (Ca)-Total			99.9		%		80-120	28-APR-17
Cesium (Cs)-Total			102.5		%		80-120	28-APR-17
Chromium (Cr)-Total			99.2		%		80-120	28-APR-17
Cobalt (Co)-Total			100.3		%		80-120	28-APR-17
Copper (Cu)-Total			98.9		%		80-120	28-APR-17
Iron (Fe)-Total			104.2		%		80-120	28-APR-17
Lead (Pb)-Total			102.2		%		80-120	28-APR-17
Lithium (Li)-Total			105.8		%		80-120	28-APR-17
Magnesium (Mg)-Total			104.6		%		80-120	28-APR-17
Manganese (Mn)-Total			99.8		%		80-120	28-APR-17
Molybdenum (Mo)-Total			93.8		%		80-120	28-APR-17
Nickel (Ni)-Total			99.4		%		80-120	28-APR-17
Phosphorus (P)-Total			106.2		%		70-130	28-APR-17
Potassium (K)-Total			109.2		%		80-120	28-APR-17
Rubidium (Rb)-Total			98.8		%		80-120	28-APR-17
Selenium (Se)-Total			94.9		%		80-120	28-APR-17
Silicon (Si)-Total			111.5		%		60-140	28-APR-17
Silver (Ag)-Total			103.0		%		80-120	28-APR-17
Sodium (Na)-Total			107.6		%		80-120	28-APR-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R3710164								
WG2518004-2 LCS								
Strontium (Sr)-Total			97.6		%		80-120	28-APR-17
Sulfur (S)-Total			102.8		%		80-120	28-APR-17
Tellurium (Te)-Total			91.7		%		80-120	28-APR-17
Thallium (Tl)-Total			100.3		%		80-120	28-APR-17
Thorium (Th)-Total			104.1		%		80-120	28-APR-17
Tin (Sn)-Total			95.9		%		80-120	28-APR-17
Titanium (Ti)-Total			100.9		%		80-120	28-APR-17
Tungsten (W)-Total			101.7		%		80-120	28-APR-17
Uranium (U)-Total			107.8		%		80-120	28-APR-17
Vanadium (V)-Total			101.1		%		80-120	28-APR-17
Zinc (Zn)-Total			92.9		%		80-120	28-APR-17
Zirconium (Zr)-Total			93.5		%		80-120	28-APR-17
WG2518004-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	28-APR-17
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	28-APR-17
Arsenic (As)-Total			<0.00010		mg/L		0.0001	28-APR-17
Barium (Ba)-Total			<0.000050		mg/L		0.00005	28-APR-17
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	28-APR-17
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	28-APR-17
Boron (B)-Total			<0.010		mg/L		0.01	28-APR-17
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	28-APR-17
Calcium (Ca)-Total			<0.050		mg/L		0.05	28-APR-17
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	28-APR-17
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	28-APR-17
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	28-APR-17
Copper (Cu)-Total			<0.00050		mg/L		0.0005	28-APR-17
Iron (Fe)-Total			<0.010		mg/L		0.01	28-APR-17
Lead (Pb)-Total			<0.000050		mg/L		0.00005	28-APR-17
Lithium (Li)-Total			<0.0010		mg/L		0.001	28-APR-17
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	28-APR-17
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	28-APR-17
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	28-APR-17
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	28-APR-17
Phosphorus (P)-Total			<0.050		mg/L		0.05	28-APR-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R3710164								
WG2518004-1 MB								
Potassium (K)-Total			<0.050		mg/L		0.05	28-APR-17
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	28-APR-17
Selenium (Se)-Total			<0.000050		mg/L		0.00005	28-APR-17
Silicon (Si)-Total			<0.10		mg/L		0.1	28-APR-17
Silver (Ag)-Total			<0.000010		mg/L		0.00001	28-APR-17
Sodium (Na)-Total			<0.050		mg/L		0.05	28-APR-17
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	28-APR-17
Sulfur (S)-Total			<0.50		mg/L		0.5	28-APR-17
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	28-APR-17
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	28-APR-17
Thorium (Th)-Total			<0.00010		mg/L		0.0001	28-APR-17
Tin (Sn)-Total			<0.00010		mg/L		0.0001	28-APR-17
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	28-APR-17
Tungsten (W)-Total			<0.00010		mg/L		0.0001	28-APR-17
Uranium (U)-Total			<0.000010		mg/L		0.00001	28-APR-17
Vanadium (V)-Total			<0.00050		mg/L		0.0005	28-APR-17
Zinc (Zn)-Total			<0.0030		mg/L		0.003	28-APR-17
Zirconium (Zr)-Total			<0.000060		mg/L		0.00006	28-APR-17
NH3-COL-TB	**Water**							
Batch R3709259								
WG2518112-2 LCS								
Ammonia, Total (as N)			99.2		%		85-115	27-APR-17
WG2518112-1 MB								
Ammonia, Total (as N)			<0.020		mg/L		0.02	27-APR-17
Batch R3709907								
WG2518804-2 LCS								
Ammonia, Total (as N)			101.4		%		85-115	28-APR-17
WG2518804-1 MB								
Ammonia, Total (as N)			<0.020		mg/L		0.02	28-APR-17
NO2-IC-N-TB	**Water**							
Batch R3709534								
WG2517980-3 DUP		**L1917630-2**						
Nitrite (as N)		0.023	0.022		mg/L	3.4	20	27-APR-17
WG2517980-2 LCS								
Nitrite (as N)			103.3		%		90-110	27-APR-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-IC-N-TB	**Water**							
Batch R3709534								
WG2517980-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	27-APR-17
WG2517980-4 MS		**L1917630-2**						
Nitrite (as N)			96.2		%		75-125	27-APR-17
NO3-IC-N-TB	**Water**							
Batch R3709534								
WG2517980-3 DUP		**L1917630-2**						
Nitrate (as N)		0.890	0.868		mg/L	2.5	20	27-APR-17
WG2517980-2 LCS								
Nitrate (as N)			100.7		%		90-110	27-APR-17
WG2517980-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	27-APR-17
WG2517980-4 MS		**L1917630-2**						
Nitrate (as N)			93.5		%		75-125	27-APR-17
P-T-COL-TB	**Water**							
Batch R3709801								
WG2518015-2 LCS								
Phosphorus (P)-Total			92.3		%		80-120	28-APR-17
WG2518015-1 MB								
Phosphorus (P)-Total			<0.0030		mg/L		0.003	28-APR-17
SO4-IC-N-TB	**Water**							
Batch R3709534								
WG2517980-3 DUP		**L1917630-2**						
Sulfate (SO4)		16.8	16.5		mg/L	2.2	20	27-APR-17
WG2517980-2 LCS								
Sulfate (SO4)			103.6		%		90-110	27-APR-17
WG2517980-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	27-APR-17
WG2517980-4 MS		**L1917630-2**						
Sulfate (SO4)			91.5		%		75-125	27-APR-17
TDS-TB	**Water**							
Batch R3710285								
WG2519146-2 LCS								
Total Dissolved Solids			97.0		%		85-115	28-APR-17
WG2519146-1 MB								
Total Dissolved Solids			<10		mg/L		10	28-APR-17
TOC-TB	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TOC-TB	**Water**							
Batch R3709678								
WG2517867-3 DUP		**L1917630-2**						
Total Organic Carbon		16.7	16.6		mg/L	0.7	20	27-APR-17
WG2517867-2 LCS								
Total Organic Carbon			101.9		%		80-120	27-APR-17
WG2517867-1 MB								
Total Organic Carbon			<1.0		mg/L		1	27-APR-17
WG2517867-4 MS		**L1917630-2**						
Total Organic Carbon			N/A	MS-B	%		-	27-APR-17
TSS-TB	**Water**							
Batch R3710052								
WG2517986-3 DUP		**L1917630-4**						
Total Suspended Solids		9.4	8.4		mg/L	10	20	27-APR-17
WG2517986-2 LCS								
Total Suspended Solids			96.9		%		85-115	27-APR-17
WG2517986-1 MB								
Total Suspended Solids			<2.0		mg/L		2	27-APR-17

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Maxxam
A Bureau Veritas Group Company

Your P.O. #: L1917630

Attention:Bobbie Caratti

ALS Laboratory Group
Environmental Div.
1081 Barton St.
Thunder Bay, ON
Canada P7B 5N3

Report Date: 2017/05/12
Report #: R4458453
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B786605
Received: 2017/05/01, 09:45

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Radium Isotopes by Alpha Spectrometry (1)	4	N/A	2017/05/10	BQL SOP-00006 BQL SOP-00017 BQL SOP-00032	Alpha Spectrometry

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam’s profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
(1) Radium-226 results have not been corrected for blanks.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6790 Kitimat Rd, Unit 4, Mississauga, ON L5N 5L9 Phone: (905) 826-3080 Fax: (905) 826-4151 Toll Free: 1 877-726-3080 www.maxxam.ca

Your P.O. #: L1917630

Attention:Bobbie Caratti

ALS Laboratory Group
Environmental Div.
1081 Barton St.
Thunder Bay, ON
Canada P7B 5N3

Report Date: 2017/05/12
Report #: R4458453
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B786605
Received: 2017/05/01, 09:45

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Simona Vatamanescu, Project Manager
Email: SVatamanescu@maxxam.ca
Phone# (905)826-3080
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B786605
Report Date: 2017/05/12

ALS Laboratory Group
Your P.O. #: L1917630

RESULTS OF ANALYSES OF WATER

Maxxam ID		EHM962	EHM963	EHM964	EHM965		
Sampling Date		2017/04/24	2017/04/24	2017/04/24	2017/04/24		
	UNITS	**L1917630-1 TRIP BLANK**	**L1917630-2 PINR EXP**	**L1917630-3 PINR DUP**	**L1917630-4 STUC REF**	**RDL**	**QC Batch**
Radium-226	Bq/L	<0.010	<0.010	<0.010	<0.010	0.010	4965003

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Analytics International Corporation o/a Maxxam Analytics 6790 Kitimat Rd, Unit 4, Mississauga, ON L5N 5L9 Phone: (905) 826-3080 Fax: (905) 826-4151 Toll Free: 1 877-726-3080 www.maxxam.ca

Maxxam Job #: B786605
Report Date: 2017/05/12

ALS Laboratory Group
Your P.O. #: L1917630

TEST SUMMARY

Maxxam ID: EHM962
Sample ID: L1917630-1 TRIP BLANK
Matrix: Water

Collected: 2017/04/24
Shipped:
Received: 2017/05/01

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Radium Isotopes by Alpha Spectrometry	AS	4965003	N/A	2017/05/10	Faiz Ahmed

Maxxam ID: EHM963
Sample ID: L1917630-2 PINR EXP
Matrix: Water

Collected: 2017/04/24
Shipped:
Received: 2017/05/01

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Radium Isotopes by Alpha Spectrometry	AS	4965003	N/A	2017/05/10	Faiz Ahmed

Maxxam ID: EHM964
Sample ID: L1917630-3 PINR DUP
Matrix: Water

Collected: 2017/04/24
Shipped:
Received: 2017/05/01

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Radium Isotopes by Alpha Spectrometry	AS	4965003	N/A	2017/05/10	Faiz Ahmed

Maxxam ID: EHM965
Sample ID: L1917630-4 STUC REF
Matrix: Water

Collected: 2017/04/24
Shipped:
Received: 2017/05/01

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Radium Isotopes by Alpha Spectrometry	AS	4965003	N/A	2017/05/10	Faiz Ahmed

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GENERAL COMMENTS

Results relate only to the items tested.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6790 Kitimat Rd, Unit 4, Mississauga, ON L5N 5L9 Phone: (905) 826-3080 Fax: (905) 826-4151 Toll Free: 1 877-726-3080 www.maxxam.ca

Maxxam Job #: B786605
Report Date: 2017/05/12

ALS Laboratory Group
Your P.O. #: L1917630

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
4965003	FA5	Spiked Blank	Radium-226	2017/05/09		92	%	85 - 115
4965003	FA5	Method Blank	Radium-226	2017/05/09	<0.010		Bq/L	
4965003	FA5	RPD	Radium-226	2017/05/09	NC		%	N/A

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Donald Burgess, Senior Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1917630-COFC

COC Number: 15 -

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minnow Environmental Inc.
Contact:	Jess Tester
Phone:	905-873-3371
	Company address below will appear on the final report
Street:	2 Lamb Street
City/Province:	Georgetown, ON
Postal Code:	L7G 3M9
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax jtester@minnow.ca

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax jtester@minnow.ca

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #: Q59584

Job #:

PO / AFE:

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only): L1917630

ALS Contact:

Sampler: KB, KM

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Alkalinity, Cl, F, SO4, NO2, NO3 (NO2+NO3)	Total Metals	Total Mercury	Dissolved Ca, Mg, Hardness (F/P) 3 Dissolved Metals	Total Ammonia, Total Phosphorus, TOC	Total Cyanide, WAD Cyanide	TSS, TDS	DOC (L)	Radium 226	Supplies				Number of Containers
	Trip Blank	24-Apr-17	—	Water	x	x	x	x	x	x	x	x	x	x				9
	PinR-EXP	24-Apr-17	13:00	Water	x	x	x	x	x	x	x	x	x					9
	PinR-DUP	24-Apr-17	13:00	Water	x	x	x	x	x	x	x	x	x					9
	StuC-REF	24-Apr-17	14:40	Water	x	x	x	x	x	x	x	x	x					9

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human drinking water use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

DOC and dissolved metals field filtered. Trip Blank unopened.

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☑ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C: 1.5

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: [signature]	Date: 2017-04-25	Time: 11:00	Received by: SD	Date: April 26/17	Time: 12:55	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

1. If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

SD

MINNOW ENVIRONMENTAL INC.
ATTN: Jess Tester
2 Lamb Street
Georgetown ON L7G 3M9

Date Received: 14-SEP-17
Report Date: 10-OCT-17 14:26 (MT)
Version: FINAL

Client Phone: 905-873-3371

Certificate of Analysis

Lab Work Order #: L1991701

Project P.O. #: NOT SUBMITTED
Job Reference: 17-12
C of C Numbers:
Legal Site Desc:

C. Paradis

Christine Paradis
Project Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1991701-1 PINR-EXP Sampled By: KB/PS on 13-SEP-17 @ 16:05 Matrix: WATER							
Physical Tests							
Hardness (as CaCO3)	257		0.50	mg/L		23-SEP-17	
Total Suspended Solids	4.6		2.0	mg/L		16-SEP-17	R3830323
Total Dissolved Solids	308		20	mg/L		16-SEP-17	R3830357
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	260		2.0	mg/L		15-SEP-17	R3829746
Ammonia, Total (as N)	0.027		0.020	mg/L		15-SEP-17	R3830865
Chloride (Cl)	12.5		0.10	mg/L		15-SEP-17	R3829990
Fluoride (F)	0.081		0.020	mg/L		15-SEP-17	R3829990
Nitrate (as N)	0.102		0.020	mg/L		15-SEP-17	R3829990
Nitrite (as N)	<0.010		0.010	mg/L		15-SEP-17	R3829990
Phosphorus (P)-Total	0.0324		0.0030	mg/L	15-SEP-17	18-SEP-17	R3831652
Sulfate (SO4)	1.79		0.30	mg/L		15-SEP-17	R3829990
Cyanides							
Cyanide, Weak Acid Diss	<0.0020		0.0020	mg/L		19-SEP-17	R3833513
Cyanide, Total	<0.0020		0.0020	mg/L		19-SEP-17	R3833513
Organic / Inorganic Carbon							
Dissolved Carbon Filtration Location	FIELD					18-SEP-17	R3831015
Dissolved Organic Carbon	28.7		1.0	mg/L	18-SEP-17	18-SEP-17	R3831540
Total Organic Carbon	29.1		1.0	mg/L		18-SEP-17	R3831570
Total Metals							
Aluminum (Al)-Total	0.0915		0.0030	mg/L	17-SEP-17	22-SEP-17	R3836532
Antimony (Sb)-Total	0.00017		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Arsenic (As)-Total	0.00145		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Barium (Ba)-Total	0.0220		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Boron (B)-Total	0.015		0.010	mg/L	17-SEP-17	22-SEP-17	R3836532
Cadmium (Cd)-Total	0.0000056		0.0000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Calcium (Ca)-Total	58.4		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Cesium (Cs)-Total	0.000011		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Chromium (Cr)-Total	0.00032		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Cobalt (Co)-Total	0.00025		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Copper (Cu)-Total	<0.00050		0.00050	mg/L	17-SEP-17	22-SEP-17	R3836532
Iron (Fe)-Total	0.201		0.010	mg/L	17-SEP-17	22-SEP-17	R3836532
Lead (Pb)-Total	0.000074		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Lithium (Li)-Total	0.0115		0.0010	mg/L	17-SEP-17	22-SEP-17	R3836532
Magnesium (Mg)-Total	28.5		0.0050	mg/L	17-SEP-17	22-SEP-17	R3836532
Manganese (Mn)-Total	0.0840		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Mercury (Hg)-Total	<0.0000050		0.0000050	mg/L		17-SEP-17	R3830424
Molybdenum (Mo)-Total	0.000185		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Nickel (Ni)-Total	0.00111		0.00050	mg/L	17-SEP-17	22-SEP-17	R3836532
Phosphorus (P)-Total	0.053		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1991701-1 PINR-EXP Sampled By: KB/PS on 13-SEP-17 @ 16:05 Matrix: WATER							
Total Metals							
Potassium (K)-Total	2.13		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Rubidium (Rb)-Total	0.00158		0.00020	mg/L	17-SEP-17	22-SEP-17	R3836532
Selenium (Se)-Total	0.000177		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Silicon (Si)-Total	2.66		0.10	mg/L	17-SEP-17	22-SEP-17	R3836532
Silver (Ag)-Total	<0.000010		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Sodium (Na)-Total	9.17		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Strontium (Sr)-Total	0.124		0.00020	mg/L	17-SEP-17	22-SEP-17	R3836532
Sulfur (S)-Total	1.20		0.50	mg/L	17-SEP-17	22-SEP-17	R3836532
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	17-SEP-17	22-SEP-17	R3836532
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Thorium (Th)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Tin (Sn)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Titanium (Ti)-Total	0.00279		0.00030	mg/L	17-SEP-17	22-SEP-17	R3836532
Tungsten (W)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Uranium (U)-Total	0.000525		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Vanadium (V)-Total	0.00079		0.00050	mg/L	17-SEP-17	22-SEP-17	R3836532
Zinc (Zn)-Total	0.0038		0.0030	mg/L	17-SEP-17	22-SEP-17	R3836532
Zirconium (Zr)-Total	0.000170		0.000060	mg/L	17-SEP-17	22-SEP-17	R3836532
Dissolved Metals							
Dissolved Metals Filtration Location	FIELD					21-SEP-17	R3835536
Calcium (Ca)-Dissolved	56.4		0.050	mg/L	21-SEP-17	21-SEP-17	R3835809
Magnesium (Mg)-Dissolved	28.2		0.0050	mg/L	21-SEP-17	21-SEP-17	R3835809
Radiological Parameters							
Ra-226	<0.010		0.010	Bq/L		27-SEP-17	R3840929
L1991701-2 PINR-DUP Sampled By: KB/PS on 13-SEP-17 @ 16:05 Matrix: WATER							
Physical Tests							
Hardness (as CaCO3)	262		0.50	mg/L		23-SEP-17	
Total Suspended Solids	4.3		2.0	mg/L		16-SEP-17	R3830323
Total Dissolved Solids	305		20	mg/L		16-SEP-17	R3830357
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	245		2.0	mg/L		15-SEP-17	R3829746
Ammonia, Total (as N)	0.053		0.020	mg/L		15-SEP-17	R3830865
Chloride (Cl)	12.4		0.10	mg/L		15-SEP-17	R3829990
Fluoride (F)	0.081		0.020	mg/L		15-SEP-17	R3829990
Nitrate (as N)	2.95		0.020	mg/L		15-SEP-17	R3829990
Nitrite (as N)	<0.010		0.010	mg/L		15-SEP-17	R3829990
Phosphorus (P)-Total	0.0337		0.0030	mg/L	15-SEP-17	18-SEP-17	R3831652
Sulfate (SO4)	2.44		0.30	mg/L		15-SEP-17	R3829990
Cyanides							
Cyanide, Weak Acid Diss	<0.0020		0.0020	mg/L		19-SEP-17	R3833513

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1991701-2 PINR-DUP Sampled By: KB/PS on 13-SEP-17 @ 16:05 Matrix: WATER							
Cyanides							
Cyanide, Total	<0.0020		0.0020	mg/L		19-SEP-17	R3833513
Organic / Inorganic Carbon							
Dissolved Carbon Filtration Location	FIELD					18-SEP-17	R3831015
Dissolved Organic Carbon	29.3		1.0	mg/L	18-SEP-17	18-SEP-17	R3831540
Total Organic Carbon	29.5		1.0	mg/L		18-SEP-17	R3831570
Total Metals							
Aluminum (Al)-Total	0.0947		0.0030	mg/L	17-SEP-17	22-SEP-17	R3836532
Antimony (Sb)-Total	0.00018		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Arsenic (As)-Total	0.00153		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Barium (Ba)-Total	0.0226		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Boron (B)-Total	0.015		0.010	mg/L	17-SEP-17	22-SEP-17	R3836532
Cadmium (Cd)-Total	<0.0000050		0.0000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Calcium (Ca)-Total	57.9		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Cesium (Cs)-Total	0.000013		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Chromium (Cr)-Total	0.00034		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Cobalt (Co)-Total	0.00027		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Copper (Cu)-Total	<0.00050		0.00050	mg/L	17-SEP-17	22-SEP-17	R3836532
Iron (Fe)-Total	0.219		0.010	mg/L	17-SEP-17	22-SEP-17	R3836532
Lead (Pb)-Total	0.000068		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Lithium (Li)-Total	0.0119		0.0010	mg/L	17-SEP-17	22-SEP-17	R3836532
Magnesium (Mg)-Total	29.7		0.0050	mg/L	17-SEP-17	22-SEP-17	R3836532
Manganese (Mn)-Total	0.0921		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Mercury (Hg)-Total	<0.0000050		0.0000050	mg/L		17-SEP-17	R3830424
Molybdenum (Mo)-Total	0.000187		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Nickel (Ni)-Total	0.00114		0.00050	mg/L	17-SEP-17	22-SEP-17	R3836532
Phosphorus (P)-Total	0.064		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Potassium (K)-Total	2.19		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Rubidium (Rb)-Total	0.00156		0.00020	mg/L	17-SEP-17	22-SEP-17	R3836532
Selenium (Se)-Total	0.000172		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Silicon (Si)-Total	2.79		0.10	mg/L	17-SEP-17	22-SEP-17	R3836532
Silver (Ag)-Total	<0.000010		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Sodium (Na)-Total	9.45		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Strontium (Sr)-Total	0.124		0.00020	mg/L	17-SEP-17	22-SEP-17	R3836532
Sulfur (S)-Total	1.67		0.50	mg/L	17-SEP-17	22-SEP-17	R3836532
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	17-SEP-17	22-SEP-17	R3836532
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Thorium (Th)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Tin (Sn)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Titanium (Ti)-Total	0.00303		0.00030	mg/L	17-SEP-17	22-SEP-17	R3836532

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1991701-2 PINR-DUP Sampled By: KB/PS on 13-SEP-17 @ 16:05 Matrix: WATER							
Total Metals							
Tungsten (W)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Uranium (U)-Total	0.000516		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Vanadium (V)-Total	0.00082		0.00050	mg/L	17-SEP-17	22-SEP-17	R3836532
Zinc (Zn)-Total	<0.0030		0.0030	mg/L	17-SEP-17	22-SEP-17	R3836532
Zirconium (Zr)-Total	0.000165		0.000060	mg/L	17-SEP-17	22-SEP-17	R3836532
Dissolved Metals							
Dissolved Metals Filtration Location	FIELD					21-SEP-17	R3835536
Calcium (Ca)-Dissolved	57.8		0.050	mg/L	21-SEP-17	21-SEP-17	R3835809
Magnesium (Mg)-Dissolved	28.5		0.0050	mg/L	21-SEP-17	21-SEP-17	R3835809
Radiological Parameters							
Ra-226	<0.010		0.010	Bq/L		27-SEP-17	R3840929
L1991701-3 STUC-REF Sampled By: KB/PS on 13-SEP-17 @ 14:09 Matrix: WATER							
Physical Tests							
Hardness (as CaCO3)	174		0.50	mg/L		23-SEP-17	
Total Suspended Solids	14.5		2.0	mg/L		16-SEP-17	R3830323
Total Dissolved Solids	239		20	mg/L		16-SEP-17	R3830357
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	166		2.0	mg/L		15-SEP-17	R3829746
Ammonia, Total (as N)	0.097		0.020	mg/L		15-SEP-17	R3830865
Chloride (Cl)	6.26		0.10	mg/L		15-SEP-17	R3829990
Fluoride (F)	0.073		0.020	mg/L		15-SEP-17	R3829990
Nitrate (as N)	0.078		0.020	mg/L		15-SEP-17	R3829990
Nitrite (as N)	<0.010		0.010	mg/L		15-SEP-17	R3829990
Phosphorus (P)-Total	0.107		0.030	mg/L	15-SEP-17	18-SEP-17	R3831652
Sulfate (SO4)	1.33		0.30	mg/L		15-SEP-17	R3829990
Cyanides							
Cyanide, Weak Acid Diss	<0.0020		0.0020	mg/L		19-SEP-17	R3833513
Cyanide, Total	<0.0020		0.0020	mg/L		19-SEP-17	R3833513
Organic / Inorganic Carbon							
Dissolved Carbon Filtration Location	FIELD					18-SEP-17	R3831015
Dissolved Organic Carbon	35.7		1.0	mg/L	18-SEP-17	18-SEP-17	R3831540
Total Organic Carbon	37.3		1.0	mg/L		18-SEP-17	R3831570
Total Metals							
Aluminum (Al)-Total	0.435		0.0030	mg/L	17-SEP-17	22-SEP-17	R3836532
Antimony (Sb)-Total	0.00017		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Arsenic (As)-Total	0.00217		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Barium (Ba)-Total	0.0237		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Boron (B)-Total	0.016		0.010	mg/L	17-SEP-17	22-SEP-17	R3836532

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1991701-3 STUC-REF Sampled By: KB/PS on 13-SEP-17 @ 14:09 Matrix: WATER							
Total Metals							
Cadmium (Cd)-Total	0.0000089		0.0000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Calcium (Ca)-Total	40.9		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Cesium (Cs)-Total	0.000054		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Chromium (Cr)-Total	0.00091		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Cobalt (Co)-Total	0.00065		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Copper (Cu)-Total	0.00110		0.00050	mg/L	17-SEP-17	22-SEP-17	R3836532
Iron (Fe)-Total	0.870		0.010	mg/L	17-SEP-17	22-SEP-17	R3836532
Lead (Pb)-Total	0.000369		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Lithium (Li)-Total	0.0072		0.0010	mg/L	17-SEP-17	22-SEP-17	R3836532
Magnesium (Mg)-Total	18.9		0.0050	mg/L	17-SEP-17	22-SEP-17	R3836532
Manganese (Mn)-Total	0.220		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Mercury (Hg)-Total	<0.0000050		0.0000050	mg/L		17-SEP-17	R3830424
Molybdenum (Mo)-Total	0.000516		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Nickel (Ni)-Total	0.00237		0.00050	mg/L	17-SEP-17	22-SEP-17	R3836532
Phosphorus (P)-Total	0.150		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Potassium (K)-Total	1.78		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Rubidium (Rb)-Total	0.00196		0.00020	mg/L	17-SEP-17	22-SEP-17	R3836532
Selenium (Se)-Total	0.000241		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Silicon (Si)-Total	2.92		0.10	mg/L	17-SEP-17	22-SEP-17	R3836532
Silver (Ag)-Total	<0.000010		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Sodium (Na)-Total	5.63		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Strontium (Sr)-Total	0.105		0.00020	mg/L	17-SEP-17	22-SEP-17	R3836532
Sulfur (S)-Total	1.01		0.50	mg/L	17-SEP-17	22-SEP-17	R3836532
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	17-SEP-17	22-SEP-17	R3836532
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Thorium (Th)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Tin (Sn)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Titanium (Ti)-Total	0.0127		0.00030	mg/L	17-SEP-17	22-SEP-17	R3836532
Tungsten (W)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Uranium (U)-Total	0.00152		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Vanadium (V)-Total	0.00242		0.00050	mg/L	17-SEP-17	22-SEP-17	R3836532
Zinc (Zn)-Total	0.0038		0.0030	mg/L	17-SEP-17	22-SEP-17	R3836532
Zirconium (Zr)-Total	0.000521		0.000060	mg/L	17-SEP-17	22-SEP-17	R3836532
Dissolved Metals							
Dissolved Metals Filtration Location	FIELD					21-SEP-17	R3835536
Calcium (Ca)-Dissolved	39.9		0.050	mg/L	21-SEP-17	21-SEP-17	R3835809
Magnesium (Mg)-Dissolved	18.0		0.0050	mg/L	21-SEP-17	21-SEP-17	R3835809
Radiological Parameters							
Ra-226	<0.010		0.010	Bq/L		27-SEP-17	R3840929
L1991701-4 FIELD BLANK Sampled By: KB/PS on 13-SEP-17 @ 14:09 Matrix: WATER							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1991701-4 FIELD BLANK Sampled By: KB/PS on 13-SEP-17 @ 14:09 Matrix: WATER							
Physical Tests							
Hardness (as CaCO3)	<0.50		0.50	mg/L		23-SEP-17	
Total Suspended Solids	<2.0		2.0	mg/L		16-SEP-17	R3830323
Total Dissolved Solids	<10		10	mg/L		16-SEP-17	R3830357
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	<2.0		2.0	mg/L		15-SEP-17	R3829746
Ammonia, Total (as N)	0.102	RRV	0.020	mg/L		19-SEP-17	R3831519
Chloride (Cl)	<0.10		0.10	mg/L		15-SEP-17	R3829990
Fluoride (F)	<0.020		0.020	mg/L		15-SEP-17	R3829990
Nitrate (as N)	<0.020		0.020	mg/L		15-SEP-17	R3829990
Nitrite (as N)	<0.010		0.010	mg/L		15-SEP-17	R3829990
Phosphorus (P)-Total	<0.0030		0.0030	mg/L	15-SEP-17	18-SEP-17	R3831652
Sulfate (SO4)	<0.30		0.30	mg/L		15-SEP-17	R3829990
Cyanides							
Cyanide, Weak Acid Diss	<0.0020		0.0020	mg/L		19-SEP-17	R3833513
Cyanide, Total	<0.0020		0.0020	mg/L		19-SEP-17	R3833513
Organic / Inorganic Carbon							
Dissolved Carbon Filtration Location	FIELD					18-SEP-17	R3831015
Dissolved Organic Carbon	<1.0		1.0	mg/L	18-SEP-17	18-SEP-17	R3831540
Total Organic Carbon	<1.0		1.0	mg/L		18-SEP-17	R3831570
Total Metals							
Aluminum (Al)-Total	<0.0030		0.0030	mg/L	17-SEP-17	22-SEP-17	R3836532
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Arsenic (As)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Barium (Ba)-Total	<0.000050		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Boron (B)-Total	<0.010		0.010	mg/L	17-SEP-17	22-SEP-17	R3836532
Cadmium (Cd)-Total	<0.0000050		0.0000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Calcium (Ca)-Total	<0.050		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Cesium (Cs)-Total	<0.000010		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Chromium (Cr)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Cobalt (Co)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Copper (Cu)-Total	<0.00050		0.00050	mg/L	17-SEP-17	22-SEP-17	R3836532
Iron (Fe)-Total	<0.010		0.010	mg/L	17-SEP-17	22-SEP-17	R3836532
Lead (Pb)-Total	<0.000050		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Lithium (Li)-Total	<0.0010		0.0010	mg/L	17-SEP-17	22-SEP-17	R3836532
Magnesium (Mg)-Total	<0.0050		0.0050	mg/L	17-SEP-17	22-SEP-17	R3836532
Manganese (Mn)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Mercury (Hg)-Total	<0.0000050		0.0000050	mg/L		17-SEP-17	R3830424
Molybdenum (Mo)-Total	<0.000050		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Nickel (Ni)-Total	<0.00050		0.00050	mg/L	17-SEP-17	22-SEP-17	R3836532
Phosphorus (P)-Total	<0.050		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1991701-4 FIELD BLANK Sampled By: KB/PS on 13-SEP-17 @ 14:09 Matrix: WATER							
Total Metals							
Potassium (K)-Total	<0.050		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Rubidium (Rb)-Total	<0.00020		0.00020	mg/L	17-SEP-17	22-SEP-17	R3836532
Selenium (Se)-Total	<0.000050		0.000050	mg/L	17-SEP-17	22-SEP-17	R3836532
Silicon (Si)-Total	<0.10		0.10	mg/L	17-SEP-17	22-SEP-17	R3836532
Silver (Ag)-Total	<0.000010		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Sodium (Na)-Total	<0.050		0.050	mg/L	17-SEP-17	22-SEP-17	R3836532
Strontium (Sr)-Total	<0.00020		0.00020	mg/L	17-SEP-17	22-SEP-17	R3836532
Sulfur (S)-Total	<0.50		0.50	mg/L	17-SEP-17	22-SEP-17	R3836532
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	17-SEP-17	22-SEP-17	R3836532
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Thorium (Th)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Tin (Sn)-Total	0.00032	RRV	0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Titanium (Ti)-Total	<0.00030		0.00030	mg/L	17-SEP-17	22-SEP-17	R3836532
Tungsten (W)-Total	<0.00010		0.00010	mg/L	17-SEP-17	22-SEP-17	R3836532
Uranium (U)-Total	<0.000010		0.000010	mg/L	17-SEP-17	22-SEP-17	R3836532
Vanadium (V)-Total	<0.00050		0.00050	mg/L	17-SEP-17	22-SEP-17	R3836532
Zinc (Zn)-Total	<0.0030		0.0030	mg/L	17-SEP-17	22-SEP-17	R3836532
Zirconium (Zr)-Total	<0.000060		0.000060	mg/L	17-SEP-17	22-SEP-17	R3836532
Dissolved Metals							
Dissolved Metals Filtration Location	FIELD					21-SEP-17	R3835536
Calcium (Ca)-Dissolved	<0.050		0.050	mg/L	21-SEP-17	21-SEP-17	R3835809
Magnesium (Mg)-Dissolved	<0.0050		0.0050	mg/L	21-SEP-17	21-SEP-17	R3835809
Radiological Parameters							
Ra-226	<0.010		0.010	Bq/L		27-SEP-17	R3840929

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Total Dissolved Solids	B	L1991701-1, -2, -3, -4
Matrix Spike	Dissolved Organic Carbon	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Total	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Boron (B)-Total	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Total	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Potassium (K)-Total	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Rubidium (Rb)-Total	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Tungsten (W)-Total	MS-B	L1991701-1, -2, -3, -4
Matrix Spike	Total Organic Carbon	MS-B	L1991701-1, -2, -3, -4

Sample Parameter Qualifier key listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

ALK-TITR-TB | Water | Alkalinity | APHA 2320B modified

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

CL-L-IC-N-TB | Water | Chloride in Water by IC (Low Level) | EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CN-TOT-WT | Water | Cyanide, Total | ISO 14403-2

Total cyanide is determined by the combination of UV digestion and distillation. Cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

When using this method, high levels of thiocyanate in samples can cause false positives at ~1-2% of the thiocyanate concentration. For samples with detectable cyanide analyzed by this method, ALS recommends analysis for thiocyanate to check for this potential interference

CN-WAD-WT | Water | Cyanide, Weak Acid Diss | APHA 4500CN I-Weak acid Dist Colorimet

Weak acid dissociable cyanide (WAD) is determined by undergoing a distillation procedure. Cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

DOC-TB | Water | Dissolved Organic Carbon | APHA 5310 B modified

Water samples are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis. Analyzed by converting all carbonaceous material to carbon dioxide (CO2) by catalytic combustion at 850?C. The CO2 generated is measured by an infrared detector and is directly proportional to concentration of carbonaceous material in the sample

F-IC-N-TB | Water | Fluoride in Water by IC | EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-TB | Water | Hardness (as CaCO3) | CALCULATION

HG-T-CVAF-TB | Water | Total Mercury in Water by CVAFS | EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAFS.

MET-D-CCMS-TB | Water | Dissolved Metals in Water by CRC ICPMS | APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-TB | Water | Total Metals in Water by CRC ICPMS | EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Reference Information

NH3-COL-TB   Water   Ammonia by Discrete Analyzer   APHA 4500-NH3 G. (modified)

Ammonia in aqueous matrices is analyzed using discrete analyzer with colourimetric detection.

NO2-IC-N-TB   Water   Nitrite in Water by IC   EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-IC-N-TB   Water   Nitrate in Water by IC   EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

P-T-COL-TB   Water   Total Phosphorus by Discrete Analyzer   APHA 4500-P B, F, G (modified)

Phosphorus in aqueous matrices is analyzed using discrete Analyzer with colourimetric detection.

SO4-IC-N-TB   Water   Sulfate in Water by IC   EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-TB   Water   Total Dissolved Solids   APHA 2540 C (modified)

Aqueous matrices are analyzed using gravimetry and evaporation

TOC-TB   Water   Total Organic Carbon (TOC)   APHA 5310 B modified

Water samples are analyzed by converting all carbonaceous material to carbon dioxide (CO2) by catalytic combustion at 850?C. The CO2 generated is measured by an infrared detector and is directly proportional to concentration of carbonaceous material in the sample

TSS-TB   Water   Total Suspended Solids   APHA 2540 D (modified)

Aqueous matrices are analyzed using gravimetry

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA
TB	ALS ENVIRONMENTAL - THUNDER BAY, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg wwt - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid weight of sample

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: MINNOW ENVIRONMENTAL INC.
2 Lamb Street
Georgetown ON L7G 3M9

Contact: Jess Tester

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-TB	**Water**							
Batch R3829746								
WG2617112-5 LCS								
Alkalinity, Total (as CaCO3)			101.3		%		85-115	15-SEP-17
WG2617112-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	15-SEP-17
CL-L-IC-N-TB	**Water**							
Batch R3829990								
WG2616930-2 LCS								
Chloride (Cl)			100.1		%		90-110	15-SEP-17
WG2616930-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	15-SEP-17
CN-TOT-WT	**Water**							
Batch R3833513								
WG2619208-6 LCS								
Cyanide, Total			93.2		%		80-120	19-SEP-17
WG2619208-5 MB								
Cyanide, Total			<0.0020		mg/L		0.002	19-SEP-17
CN-WAD-WT	**Water**							
Batch R3833513								
WG2619208-6 LCS								
Cyanide, Weak Acid Diss			98.3		%		80-120	19-SEP-17
WG2619208-5 MB								
Cyanide, Weak Acid Diss			<0.0020		mg/L		0.002	19-SEP-17
DOC-TB	**Water**							
Batch R3831540								
WG2618669-3 DUP		**L1991701-1**						
Dissolved Organic Carbon		28.7	28.7		mg/L	0.1	20	18-SEP-17
WG2618669-2 LCS								
Dissolved Organic Carbon			105.5		%		80-120	18-SEP-17
WG2618669-1 MB								
Dissolved Organic Carbon			<1.0		mg/L		1	18-SEP-17
WG2618669-4 MS		**L1991701-1**						
Dissolved Organic Carbon			N/A	MS-B	%		-	18-SEP-17
F-IC-N-TB	**Water**							
Batch R3829990								
WG2616930-2 LCS								
Fluoride (F)			107.4		%		90-110	15-SEP-17
WG2616930-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-IC-N-TB	**Water**							
Batch R3829990								
WG2616930-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	15-SEP-17
HG-T-CVAF-TB	**Water**							
Batch R3830424								
WG2617985-3 DUP		**L1991701-1**						
Mercury (Hg)-Total		<0.0000050	<0.0000050	RPD-NA	mg/L	N/A	20	17-SEP-17
WG2617985-2 LCS								
Mercury (Hg)-Total			99.5		%		80-120	17-SEP-17
WG2617985-1 MB								
Mercury (Hg)-Total			<0.0000050		mg/L		0.000005	17-SEP-17
WG2617985-4 MS		**L1991701-2**						
Mercury (Hg)-Total			106.8		%		70-130	17-SEP-17
MET-D-CCMS-TB	**Water**							
Batch R3835809								
WG2620478-2 LCS								
Calcium (Ca)-Dissolved			101.2		%		80-120	21-SEP-17
Magnesium (Mg)-Dissolved			110.4		%		80-120	21-SEP-17
WG2620478-1 MB								
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	21-SEP-17
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	21-SEP-17
MET-T-CCMS-TB	**Water**							
Batch R3836532								
WG2617916-2 LCS								
Aluminum (Al)-Total			105.4		%		80-120	22-SEP-17
Antimony (Sb)-Total			103.7		%		80-120	22-SEP-17
Arsenic (As)-Total			102.6		%		80-120	22-SEP-17
Barium (Ba)-Total			102.0		%		80-120	22-SEP-17
Beryllium (Be)-Total			104.6		%		80-120	22-SEP-17
Bismuth (Bi)-Total			102.9		%		80-120	22-SEP-17
Boron (B)-Total			93.3		%		80-120	22-SEP-17
Cadmium (Cd)-Total			101.9		%		80-120	22-SEP-17
Calcium (Ca)-Total			103.9		%		80-120	22-SEP-17
Cesium (Cs)-Total			101.0		%		80-120	22-SEP-17
Chromium (Cr)-Total			104.3		%		80-120	22-SEP-17
Cobalt (Co)-Total			105.1		%		80-120	22-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R3836532								
WG2617916-2 LCS								
Copper (Cu)-Total			102.6		%		80-120	22-SEP-17
Iron (Fe)-Total			101.9		%		80-120	22-SEP-17
Lead (Pb)-Total			101.1		%		80-120	22-SEP-17
Lithium (Li)-Total			106.2		%		80-120	22-SEP-17
Magnesium (Mg)-Total			111.2		%		80-120	22-SEP-17
Manganese (Mn)-Total			102.3		%		80-120	22-SEP-17
Molybdenum (Mo)-Total			102.2		%		80-120	22-SEP-17
Nickel (Ni)-Total			103.3		%		80-120	22-SEP-17
Phosphorus (P)-Total			101.4		%		70-130	22-SEP-17
Potassium (K)-Total			108.2		%		80-120	22-SEP-17
Rubidium (Rb)-Total			104.5		%		80-120	22-SEP-17
Selenium (Se)-Total			101.1		%		80-120	22-SEP-17
Silicon (Si)-Total			108.3		%		60-140	22-SEP-17
Silver (Ag)-Total			101.5		%		80-120	22-SEP-17
Sodium (Na)-Total			106.0		%		80-120	22-SEP-17
Strontium (Sr)-Total			104.2		%		80-120	22-SEP-17
Sulfur (S)-Total			100.4		%		80-120	22-SEP-17
Tellurium (Te)-Total			95.9		%		80-120	22-SEP-17
Thallium (Tl)-Total			101.6		%		80-120	22-SEP-17
Thorium (Th)-Total			100.1		%		80-120	22-SEP-17
Tin (Sn)-Total			101.7		%		80-120	22-SEP-17
Titanium (Ti)-Total			103.0		%		80-120	22-SEP-17
Tungsten (W)-Total			103.4		%		80-120	22-SEP-17
Uranium (U)-Total			102.4		%		80-120	22-SEP-17
Vanadium (V)-Total			105.7		%		80-120	22-SEP-17
Zinc (Zn)-Total			102.0		%		80-120	22-SEP-17
Zirconium (Zr)-Total			101.0		%		80-120	22-SEP-17
WG2617916-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	22-SEP-17
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	22-SEP-17
Arsenic (As)-Total			<0.00010		mg/L		0.0001	22-SEP-17
Barium (Ba)-Total			<0.000050		mg/L		0.00005	22-SEP-17
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	22-SEP-17
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	22-SEP-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R3836532								
WG2617916-1 MB								
Boron (B)-Total			<0.010		mg/L		0.01	22-SEP-17
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	22-SEP-17
Calcium (Ca)-Total			<0.050		mg/L		0.05	22-SEP-17
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	22-SEP-17
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	22-SEP-17
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	22-SEP-17
Copper (Cu)-Total			<0.00050		mg/L		0.0005	22-SEP-17
Iron (Fe)-Total			<0.010		mg/L		0.01	22-SEP-17
Lead (Pb)-Total			<0.000050		mg/L		0.00005	22-SEP-17
Lithium (Li)-Total			<0.0010		mg/L		0.001	22-SEP-17
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	22-SEP-17
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	22-SEP-17
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	22-SEP-17
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	22-SEP-17
Phosphorus (P)-Total			<0.050		mg/L		0.05	22-SEP-17
Potassium (K)-Total			<0.050		mg/L		0.05	22-SEP-17
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	22-SEP-17
Selenium (Se)-Total			<0.000050		mg/L		0.00005	22-SEP-17
Silicon (Si)-Total			<0.10		mg/L		0.1	22-SEP-17
Silver (Ag)-Total			<0.000010		mg/L		0.00001	22-SEP-17
Sodium (Na)-Total			<0.050		mg/L		0.05	22-SEP-17
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	22-SEP-17
Sulfur (S)-Total			<0.50		mg/L		0.5	22-SEP-17
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	22-SEP-17
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	22-SEP-17
Thorium (Th)-Total			<0.00010		mg/L		0.0001	22-SEP-17
Tin (Sn)-Total			<0.00010		mg/L		0.0001	22-SEP-17
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	22-SEP-17
Tungsten (W)-Total			<0.00010		mg/L		0.0001	22-SEP-17
Uranium (U)-Total			<0.000010		mg/L		0.00001	22-SEP-17
Vanadium (V)-Total			<0.00050		mg/L		0.0005	22-SEP-17
Zinc (Zn)-Total			<0.0030		mg/L		0.003	22-SEP-17
Zirconium (Zr)-Total			<0.000060		mg/L		0.00006	22-SEP-17
NH3-COL-TB	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-COL-TB	**Water**							
Batch R3830865								
WG2617082-3 DUP		**L1991701-1**						
Ammonia, Total (as N)		0.027	0.027		mg/L	0.8	20	15-SEP-17
WG2617082-2 LCS								
Ammonia, Total (as N)			97.3		%		85-115	15-SEP-17
WG2617082-1 MB								
Ammonia, Total (as N)			<0.020		mg/L		0.02	15-SEP-17
WG2617082-4 MS		**L1991701-1**						
Ammonia, Total (as N)			89.0		%		75-125	15-SEP-17
Batch R3831519								
WG2619165-2 LCS								
Ammonia, Total (as N)			94.2		%		85-115	19-SEP-17
WG2619165-1 MB								
Ammonia, Total (as N)			<0.020		mg/L		0.02	19-SEP-17
NO2-IC-N-TB	**Water**							
Batch R3829990								
WG2616930-2 LCS								
Nitrite (as N)			105.6		%		90-110	15-SEP-17
WG2616930-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	15-SEP-17
NO3-IC-N-TB	**Water**							
Batch R3829990								
WG2616930-2 LCS								
Nitrate (as N)			99.2		%		90-110	15-SEP-17
WG2616930-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	15-SEP-17
P-T-COL-TB	**Water**							
Batch R3831652								
WG2616841-3 DUP		**L1991701-1**						
Phosphorus (P)-Total		0.0324	0.0358		mg/L	10	20	18-SEP-17
WG2616841-2 LCS								
Phosphorus (P)-Total			103.4		%		80-120	18-SEP-17
WG2616841-1 MB								
Phosphorus (P)-Total			<0.0030		mg/L		0.003	18-SEP-17
WG2616841-4 MS		**L1991701-1**						
Phosphorus (P)-Total			81.7		%		70-130	18-SEP-17
SO4-IC-N-TB	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-TB	**Water**							
Batch R3829990								
WG2616930-2 LCS								
Sulfate (SO4)			100.9		%		90-110	15-SEP-17
WG2616930-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	15-SEP-17
TDS-TB	**Water**							
Batch R3830357								
WG2617611-2 LCS								
Total Dissolved Solids			99.4		%		85-115	16-SEP-17
WG2617611-1 MB								
Total Dissolved Solids			10	B	mg/L		10	16-SEP-17
TOC-TB	**Water**							
Batch R3831570								
WG2618316-3 DUP		**L1991701-1**						
Total Organic Carbon		29.1	30.2		mg/L	3.6	20	18-SEP-17
WG2618316-2 LCS								
Total Organic Carbon			110.1		%		80-120	18-SEP-17
WG2618316-1 MB								
Total Organic Carbon			<1.0		mg/L		1	18-SEP-17
WG2618316-4 MS		**L1991701-1**						
Total Organic Carbon			N/A	MS-B	%		-	18-SEP-17
TSS-TB	**Water**							
Batch R3830323								
WG2617757-2 LCS								
Total Suspended Solids			96.4		%		85-115	16-SEP-17
WG2617757-1 MB								
Total Suspended Solids			<2.0		mg/L		2	16-SEP-17

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Your P.O. #: L1991701

Attention:Christine Paradis

ALS Laboratory Group
Environmental Div.
1081 Barton St.
Thunder Bay, ON
Canada P7B 5N3

Report Date: 2017/09/29
Report #: R4744993
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7K2765
Received: 2017/09/18, 09:50

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Radium Isotopes by Alpha Spectrometry (1)	4	N/A	2017/09/27	BQL SOP-00006 BQL SOP-00017 BQL SOP-00032	Alpha Spectrometry

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
(1) Radium-226 results have not been corrected for blanks.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6790 Kitimat Rd, Unit 4, Mississauga, ON L5N 5L9 Phone: (905) 826-3080 Fax: (905) 826-4151 Toll Free: 1 877-726-3080 www.maxxam.ca

Your P.O. #: L1991701

Attention:Christine Paradis

ALS Laboratory Group
Environmental Div.
1081 Barton St.
Thunder Bay, ON
Canada P7B 5N3

Report Date: 2017/09/29
Report #: R4744993
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7K2765
Received: 2017/09/18, 09:50

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Simona Vatamanescu, Project Manager
Email: SVatamanescu@maxxam.ca
Phone# (905)826-3080
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF ANALYSES OF WATER

Maxxam ID		FDH376	FDH377	FDH378	FDH379		
Sampling Date		2017/09/13	2017/09/13	2017/09/13	2017/09/13		
	UNITS	**L1991701-1 PINR-EXP**	**L1991701-2 PINR-DUP**	**L1991701-3 STUC-REF**	**L1991701-4 FIELD BLANK**	**RDL**	**QC Batch**
Radium-226	Bq/L	<0.010	<0.010	<0.010	<0.010	0.010	5173929

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Maxxam ID: FDH376
Sample ID: L1991701-1 PINR-EXP
Matrix: Water

Collected: 2017/09/13
Shipped:
Received: 2017/09/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Radium Isotopes by Alpha Spectrometry	AS	5173929	N/A	2017/09/27	Faiz Ahmed

Maxxam ID: FDH377
Sample ID: L1991701-2 PINR-DUP
Matrix: Water

Collected: 2017/09/13
Shipped:
Received: 2017/09/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Radium Isotopes by Alpha Spectrometry	AS	5173929	N/A	2017/09/27	Faiz Ahmed

Maxxam ID: FDH378
Sample ID: L1991701-3 STUC-REF
Matrix: Water

Collected: 2017/09/13
Shipped:
Received: 2017/09/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Radium Isotopes by Alpha Spectrometry	AS	5173929	N/A	2017/09/27	Faiz Ahmed

Maxxam ID: FDH379
Sample ID: L1991701-4 FIELD BLANK
Matrix: Water

Collected: 2017/09/13
Shipped:
Received: 2017/09/18

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Radium Isotopes by Alpha Spectrometry	AS	5173929	N/A	2017/09/27	Faiz Ahmed

Maxxam Analytics International Corporation o/a Maxxam Analytics 6790 Kitimat Rd, Unit 4, Mississauga, ON L5N 5L9 Phone: (905) 826-3080 Fax: (905) 826-4151 Toll Free: 1 877-726-3080 www.maxxam.ca

GENERAL COMMENTS

Results relate only to the items tested.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6790 Kitimat Rd, Unit 4, Mississauga, ON L5N 5L9 Phone: (905) 826-3080 Fax: (905) 826-4151 Toll Free: 1 877-726-3080 www.maxxam.ca

Maxxam Job #: B7K2765
Report Date: 2017/09/29

ALS Laboratory Group
Your P.O. #: L1991701

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
5173929	FA5	Spiked Blank	Radium-226	2017/09/27		91	%	85 - 115
5173929	FA5	Method Blank	Radium-226	2017/09/27	<0.010		Bq/L	
5173929	FA5	RPD	Radium-226	2017/09/27	NC		%	N/A

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Kurt Headrick

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
KURT HEADRICK, PH.D.
CHEMIST

Kurt Headrick, Ph.D., C. Chem., Laboratory Manager

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1991701-COFC

COC Number: 15 -

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minnow Environmental Inc.
Contact:	Jess Tester
Phone:	905-873-3371
	Company address below will appear on the final report
Street:	2 Lamb Street
City/Province:	Georgetown, ON
Postal Code:	L7G 3M9
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax jtester@minnow.ca

Email 2 kbatchelar@minnow.ca

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax jtester@minnow.ca

Email 2 kbatchelar@minnow.ca

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #: Q59584

Job #: 17-12

PO / AFE:

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: | PO#

Major/Minor Code: | Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only) L1991701

ALS Contact: Christine Paradis

Sampler: KB, PS

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Alkalinity, Cl, F, SO4, NO2, NO3 (NO2+NO3)	Total Metals	Total Mercury	Dissolved Ca, Mg, Hardness	Total Ammonia, Total Phosphorus, TOC	Total Cyanide, WAD Cyanide	TSS, TDS	DOC	Radium 226	Supplies				Number of Containers
					P	P	P	F/P		P		F/P	P					
	PinR-EXP	13-Sept-17	16:05	Water	x	x	x	x	x	x	x	x	x	x				9
	PinR-DUP	13-Sept-17	16:05	Water	x	x	x	x	x	x	x	x	x					9
	StuC-REF	13-Sept-17	14:09	Water	x	x	x	x	x	x	x	x	x					9
	Field Blank	13-Sept-17	14:09	Water	x	x	x	x	x	x	x	x	x					9
	~~Trip Blank~~			~~Water~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	KB				

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

Do not analyse trip blank. Not needed, returned unopened.

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☒ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☒

INITIAL COOLER TEMPERATURES °C: 5.9

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Katharina Batchelar	Date: Sept 14/17	Time: 11:00	Received by: [signature]	Date: Sept 14/17	Time: 5:15	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

MINNOW ENVIRONMENTAL INC.
ATTN: Jess Tester
2 Lamb Street
Georgetown ON L7G 3M9

Date Received: 19-SEP-17
Report Date: 05-OCT-17 15:03 (MT)
Version: FINAL

Client Phone: 905-873-3371

Certificate of Analysis

Lab Work Order #: L1995196
Project P.O. #: NOT SUBMITTED
Job Reference: 17-13
C of C Numbers:
Legal Site Desc:

C. Paradis

Christine Paradis
Project Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-1 PINR-EXP-1 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Physical Tests							
% Moisture	81.8		0.10	%	27-SEP-17	27-SEP-17	R3839576
Particle Size							
% Gravel (>2mm)	<1.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Sand (2.0mm - 0.063mm)	8.3		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Silt (0.063mm - 4um)	60.2		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Clay (<4um)	31.5		1.0	%	28-SEP-17	29-SEP-17	R3841635
Texture	Silt loam				28-SEP-17	29-SEP-17	R3841635
Leachable Anions & Nutrients							
Total Kjeldahl Nitrogen	0.61	DLHC	0.10	%	02-OCT-17	03-OCT-17	R3845492
Organic / Inorganic Carbon							
FOC	0.0785		0.0010	g/g		30-SEP-17	
Total Organic Carbon	7.85		0.050	%		30-SEP-17	
Metals							
Aluminum (Al)	16700		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Antimony (Sb)	0.14		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Arsenic (As)	4.36		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Barium (Ba)	129		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Beryllium (Be)	0.62		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Bismuth (Bi)	<0.20		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Boron (B)	10.4		5.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cadmium (Cd)	0.448		0.020	mg/kg	28-SEP-17	29-SEP-17	R3841942
Calcium (Ca)	13700		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Chromium (Cr)	34.8		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cobalt (Co)	12.1		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Copper (Cu)	19.3		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Iron (Fe)	20000		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lead (Pb)	8.60		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lithium (Li)	18.2		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Magnesium (Mg)	7950		20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Manganese (Mn)	609		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Mercury (Hg)	0.0630		0.0050	mg/kg	28-SEP-17	28-SEP-17	R3840575
Molybdenum (Mo)	1.02		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Nickel (Ni)	24.8		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Phosphorus (P)	781		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Potassium (K)	1790		100	mg/kg	28-SEP-17	29-SEP-17	R3841942
Selenium (Se)	0.56		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Silver (Ag)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sodium (Na)	148		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Strontium (Sr)	32.0		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sulfur (S)	1700		1000	mg/kg	28-SEP-17	29-SEP-17	R3841942
Thallium (Tl)	0.187		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tin (Sn)	<1.0		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-1 PINR-EXP-1 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Metals							
Titanium (Ti)	118		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tungsten (W)	<0.50		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Uranium (U)	1.88		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Vanadium (V)	42.9		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zinc (Zn)	93.9		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zirconium (Zr)	4.9		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
L1995196-2 PINR-EXP-2 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Physical Tests							
% Moisture	76.5		0.10	%	27-SEP-17	27-SEP-17	R3839576
Particle Size							
% Gravel (>2mm)	<1.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Sand (2.0mm - 0.063mm)	16.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Silt (0.063mm - 4um)	53.4		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Clay (<4um)	30.5		1.0	%	28-SEP-17	29-SEP-17	R3841635
Texture	Silt loam				28-SEP-17	29-SEP-17	R3841635
Leachable Anions & Nutrients							
Total Kjeldahl Nitrogen	0.43	DLHC	0.10	%	02-OCT-17	03-OCT-17	R3845492
Organic / Inorganic Carbon							
FOC	0.0601		0.0010	g/g		30-SEP-17	
Total Organic Carbon	6.01		0.050	%		30-SEP-17	
Metals							
Aluminum (Al)	13900		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Antimony (Sb)	0.19		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Arsenic (As)	3.75		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Barium (Ba)	120		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Beryllium (Be)	0.65		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Bismuth (Bi)	<0.20		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Boron (B)	11.5		5.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cadmium (Cd)	0.323		0.020	mg/kg	28-SEP-17	29-SEP-17	R3841942
Calcium (Ca)	20200		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Chromium (Cr)	36.1		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cobalt (Co)	10.9		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Copper (Cu)	16.4		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Iron (Fe)	18300		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lead (Pb)	8.45		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lithium (Li)	16.3		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Magnesium (Mg)	10100		20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Manganese (Mn)	657		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Mercury (Hg)	0.0505		0.0050	mg/kg	28-SEP-17	28-SEP-17	R3840575
Molybdenum (Mo)	1.23		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-2 PINR-EXP-2 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Metals							
Nickel (Ni)	25.2		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Phosphorus (P)	648		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Potassium (K)	1600		100	mg/kg	28-SEP-17	29-SEP-17	R3841942
Selenium (Se)	0.45		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Silver (Ag)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sodium (Na)	131		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Strontium (Sr)	36.2		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sulfur (S)	1400		1000	mg/kg	28-SEP-17	29-SEP-17	R3841942
Thallium (Tl)	0.178		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tin (Sn)	<1.0		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Titanium (Ti)	149		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tungsten (W)	<0.50		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Uranium (U)	1.49		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Vanadium (V)	39.8		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zinc (Zn)	75.8		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zirconium (Zr)	5.3		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
L1995196-3 PINR-EXP-3 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Physical Tests							
% Moisture	85.5		0.10	%	27-SEP-17	27-SEP-17	R3839576
Particle Size							
% Gravel (>2mm)	<1.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Sand (2.0mm - 0.063mm)	2.4		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Silt (0.063mm - 4um)	69.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Clay (<4um)	28.6		1.0	%	28-SEP-17	29-SEP-17	R3841635
Texture	Silt loam				28-SEP-17	29-SEP-17	R3841635
Leachable Anions & Nutrients							
Total Kjeldahl Nitrogen	0.69	DLHC	0.20	%	02-OCT-17	03-OCT-17	R3845492
Organic / Inorganic Carbon							
FOC	0.0897		0.0010	g/g		30-SEP-17	
Total Organic Carbon	8.97		0.050	%		30-SEP-17	
Metals							
Aluminum (Al)	14100		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Antimony (Sb)	0.16		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Arsenic (As)	4.83		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Barium (Ba)	111		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Beryllium (Be)	0.56		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Bismuth (Bi)	<0.20		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Boron (B)	10.8		5.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cadmium (Cd)	0.401		0.020	mg/kg	28-SEP-17	29-SEP-17	R3841942
Calcium (Ca)	18500		50	mg/kg	28-SEP-17	29-SEP-17	R3841942

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-3 PINR-EXP-3 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Metals							
Chromium (Cr)	33.8		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cobalt (Co)	11.2		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Copper (Cu)	17.5		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Iron (Fe)	18400		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lead (Pb)	7.65		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lithium (Li)	17.7		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Magnesium (Mg)	10400		20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Manganese (Mn)	438		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Mercury (Hg)	0.0587		0.0050	mg/kg	28-SEP-17	28-SEP-17	R3840575
Molybdenum (Mo)	1.44		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Nickel (Ni)	25.0		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Phosphorus (P)	777		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Potassium (K)	1760		100	mg/kg	28-SEP-17	29-SEP-17	R3841942
Selenium (Se)	0.62		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Silver (Ag)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sodium (Na)	171		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Strontium (Sr)	37.6		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sulfur (S)	2400		1000	mg/kg	28-SEP-17	29-SEP-17	R3841942
Thallium (Tl)	0.177		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tin (Sn)	<1.0		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Titanium (Ti)	138		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tungsten (W)	<0.50		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Uranium (U)	2.07		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Vanadium (V)	40.5		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zinc (Zn)	88.9		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zirconium (Zr)	3.7		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
L1995196-4 PINR-EXP-4 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Physical Tests							
% Moisture	53.5		0.10	%	27-SEP-17	27-SEP-17	R3839576
Particle Size							
% Gravel (>2mm)	<1.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Sand (2.0mm - 0.063mm)	30.8		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Silt (0.063mm - 4um)	44.6		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Clay (<4um)	24.6		1.0	%	28-SEP-17	29-SEP-17	R3841635
Texture	Loam				28-SEP-17	29-SEP-17	R3841635
Leachable Anions & Nutrients							
Total Kjeldahl Nitrogen	0.243	DLHC	0.040	%	02-OCT-17	03-OCT-17	R3845492
Organic / Inorganic Carbon							
FOC	0.0346		0.0010	g/g		30-SEP-17	
Total Organic Carbon	3.46		0.050	%		30-SEP-17	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-4 PINR-EXP-4 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Organic / Inorganic Carbon							
Metals							
Aluminum (Al)	9350		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Antimony (Sb)	0.11		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Arsenic (As)	2.23		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Barium (Ba)	61.2		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Beryllium (Be)	0.44		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Bismuth (Bi)	<0.20		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Boron (B)	7.1		5.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cadmium (Cd)	0.200		0.020	mg/kg	28-SEP-17	29-SEP-17	R3841942
Calcium (Ca)	11600		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Chromium (Cr)	21.2		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cobalt (Co)	6.65		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Copper (Cu)	9.83		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Iron (Fe)	12600		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lead (Pb)	6.25		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lithium (Li)	12.2		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Magnesium (Mg)	6770		20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Manganese (Mn)	315		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Mercury (Hg)	0.0490		0.0050	mg/kg	28-SEP-17	28-SEP-17	R3840575
Molybdenum (Mo)	0.35		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Nickel (Ni)	14.9		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Phosphorus (P)	496		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Potassium (K)	1040		100	mg/kg	28-SEP-17	29-SEP-17	R3841942
Selenium (Se)	0.34		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Silver (Ag)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sodium (Na)	96		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Strontium (Sr)	21.7		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sulfur (S)	<1000		1000	mg/kg	28-SEP-17	29-SEP-17	R3841942
Thallium (Tl)	0.122		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tin (Sn)	<1.0		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Titanium (Ti)	137		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tungsten (W)	<0.50		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Uranium (U)	1.09		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Vanadium (V)	25.0		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zinc (Zn)	50.1		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zirconium (Zr)	4.7		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
L1995196-5 PINR-EXP-5 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Physical Tests							
% Moisture	72.6		0.10	%	27-SEP-17	27-SEP-17	R3839576
Particle Size							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-5 PINR-EXP-5 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Particle Size							
% Gravel (>2mm)	<1.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Sand (2.0mm - 0.063mm)	10.7		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Silt (0.063mm - 4um)	64.7		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Clay (<4um)	24.6		1.0	%	28-SEP-17	29-SEP-17	R3841635
Texture	Silt loam				28-SEP-17	29-SEP-17	R3841635
Leachable Anions & Nutrients							
Total Kjeldahl Nitrogen	0.64	DLHC	0.20	%	02-OCT-17	03-OCT-17	R3845492
Organic / Inorganic Carbon							
FOC	0.0939		0.0010	g/g		30-SEP-17	
Total Organic Carbon	9.39		0.050	%		30-SEP-17	
Metals							
Aluminum (Al)	12500		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Antimony (Sb)	0.15		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Arsenic (As)	2.85		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Barium (Ba)	93.0		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Beryllium (Be)	0.52		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Bismuth (Bi)	<0.20		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Boron (B)	7.8		5.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cadmium (Cd)	0.364		0.020	mg/kg	28-SEP-17	29-SEP-17	R3841942
Calcium (Ca)	10200		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Chromium (Cr)	27.1		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cobalt (Co)	7.30		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Copper (Cu)	13.3		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Iron (Fe)	15300		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lead (Pb)	7.67		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lithium (Li)	13.8		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Magnesium (Mg)	4830		20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Manganese (Mn)	362		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Mercury (Hg)	0.0539		0.0050	mg/kg	28-SEP-17	28-SEP-17	R3840575
Molybdenum (Mo)	0.76		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Nickel (Ni)	18.8		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Phosphorus (P)	676		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Potassium (K)	1280		100	mg/kg	28-SEP-17	29-SEP-17	R3841942
Selenium (Se)	0.53		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Silver (Ag)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sodium (Na)	113		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Strontium (Sr)	31.5		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sulfur (S)	1600		1000	mg/kg	28-SEP-17	29-SEP-17	R3841942
Thallium (Tl)	0.135		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tin (Sn)	<1.0		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Titanium (Ti)	97.6		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tungsten (W)	<0.50		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-5 PINR-EXP-5 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Metals							
Uranium (U)	2.07		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Vanadium (V)	34.0		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zinc (Zn)	63.7		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zirconium (Zr)	4.9		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
L1995196-6 PINR-EXP-4X Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Physical Tests							
% Moisture	59.6		0.10	%	27-SEP-17	27-SEP-17	R3839576
Particle Size							
% Gravel (>2mm)	<1.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Sand (2.0mm - 0.063mm)	32.4		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Silt (0.063mm - 4um)	40.9		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Clay (<4um)	26.7		1.0	%	28-SEP-17	29-SEP-17	R3841635
Texture	Loam				28-SEP-17	29-SEP-17	R3841635
Leachable Anions & Nutrients							
Total Kjeldahl Nitrogen	0.226	DLHC	0.040	%	02-OCT-17	03-OCT-17	R3845492
Organic / Inorganic Carbon							
FOC	0.0326		0.0010	g/g		30-SEP-17	
Total Organic Carbon	3.26		0.050	%		30-SEP-17	
Metals							
Aluminum (Al)	9590		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Antimony (Sb)	0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Arsenic (As)	2.11		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Barium (Ba)	61.6		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Beryllium (Be)	0.40		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Bismuth (Bi)	<0.20		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Boron (B)	6.0		5.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cadmium (Cd)	0.187		0.020	mg/kg	28-SEP-17	29-SEP-17	R3841942
Calcium (Ca)	9080		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Chromium (Cr)	21.1		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cobalt (Co)	6.52		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Copper (Cu)	9.62		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Iron (Fe)	12500		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lead (Pb)	5.81		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lithium (Li)	11.7		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Magnesium (Mg)	6100		20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Manganese (Mn)	303		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Mercury (Hg)	0.0328		0.0050	mg/kg	28-SEP-17	28-SEP-17	R3840575
Molybdenum (Mo)	0.29		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Nickel (Ni)	14.9		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Phosphorus (P)	469		50	mg/kg	28-SEP-17	29-SEP-17	R3841942

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-6 PINR-EXP-4X Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Metals							
Potassium (K)	1060		100	mg/kg	28-SEP-17	29-SEP-17	R3841942
Selenium (Se)	0.28		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Silver (Ag)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sodium (Na)	84		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Strontium (Sr)	19.6		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sulfur (S)	<1000		1000	mg/kg	28-SEP-17	29-SEP-17	R3841942
Thallium (Tl)	0.110		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tin (Sn)	<1.0		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Titanium (Ti)	128		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tungsten (W)	<0.50		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Uranium (U)	0.970		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Vanadium (V)	25.5		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zinc (Zn)	48.3		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zirconium (Zr)	4.4		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
L1995196-7 STUC-REF-1 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Physical Tests							
% Moisture	62.5		0.10	%	27-SEP-17	27-SEP-17	R3839576
Particle Size							
% Gravel (>2mm)	<1.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Sand (2.0mm - 0.063mm)	27.3		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Silt (0.063mm - 4um)	41.7		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Clay (<4um)	31.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
Texture	Clay loam				28-SEP-17	29-SEP-17	R3841635
Leachable Anions & Nutrients							
Total Kjeldahl Nitrogen	0.239	DLHC	0.040	%	02-OCT-17	03-OCT-17	R3845492
Organic / Inorganic Carbon							
FOC	0.0319		0.0010	g/g		30-SEP-17	
Total Organic Carbon	3.19		0.050	%		30-SEP-17	
Metals							
Aluminum (Al)	11900		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Antimony (Sb)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Arsenic (As)	2.47		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Barium (Ba)	71.4		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Beryllium (Be)	0.45		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Bismuth (Bi)	<0.20		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Boron (B)	7.6		5.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cadmium (Cd)	0.242		0.020	mg/kg	28-SEP-17	29-SEP-17	R3841942
Calcium (Ca)	6330		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Chromium (Cr)	27.0		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cobalt (Co)	8.90		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-7 STUC-REF-1 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Metals							
Copper (Cu)	9.82		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Iron (Fe)	13500		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lead (Pb)	6.24		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lithium (Li)	14.0		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Magnesium (Mg)	4880		20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Manganese (Mn)	319		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Mercury (Hg)	0.0389		0.0050	mg/kg	28-SEP-17	28-SEP-17	R3840575
Molybdenum (Mo)	0.51		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Nickel (Ni)	16.9		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Phosphorus (P)	493		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Potassium (K)	1440		100	mg/kg	28-SEP-17	29-SEP-17	R3841942
Selenium (Se)	0.27		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Silver (Ag)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sodium (Na)	88		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Strontium (Sr)	23.4		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sulfur (S)	<1000		1000	mg/kg	28-SEP-17	29-SEP-17	R3841942
Thallium (Tl)	0.135		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tin (Sn)	<1.0		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Titanium (Ti)	155		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tungsten (W)	<0.50		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Uranium (U)	1.36		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Vanadium (V)	32.4		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zinc (Zn)	61.2		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zirconium (Zr)	5.1		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
L1995196-8 STUC-REF-2 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Physical Tests							
% Moisture	65.0		0.10	%	27-SEP-17	27-SEP-17	R3839576
Particle Size							
% Gravel (>2mm)	<1.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Sand (2.0mm - 0.063mm)	11.9		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Silt (0.063mm - 4um)	50.5		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Clay (<4um)	37.6		1.0	%	28-SEP-17	29-SEP-17	R3841635
Texture	Silty clay loam				28-SEP-17	29-SEP-17	R3841635
Leachable Anions & Nutrients							
Total Kjeldahl Nitrogen	0.32	DLHC	0.10	%	02-OCT-17	03-OCT-17	R3845492
Organic / Inorganic Carbon							
FOC	0.0401		0.0010	g/g		30-SEP-17	
Total Organic Carbon	4.01		0.050	%		30-SEP-17	
Metals							
Aluminum (Al)	15000		50	mg/kg	28-SEP-17	29-SEP-17	R3841942

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-8 STUC-REF-2 Sampled By: KB/PS on 14-SEP-17 @ 00:01 Matrix: Sediment							
Metals							
Antimony (Sb)	0.11		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Arsenic (As)	2.87		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Barium (Ba)	98.6		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Beryllium (Be)	0.56		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Bismuth (Bi)	<0.20		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Boron (B)	8.7		5.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cadmium (Cd)	0.322		0.020	mg/kg	28-SEP-17	29-SEP-17	R3841942
Calcium (Ca)	7330		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Chromium (Cr)	37.9		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cobalt (Co)	10.6		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Copper (Cu)	12.7		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Iron (Fe)	17000		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lead (Pb)	7.96		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lithium (Li)	19.1		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Magnesium (Mg)	5670		20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Manganese (Mn)	374		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Mercury (Hg)	0.0510		0.0050	mg/kg	28-SEP-17	28-SEP-17	R3840575
Molybdenum (Mo)	1.05		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Nickel (Ni)	23.4		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Phosphorus (P)	554		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Potassium (K)	1780		100	mg/kg	28-SEP-17	29-SEP-17	R3841942
Selenium (Se)	0.38		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Silver (Ag)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sodium (Na)	103		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Strontium (Sr)	26.0		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sulfur (S)	1100		1000	mg/kg	28-SEP-17	29-SEP-17	R3841942
Thallium (Tl)	0.166		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tin (Sn)	<1.0		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Titanium (Ti)	152		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tungsten (W)	<0.50		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Uranium (U)	1.80		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Vanadium (V)	40.2		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zinc (Zn)	79.0		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zirconium (Zr)	6.6		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
L1995196-9 STUC-REF-3 Sampled By: KB/PS on 15-SEP-17 @ 00:01 Matrix: Sediment							
Physical Tests							
% Moisture	51.5		0.10	%	27-SEP-17	27-SEP-17	R3839576
Particle Size							
% Gravel (>2mm)	<1.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Sand (2.0mm - 0.063mm)	30.9		1.0	%	28-SEP-17	29-SEP-17	R3841635

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-9 STUC-REF-3 Sampled By: KB/PS on 15-SEP-17 @ 00:01 Matrix: Sediment							
Particle Size							
% Silt (0.063mm - 4um)	36.9		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Clay (<4um)	32.2		1.0	%	28-SEP-17	29-SEP-17	R3841635
Texture	Loam / Clay loam				28-SEP-17	29-SEP-17	R3841635
Leachable Anions & Nutrients							
Total Kjeldahl Nitrogen	0.197		0.020	%	02-OCT-17	03-OCT-17	R3845492
Organic / Inorganic Carbon							
FOC	0.0278		0.0010	g/g		30-SEP-17	
Total Organic Carbon	2.78		0.050	%		30-SEP-17	
Metals							
Aluminum (Al)	11800		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Antimony (Sb)	0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Arsenic (As)	2.13		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Barium (Ba)	68.4		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Beryllium (Be)	0.51		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Bismuth (Bi)	<0.20		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Boron (B)	7.8		5.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cadmium (Cd)	0.213		0.020	mg/kg	28-SEP-17	29-SEP-17	R3841942
Calcium (Ca)	6670		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Chromium (Cr)	27.3		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cobalt (Co)	8.77		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Copper (Cu)	9.50		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Iron (Fe)	13200		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lead (Pb)	7.23		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lithium (Li)	14.7		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Magnesium (Mg)	4660		20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Manganese (Mn)	264		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Mercury (Hg)	0.0407		0.0050	mg/kg	28-SEP-17	28-SEP-17	R3840575
Molybdenum (Mo)	0.54		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Nickel (Ni)	16.5		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Phosphorus (P)	471		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Potassium (K)	1380		100	mg/kg	28-SEP-17	29-SEP-17	R3841942
Selenium (Se)	0.27		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Silver (Ag)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sodium (Na)	85		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Strontium (Sr)	23.7		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sulfur (S)	<1000		1000	mg/kg	28-SEP-17	29-SEP-17	R3841942
Thallium (Tl)	0.156		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tin (Sn)	<1.0		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Titanium (Ti)	162		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tungsten (W)	<0.50		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Uranium (U)	1.56		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Vanadium (V)	31.8		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-9 STUC-REF-3 Sampled By: KB/PS on 15-SEP-17 @ 00:01 Matrix: Sediment							
Metals							
Zinc (Zn)	59.2		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zirconium (Zr)	6.0		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
L1995196-10 STUC-REF-4 Sampled By: KB/PS on 15-SEP-17 @ 00:01 Matrix: Sediment							
Physical Tests							
% Moisture	75.5		0.10	%	29-SEP-17	29-SEP-17	R3841080
Particle Size							
% Gravel (>2mm)	<1.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Sand (2.0mm - 0.063mm)	6.8		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Silt (0.063mm - 4um)	51.9		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Clay (<4um)	41.3		1.0	%	28-SEP-17	29-SEP-17	R3841635
Texture	Silty clay loam				28-SEP-17	29-SEP-17	R3841635
Leachable Anions & Nutrients							
Total Kjeldahl Nitrogen	0.39	DLHC	0.10	%	02-OCT-17	03-OCT-17	R3845492
Organic / Inorganic Carbon							
FOC	0.0549		0.0010	g/g		30-SEP-17	
Total Organic Carbon	5.49		0.050	%		30-SEP-17	
Metals							
Aluminum (Al)	15300		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Antimony (Sb)	0.13		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Arsenic (As)	3.34		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Barium (Ba)	106		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Beryllium (Be)	0.62		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Bismuth (Bi)	<0.20		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Boron (B)	9.5		5.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cadmium (Cd)	0.388		0.020	mg/kg	28-SEP-17	29-SEP-17	R3841942
Calcium (Ca)	7960		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Chromium (Cr)	43.8		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cobalt (Co)	11.8		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Copper (Cu)	14.4		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Iron (Fe)	18000		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lead (Pb)	9.15		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lithium (Li)	18.8		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Magnesium (Mg)	6000		20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Manganese (Mn)	431		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Mercury (Hg)	0.0613		0.0050	mg/kg	28-SEP-17	28-SEP-17	R3840575
Molybdenum (Mo)	1.48		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Nickel (Ni)	26.8		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Phosphorus (P)	571		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Potassium (K)	1960		100	mg/kg	28-SEP-17	29-SEP-17	R3841942
Selenium (Se)	0.48		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-10 STUC-REF-4 Sampled By: KB/PS on 15-SEP-17 @ 00:01 Matrix: Sediment							
Metals							
Silver (Ag)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sodium (Na)	111		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Strontium (Sr)	30.5		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sulfur (S)	1400		1000	mg/kg	28-SEP-17	29-SEP-17	R3841942
Thallium (Tl)	0.186		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tin (Sn)	<1.0		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Titanium (Ti)	148		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tungsten (W)	<0.50		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Uranium (U)	2.19		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Vanadium (V)	44.1		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zinc (Zn)	91.2		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zirconium (Zr)	7.3		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
L1995196-11 STUC-REF-5 Sampled By: KB/PS on 15-SEP-17 @ 00:01 Matrix: Sediment							
Physical Tests							
% Moisture	59.0		0.10	%	29-SEP-17	29-SEP-17	R3841080
Particle Size							
% Gravel (>2mm)	<1.0		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Sand (2.0mm - 0.063mm)	22.3		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Silt (0.063mm - 4um)	42.8		1.0	%	28-SEP-17	29-SEP-17	R3841635
% Clay (<4um)	34.8		1.0	%	28-SEP-17	29-SEP-17	R3841635
Texture	Clay loam				28-SEP-17	29-SEP-17	R3841635
Leachable Anions & Nutrients							
Total Kjeldahl Nitrogen	0.234	DLHC	0.040	%	02-OCT-17	03-OCT-17	R3845492
Organic / Inorganic Carbon							
FOC	0.0318		0.0010	g/g		30-SEP-17	
Total Organic Carbon	3.18		0.050	%		30-SEP-17	
Metals							
Aluminum (Al)	14100		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Antimony (Sb)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Arsenic (As)	2.32		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Barium (Ba)	90.0		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Beryllium (Be)	0.53		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Bismuth (Bi)	<0.20		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Boron (B)	7.6		5.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cadmium (Cd)	0.201		0.020	mg/kg	28-SEP-17	29-SEP-17	R3841942
Calcium (Ca)	6470		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Chromium (Cr)	33.1		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Cobalt (Co)	9.27		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Copper (Cu)	11.4		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Iron (Fe)	16000		50	mg/kg	28-SEP-17	29-SEP-17	R3841942

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1995196-11 STUC-REF-5 Sampled By: KB/PS on 15-SEP-17 @ 00:01 Matrix: Sediment							
Metals							
Lead (Pb)	7.43		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Lithium (Li)	16.4		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Magnesium (Mg)	5260		20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Manganese (Mn)	343		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Mercury (Hg)	0.0482		0.0050	mg/kg	28-SEP-17	28-SEP-17	R3840575
Molybdenum (Mo)	0.63		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Nickel (Ni)	19.8		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Phosphorus (P)	508		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Potassium (K)	1610		100	mg/kg	28-SEP-17	29-SEP-17	R3841942
Selenium (Se)	0.34		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Silver (Ag)	<0.10		0.10	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sodium (Na)	95		50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Strontium (Sr)	23.2		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Sulfur (S)	<1000		1000	mg/kg	28-SEP-17	29-SEP-17	R3841942
Thallium (Tl)	0.154		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tin (Sn)	<1.0		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Titanium (Ti)	145		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Tungsten (W)	<0.50		0.50	mg/kg	28-SEP-17	29-SEP-17	R3841942
Uranium (U)	1.55		0.050	mg/kg	28-SEP-17	29-SEP-17	R3841942
Vanadium (V)	36.6		0.20	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zinc (Zn)	67.3		2.0	mg/kg	28-SEP-17	29-SEP-17	R3841942
Zirconium (Zr)	5.1		1.0	mg/kg	28-SEP-17	29-SEP-17	R3841942

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier key listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TIC-PCT-SK	Soil	Total Inorganic Carbon in Soil	CSSS (2008) P216-217

A known quantity of acetic acid is consumed by reaction with carbonates in the soil. The pH of the resulting solution is measured and compared against a standard curve relating pH to weight of carbonate.

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOC-CALC-SK	Soil	Total Organic Carbon Calculation	CSSS (2008) 21.2

Total Organic Carbon (TOC) is calculated by the difference between total carbon (TC) and total inorganic carbon. (TIC)

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	CSSS (2008) 21.2

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

ALS Test Code	Matrix	Test Description	Method Reference**
FOC-CALC-SK	Soil	Fraction of Organic Carbon - Calculation	AUTO CALCULATION
HG-200.2-CVAA-SK	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

ALS Test Code	Matrix	Test Description	Method Reference**
IC-CACO3-CALC-SK	Soil	Inorganic Carbon as CaCO3 Equivalent	Calculation
MET-200.2-CCMS-SK	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
MOIST-SK	Soil	Moisture Content	ASTM D2216-80

The weighed portion of soil is placed in a 105°C oven overnight. The dried soil is allowed to cooled to room temperature, weighed and the % moisture is calculated.

ALS Test Code	Matrix	Test Description	Method Reference**
N-TOTKJ-COL-SK	Soil	Total Kjeldahl Nitrogen	CSSS (2008) 22.2.3

The soil is digested with sulfuric acid in the presence of CuSO4 and K2SO4 catalysts. Ammonia in the soil extract is determined colrimetrically at 660 nm.

ALS Test Code	Matrix	Test Description	Method Reference**
PSA-PIPET+GRAVEL-SK	Soil	Particle size - Sieve and Pipette	SSIR-51 METHOD 3.2.1

Particle size distribution is determined by a combination of techniques. Dry sieving is performed for coarse particles, wet sieving for sand particles and the pipette sedimentation method for clay particles.

Reference:

Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1995196 Report Date: 05-OCT-17

Client: MINNOW ENVIRONMENTAL INC.
2 Lamb Street
Georgetown ON L7G 3M9
Contact: Jess Tester

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-TIC-PCT-SK	**Soil**							
Batch R3840401								
WG2624822-2 LCS								
Inorganic Carbon			98.1		%		80-120	28-SEP-17
WG2624822-3 MB								
Inorganic Carbon			<0.050		%		0.05	28-SEP-17
Batch R3841822								
WG2624824-2 LCS								
Inorganic Carbon			98.9		%		80-120	30-SEP-17
WG2624824-3 MB								
Inorganic Carbon			<0.050		%		0.05	30-SEP-17
C-TOT-LECO-SK	**Soil**							
Batch R3841699								
WG2625479-1 DUP		**L1995196-1**						
Total Carbon by Combustion		8.19	8.23		%	0.5	20	28-SEP-17
WG2625479-2 IRM		**08-109_SOIL**						
Total Carbon by Combustion			100.2		%		80-120	28-SEP-17
WG2625479-3 MB								
Total Carbon by Combustion			<0.05		%		0.05	28-SEP-17
HG-200.2-CVAA-SK	**Soil**							
Batch R3840575								
WG2627376-3 CRM		**TILL-1**						
Mercury (Hg)			99.2		%		70-130	28-SEP-17
WG2627376-2 DUP		**L1995196-7**						
Mercury (Hg)		0.0389	0.0414		mg/kg	6.0	40	28-SEP-17
WG2627376-4 LCS								
Mercury (Hg)			108.7		%		80-120	28-SEP-17
WG2627376-1 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	28-SEP-17
MET-200.2-CCMS-SK	**Soil**							
Batch R3841942								
WG2627376-3 CRM		**TILL-1**						
Aluminum (Al)			100.2		%		70-130	29-SEP-17
Antimony (Sb)			96.0		%		70-130	29-SEP-17
Arsenic (As)			98.2		%		70-130	29-SEP-17
Barium (Ba)			107.6		%		70-130	29-SEP-17
Beryllium (Be)			106.0		%		70-130	29-SEP-17
Boron (B)			3.7		mg/kg		0-8.2	29-SEP-17
Bismuth (Bi)			91.2		%		70-130	29-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-SK	**Soil**							
Batch R3841942								
WG2627376-3 CRM		**TILL-1**						
Cadmium (Cd)			92.2		%		70-130	29-SEP-17
Calcium (Ca)			98.0		%		70-130	29-SEP-17
Chromium (Cr)			96.0		%		70-130	29-SEP-17
Cobalt (Co)			99.0		%		70-130	29-SEP-17
Copper (Cu)			99.2		%		70-130	29-SEP-17
Iron (Fe)			102.3		%		70-130	29-SEP-17
Lead (Pb)			92.6		%		70-130	29-SEP-17
Lithium (Li)			103.6		%		70-130	29-SEP-17
Magnesium (Mg)			96.6		%		70-130	29-SEP-17
Manganese (Mn)			99.7		%		70-130	29-SEP-17
Molybdenum (Mo)			97.2		%		70-130	29-SEP-17
Nickel (Ni)			97.7		%		70-130	29-SEP-17
Phosphorus (P)			98.5		%		70-130	29-SEP-17
Potassium (K)			88.0		%		70-130	29-SEP-17
Selenium (Se)			0.31		mg/kg		0.11-0.51	29-SEP-17
Silver (Ag)			0.21		mg/kg		0.13-0.33	29-SEP-17
Sodium (Na)			88.8		%		70-130	29-SEP-17
Strontium (Sr)			95.5		%		70-130	29-SEP-17
Thallium (Tl)			0.110		mg/kg		0.077-0.18	29-SEP-17
Tin (Sn)			1.2		mg/kg		0-3.1	29-SEP-17
Titanium (Ti)			96.7		%		70-130	29-SEP-17
Tungsten (W)			0.18		mg/kg		0-0.66	29-SEP-17
Uranium (U)			85.9		%		70-130	29-SEP-17
Vanadium (V)			95.3		%		70-130	29-SEP-17
Zinc (Zn)			100.0		%		70-130	29-SEP-17
Zirconium (Zr)			0.8		mg/kg		0-1.8	29-SEP-17
WG2627376-2 DUP		**L1995196-7**						
Aluminum (Al)		11900	11900		mg/kg	0.2	40	29-SEP-17
Antimony (Sb)		<0.10	<0.10	RPD-NA	mg/kg	N/A	30	29-SEP-17
Arsenic (As)		2.47	2.42		mg/kg	2.0	30	29-SEP-17
Barium (Ba)		71.4	74.0		mg/kg	3.7	40	29-SEP-17
Beryllium (Be)		0.45	0.46		mg/kg	3.2	30	29-SEP-17
Boron (B)		7.6	7.5		mg/kg	1.6	30	29-SEP-17
Bismuth (Bi)		<0.20	<0.20	RPD-NA	mg/kg	N/A	30	29-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-SK	**Soil**							
Batch R3841942								
WG2627376-2 DUP		**L1995196-7**						
Cadmium (Cd)		0.242	0.244		mg/kg	1.0	30	29-SEP-17
Calcium (Ca)		6330	6200		mg/kg	2.1	30	29-SEP-17
Chromium (Cr)		27.0	27.2		mg/kg	1.1	30	29-SEP-17
Cobalt (Co)		8.90	8.94		mg/kg	0.4	30	29-SEP-17
Copper (Cu)		9.82	9.82		mg/kg	0.0	30	29-SEP-17
Iron (Fe)		13500	13900		mg/kg	3.0	30	29-SEP-17
Lead (Pb)		6.24	6.66		mg/kg	6.5	40	29-SEP-17
Lithium (Li)		14.0	14.2		mg/kg	1.5	30	29-SEP-17
Magnesium (Mg)		4880	4720		mg/kg	3.3	30	29-SEP-17
Manganese (Mn)		319	309		mg/kg	3.1	30	29-SEP-17
Molybdenum (Mo)		0.51	0.52		mg/kg	2.3	40	29-SEP-17
Nickel (Ni)		16.9	17.5		mg/kg	3.4	30	29-SEP-17
Phosphorus (P)		493	458		mg/kg	7.3	30	29-SEP-17
Potassium (K)		1440	1470		mg/kg	1.7	40	29-SEP-17
Selenium (Se)		0.27	0.32		mg/kg	15	30	29-SEP-17
Silver (Ag)		<0.10	<0.10	RPD-NA	mg/kg	N/A	40	29-SEP-17
Sodium (Na)		88	88		mg/kg	0.4	40	29-SEP-17
Strontium (Sr)		23.4	22.6		mg/kg	3.4	40	29-SEP-17
Sulfur (S)		<1000	<1000	RPD-NA	mg/kg	N/A	30	29-SEP-17
Thallium (Tl)		0.135	0.143		mg/kg	5.7	30	29-SEP-17
Tin (Sn)		<1.0	<1.0	RPD-NA	mg/kg	N/A	40	29-SEP-17
Titanium (Ti)		155	160		mg/kg	2.9	40	29-SEP-17
Tungsten (W)		<0.50	<0.50	RPD-NA	mg/kg	N/A	30	29-SEP-17
Uranium (U)		1.36	1.48		mg/kg	8.2	30	29-SEP-17
Vanadium (V)		32.4	33.1		mg/kg	2.1	30	29-SEP-17
Zinc (Zn)		61.2	62.2		mg/kg	1.6	30	29-SEP-17
Zirconium (Zr)		5.1	5.4		mg/kg	5.4	30	29-SEP-17
WG2627376-4 LCS								
Aluminum (Al)			98.1		%		80-120	29-SEP-17
Antimony (Sb)			95.0		%		80-120	29-SEP-17
Arsenic (As)			97.4		%		80-120	29-SEP-17
Barium (Ba)			102.5		%		80-120	29-SEP-17
Beryllium (Be)			100.1		%		80-120	29-SEP-17
Boron (B)			96.1		%		80-120	29-SEP-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-SK	**Soil**							
Batch R3841942								
WG2627376-4 LCS								
Bismuth (Bi)			93.7		%		80-120	29-SEP-17
Cadmium (Cd)			94.7		%		80-120	29-SEP-17
Calcium (Ca)			98.2		%		80-120	29-SEP-17
Chromium (Cr)			94.7		%		80-120	29-SEP-17
Cobalt (Co)			96.1		%		80-120	29-SEP-17
Copper (Cu)			93.2		%		80-120	29-SEP-17
Iron (Fe)			96.9		%		80-120	29-SEP-17
Lead (Pb)			92.1		%		80-120	29-SEP-17
Lithium (Li)			109.1		%		80-120	29-SEP-17
Magnesium (Mg)			94.3		%		80-120	29-SEP-17
Manganese (Mn)			97.6		%		80-120	29-SEP-17
Molybdenum (Mo)			96.7		%		80-120	29-SEP-17
Nickel (Ni)			94.9		%		80-120	29-SEP-17
Phosphorus (P)			109.2		%		80-120	29-SEP-17
Potassium (K)			101.8		%		80-120	29-SEP-17
Selenium (Se)			98.9		%		80-120	29-SEP-17
Silver (Ag)			98.1		%		80-120	29-SEP-17
Sodium (Na)			91.8		%		80-120	29-SEP-17
Strontium (Sr)			106.7		%		80-120	29-SEP-17
Sulfur (S)			96.8		%		80-120	29-SEP-17
Thallium (Tl)			91.9		%		80-120	29-SEP-17
Tin (Sn)			94.9		%		80-120	29-SEP-17
Titanium (Ti)			99.5		%		80-120	29-SEP-17
Tungsten (W)			91.3		%		80-120	29-SEP-17
Uranium (U)			94.2		%		80-120	29-SEP-17
Vanadium (V)			97.0		%		80-120	29-SEP-17
Zinc (Zn)			93.6		%		80-120	29-SEP-17
Zirconium (Zr)			96.6		%		80-120	29-SEP-17
WG2627376-1 MB								
Aluminum (Al)			<50		mg/kg		50	29-SEP-17
Antimony (Sb)			<0.10		mg/kg		0.1	29-SEP-17
Arsenic (As)			<0.10		mg/kg		0.1	29-SEP-17
Barium (Ba)			<0.50		mg/kg		0.5	29-SEP-17
Beryllium (Be)			<0.10		mg/kg		0.1	29-SEP-17

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-SK	**Soil**							
Batch R3841942								
WG2627376-1 MB								
Boron (B)			<5.0		mg/kg		5	29-SEP-17
Bismuth (Bi)			<0.20		mg/kg		0.2	29-SEP-17
Cadmium (Cd)			<0.020		mg/kg		0.02	29-SEP-17
Calcium (Ca)			<50		mg/kg		50	29-SEP-17
Chromium (Cr)			<0.50		mg/kg		0.5	29-SEP-17
Cobalt (Co)			<0.10		mg/kg		0.1	29-SEP-17
Copper (Cu)			<0.50		mg/kg		0.5	29-SEP-17
Iron (Fe)			<50		mg/kg		50	29-SEP-17
Lead (Pb)			<0.50		mg/kg		0.5	29-SEP-17
Lithium (Li)			<2.0		mg/kg		2	29-SEP-17
Magnesium (Mg)			<20		mg/kg		20	29-SEP-17
Manganese (Mn)			<1.0		mg/kg		1	29-SEP-17
Molybdenum (Mo)			<0.10		mg/kg		0.1	29-SEP-17
Nickel (Ni)			<0.50		mg/kg		0.5	29-SEP-17
Phosphorus (P)			<50		mg/kg		50	29-SEP-17
Potassium (K)			<100		mg/kg		100	29-SEP-17
Selenium (Se)			<0.20		mg/kg		0.2	29-SEP-17
Silver (Ag)			<0.10		mg/kg		0.1	29-SEP-17
Sodium (Na)			<50		mg/kg		50	29-SEP-17
Strontium (Sr)			<0.50		mg/kg		0.5	29-SEP-17
Sulfur (S)			<1000		mg/kg		1000	29-SEP-17
Thallium (Tl)			<0.050		mg/kg		0.05	29-SEP-17
Tin (Sn)			<1.0		mg/kg		1	29-SEP-17
Titanium (Ti)			<1.0		mg/kg		1	29-SEP-17
Tungsten (W)			<0.50		mg/kg		0.5	29-SEP-17
Uranium (U)			<0.050		mg/kg		0.05	29-SEP-17
Vanadium (V)			<0.20		mg/kg		0.2	29-SEP-17
Zinc (Zn)			<2.0		mg/kg		2	29-SEP-17
Zirconium (Zr)			<1.0		mg/kg		1	29-SEP-17
MOIST-SK	**Soil**							
Batch R3839576								
WG2623587-1 DUP		**L1995196-3**						
% Moisture		85.5	85.3		%	0.2	20	27-SEP-17
WG2623587-3 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MOIST-SK	**Soil**							
Batch R3839576								
WG2623587-3 LCS								
% Moisture			103.1		%		90-110	27-SEP-17
WG2623587-2 MB								
% Moisture			<0.10		%		0.1	27-SEP-17
Batch R3841080								
WG2626810-3 LCS								
% Moisture			99.3		%		90-110	29-SEP-17
WG2626810-2 MB								
% Moisture			<0.10		%		0.1	29-SEP-17
N-TOTKJ-COL-SK	**Soil**							
Batch R3845492								
WG2624238-2 IRM		**08-109_SOIL**						
Total Kjeldahl Nitrogen			95.1		%		80-120	03-OCT-17
WG2624238-3 MB								
Total Kjeldahl Nitrogen			<0.020		%		0.02	03-OCT-17
PSA-PIPET+GRAVEL-SK	**Soil**							
Batch R3841635								
WG2623164-2 IRM		**2017-PSA**						
% Sand (2.0mm - 0.063mm)			45.0		%		39.1-49.1	29-SEP-17
% Silt (0.063mm - 4um)			36.6		%		32.5-42.5	29-SEP-17
% Clay (<4um)			18.4		%		13.4-23.4	29-SEP-17

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

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Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1995196-COFC

COC Number: 15 -

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minnow Environmental Inc.
Contact:	Katharina Batchelar
Phone:	250-595-1627
	Company address below will appear on the final report
Street:	101-1025 Hillside Avenue
City/Province:	Victoria, BC
Postal Code:	V8T 2A2
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	
Contact:	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax kbatchelar@minnow.ca

Email 2 jtester@minnow.ca

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax kbatchelar@minnow.ca

Email 2 jtester@minnow.ca

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #: Q62002

Job #: 17-13

PO / AFE:

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only) L1995196

ALS Contact: Selam Worku

Sampler: KB, PS

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	HG-200.2-CVAA-WT (Hg in Soil)	MET-200.2-CCMS-WT (Metals in Soil)	MOISTURE-WT (% Moisture)	N-TOTKJ-COL-SK (Total Kjeldahl Nitrogen)	PSA-PIPET+GRAVEL-SK (Particle Size)	TOC-WT (TOC and FOC in Solids)	Number of Containers
	PinR-EXP-1	14-Sept-17	—	Sediment	✓	✓	✓	✓	✓	✓	1
	PinR-EXP-2	14-Sept-17	—	Sediment	✓	✓	✓	✓	✓	✓	1
	PinR-EXP-3	14-Sept-17	—	Sediment	✓	✓	✓	✓	✓	✓	1
	PinR-EXP-4	14-Sept-17	—	Sediment	✓	✓	✓	✓	✓	✓	1
	PinR-EXP-5	14-Sept-17	—	Sediment	✓	✓	✓	✓	✓	✓	1
	PinR-EXP-4X	14-Sept-17	—	Sediment	✓	✓	✓	✓	✓	✓	1
	StuC-Ref-1	14-Sept-17	—	Sediment	✓	✓	✓	✓	✓	✓	1
	StuC-Ref-2	14-Sept-17	—	Sediment	✓	✓	✓	✓	✓	✓	1
	StuC-Ref-3	15-Sept-17	—	Sediment	✓	✓	✓	✓	✓	✓	1
	StuC-Ref-4	15-Sept-17	—	Sediment	✓	✓	✓	✓	✓	✓	1
	StuC-Ref-5	15-Sept-17	—	Sediment	✓	✓	✓	✓	✓	✓	1
				Sediment							

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO

Are samples for human drinking water use? ☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 9.9

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Batchelar	Date: 18-Sept-17	Time: 11:00	Received by: CS	Date: 09/19/17	Time: 15:30	Received by:	Date:	Time:

... SAMPLING INFORMATION   WHITE - LABORATORY COPY   YELLOW - CLIENT COPY   OCTOBER 2015 FRONT

... form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

... using an Authorized DW COC form.

APPENDIX D
BENTHIC INVERTEBRATE COMMUNITY DATA

Laboratory Reports

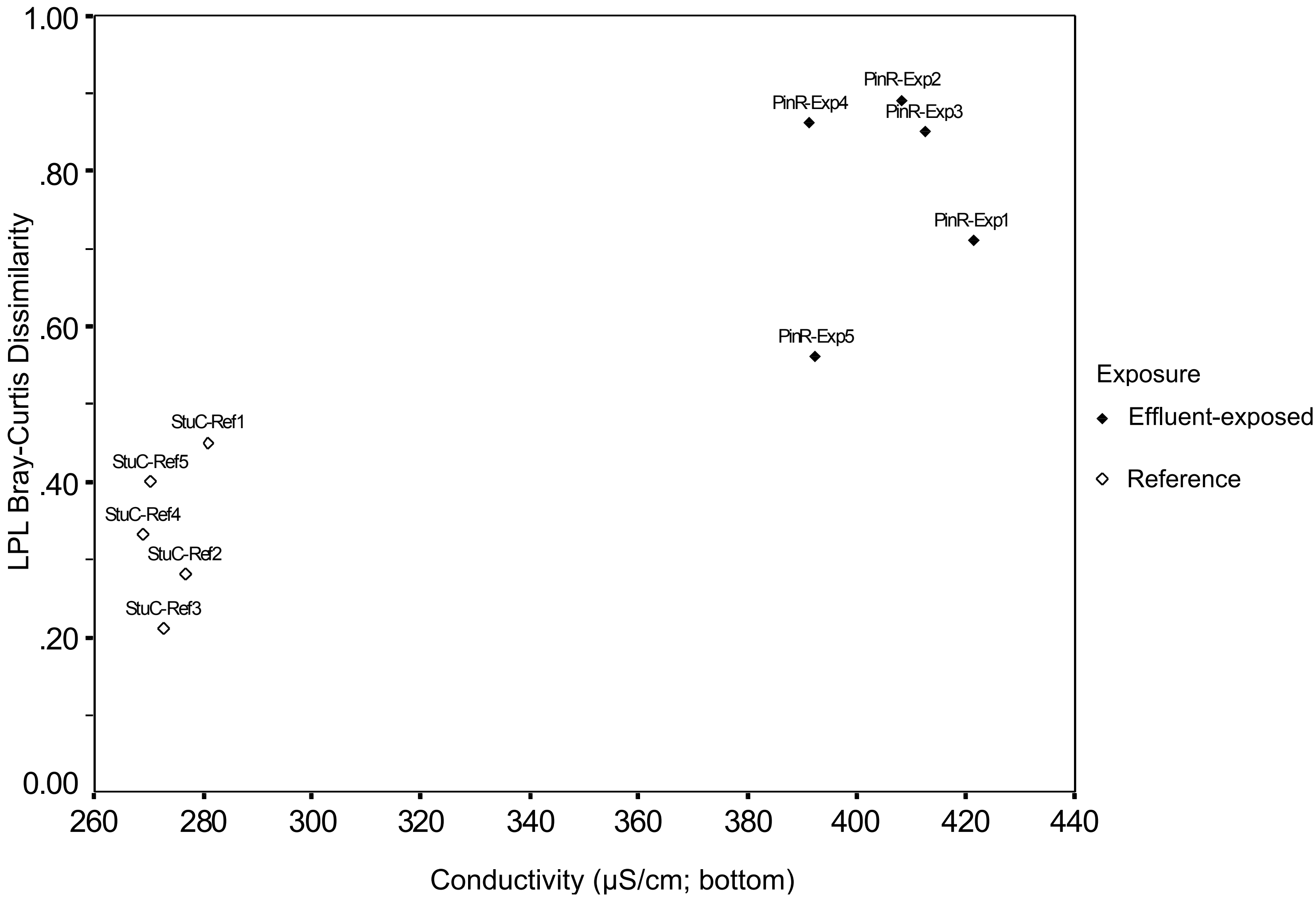

Figure D.1a: **Benthic Metrics and Supporting Measures at RRP Stations, 2017**

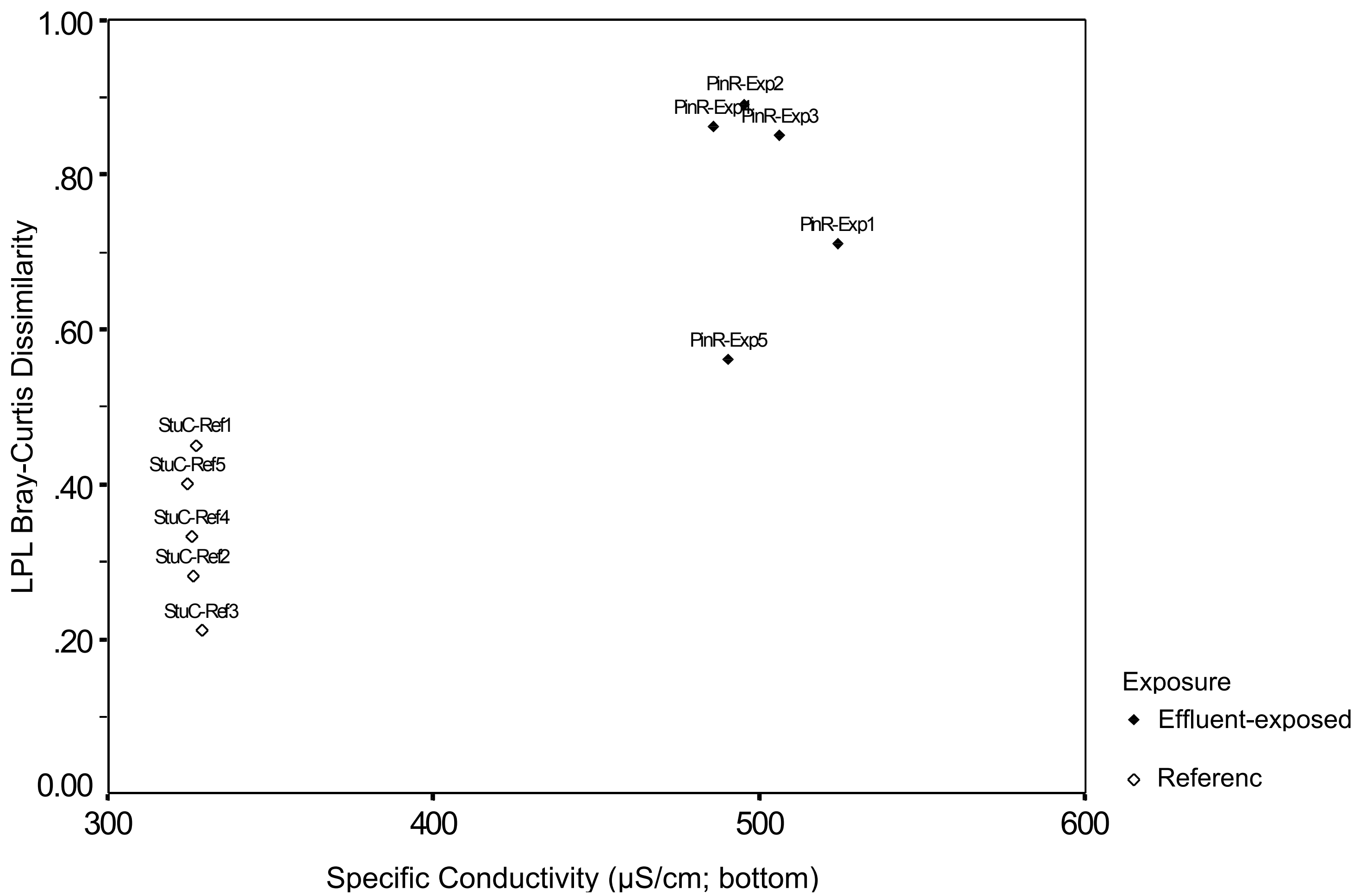

Figure D.1b: **Benthic Metrics and Supporting Measures at RRP Stations, 2017**

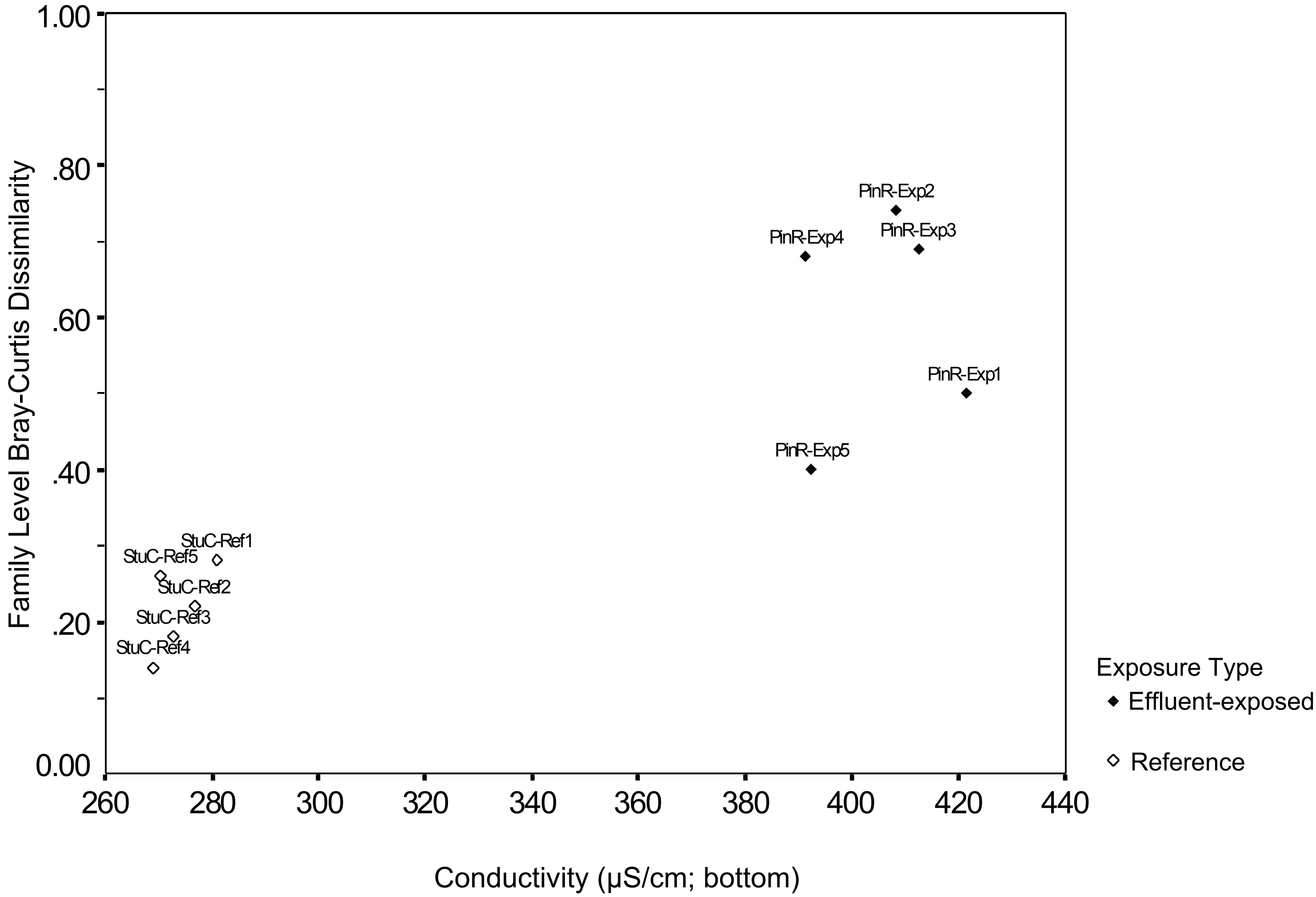

Figure D.1c: **Benthic Metrics and Supporting Measures at RRP Stations, 2017**

Table D.1: Latitudes and Longitudes of Benthic Invertebrate Sampling Stations, RRP Phase 1 EEM, 2017

Study Area	Station ID	Date Sampled	Latitude (dd mm ss.s)[a]	Longitude (dd mm ss.s)[a]
Sturgeon Creek (Reference)	StuC-REF1	14-Sep-17	48 43 18.8	-93 57 25.6
	StuC-REF2	14-Sep-17	48 43 19.1	-93 57 27.8
	StuC-REF3	15-Sep-17	48 43 17.9	-93 57 31.3
	StuC-REF4	15-Sep-17	48 43 17.3	-93 57 36.9
	StuC-REF5	15-Sep-17	48 43 16.2	-93 57 37.5
Pinewood River (Effluent-exposed)	PinR-EXP1	14-Sep-17	48 49 48.0	-94 03 48.1
	PinR-EXP2	14-Sep-17	48 49 48.3	-94 03 49.2
	PinR-EXP3	14-Sep-17	48 49 48.0	-94 03 48.1
	PinR-EXP4	14-Sep-17	48 49 47.5	-94 03 49.9
	PinR-EXP5	14-Sep-17	48 49 46.5	-94 03 50.4

[a] d-degrees, m-minutes, s-seconds
Note: Map Datum (NAD) 83

Table D.2: Number of Invertebrates per m^2, RRP Phase 1 EEM, 2017

Station	StuC-Ref					PinR-Exp				
Replicate	1	2	3	4	5	1	2	3	4	5
ROUNDWORMS										
P. Nemata	459	574	344	459	2,755	918	3,902	230	230	230
ANNELIDS										
P. Annelida										
WORMS										
Cl. Oligochaeta										
F. Naididae										
S.F. Naidinae										
Dero digitata	0	0	115	230	0	230	689	0	0	0
Dero nivea	459	0	0	0	0	0	0	0	0	0
Nais alpina/simplex	0	230	0	0	230	0	0	0	0	0
S.F. Tubificinae										
Aulodrilus pigueti	0	0	0	689	0	0	689	0	0	0
Limnodrilus udekemianus	230	1,263	115	0	2,984	0	4,132	230	1,377	344
immatures with hair chaetae	0	115	0	0	459	0	0	0	0	0
immatures without hair chaetae	230	230	0	459	689	0	8,264	0	0	344
LEECHES										
Cl. Hirudinea										
F. Glossiphoniidae										
Glossiphonia complanata	0	115	0	0	0	0	0	0	0	0
ARTHROPODS										
P. Arthropoda										
MITES										
Cl. Arachnida										
Subcl. Acari	0	0	0	0	0	0	230	0	0	0
O. Trombidiformes										
F. Arrenuridae										
Arrenurus	0	0	0	0	0	0	0	230	0	0
F. Limnesiidae										
Limnesia	0	115	115	0	230	0	0	0	0	0
F. Oxidae										
Oxus	0	0	115	0	0	0	0	0	0	0
F. Pionidae										
indeterminate	230	115	0	0	0	0	0	0	0	0
F. Unionicolidae										
Neumania	0	115	115	0	0	0	0	0	0	0
Unionicola	0	0	0	0	230	0	0	0	0	0
HARPACTICOIDS										
O. Harpacticoida	689	0	0	689	459	0	0	0	0	0
SEED SHRIMPS										
Cl. Ostracoda	230	0	0	230	0	918	230	0	0	115
INSECTS										
Cl. Insecta										
MAYFLIES										
O. Ephemeroptera										
F. Caenidae										
Caenis	0	115	0	0	0	0	0	230	0	0
O. Odonata										
DRAGONFLIES										
F. Corduliidae										
Epitheca	0	0	0	0	0	0	14	0	0	0
CADDISFLIES										
O. Trichoptera										
F. Hydroptilidae										
Oxyethira	0	0	115	0	0	0	0	0	0	0
TRUE FLIES										
O. Diptera										
BITING-MIDGE										
F. Ceratopogonidae										
Bezzia	0	0	0	0	0	230	0	230	0	0
Dasyhelea	0	0	0	0	0	0	230	230	0	0
Sphaeromias	0	0	0	0	230	0	0	0	0	0
pupae	0	0	0	0	0	0	0	0	0	115

Table D.2: Number of Invertebrates per m^2, RRP Phase 1 EEM, 2017

Station	StuC-Ref					PinR-Exp				
Replicate	1	2	3	4	5	1	2	3	4	5
PHANTOM MIDGE										
F. Chaoboridae										
Chaoborus flavicans	0	115	0	0	0	0	0	230	0	0
Chaoborus punctipennis	1,148	3,214	2,410	2,066	2,755	0	0	0	0	574
MIDGES										
F. Chironomidae										
chironomid pupae	0	0	0	0	0	230	0	0	0	0
S.F. Chironominae										
Chironomus	0	230	0	689	918	918	0	689	230	1,033
Cladopelma	0	0	230	0	230	0	0	0	0	0
Dicrotendipes	0	0	0	0	0	1,377	230	0	0	0
Einfeldia	1,836	230	0	2,525	689	459	0	0	0	574
Endochironomus	1,377	0	230	0	230	0	230	0	0	0
Glyptotendipes	689	344	574	689	230	459	0	0	0	0
Parachironomus	0	0	0	0	0	459	0	0	0	0
Paratanytarsus	0	0	0	0	0	0	230	0	0	0
Polypedilum sordens	0	0	230	0	0	0	0	0	0	0
Tanytarsus	459	115	0	0	0	459	459	0	0	0
S.F. Orthocladiinae										
Cricotopus (Isocladius)	0	0	0	0	230	0	0	0	0	0
S.F. Tanypodinae										
Ablabesmyia	0	0	0	0	0	0	230	230	0	0
Guttipelopia	1,148	230	230	0	0	689	0	0	0	115
Labrudinia	0	0	0	0	0	0	230	230	0	0
Procladius	230	803	1,148	918	918	230	230	0	0	344
Psectrotanypus	0	0	0	0	0	0	0	0	0	230
Tanypus	0	0	0	0	0	0	0	0	0	115
MOLLUSCS										
P. Mollusca										
SNAILS										
Cl. Gastropoda										
F. Ancylidae										
Ferrissia	230	230	115	0	0	459	0	0	0	0
F. Hydrobiidae										
Amnicola	0	0	0	0	0	0	689	1,836	0	0
F. Planorbidae										
Gyraulus	459	0	0	0	0	230	0	230	0	0
immature	230	0	0	0	0	0	0	0	0	0
CLAMS										
Cl. Bivalvia										
F. Sphaeriidae										
Cyclocalyx	0	0	115	0	0	0	0	0	0	0
Sphaerium (Musculium)	0	0	0	0	0	0	459	0	1,148	230
TOTAL NUMBER OF ORGANISMS	####	8,498	6,316	9,643	####	8,265	####	4,825	2,985	4,363
TOTAL NUMBER OF TAXA [a]	16	19	16	11	17	14	18	12	4	13

[a] Bold entries excluded from taxa count

Table D.3: Benthic Analyses: Index Values for Benthic Sample Stations, RRP Phase 1 EEM, 2017

Station ID	Density (Ind./m2)	LPL Number of Taxa	LPL Simpson's E	LPL BC Dissimilarity	LPL Simpson's D	% Oligochaeta	% Ostracoda	% Ephemeroptera	% Trichoptera	% Chaoboridae	% Chironomidae	% Metal Sensitive Chironomidae	% Gastropoda	% Bivalvia	% Collector Gatherers	% Filterers	% Scrapers	% Shredders	% Clingers	% Sprawlers	% Burrowers	LPLsimpEk
StuC-REF-1	10436	16.0000	0.6500	0.4500	0.9000	8.8900	2.2200	0.0000	0.0000	11.1100	55.5500	4.4500	8.8900	0.0000	40.0100	4.4500	9	20.0000	28.8900	31.1000	40.0100	0.9600
StuC-REF-2	8581	17.0000	0.3100	0.2800	0.8100	21.6200	0.0000	1.3500	0.0000	39.1800	22.9800	1.3500	2.7000	0.0000	35.1400	1.3500	3	4.0600	9.4600	52.7000	37.8400	0.8600
StuC-REF-3	6378	14.0000	0.3600	0.2100	0.8000	3.6400	0.0000	0.0000	1.8200	38.1800	41.8200	0.0000	1.8200	1.8200	12.7300	1.8200	4	16.3700	16.3700	59.9900	21.8300	0.8600
StuC-REF-4	9742	11.0000	0.6100	0.3300	0.8500	14.2900	2.3800	0.0000	0.0000	21.4200	50.0000	0.0000	0.0000	0.0000	61.9100	0.0000	0	7.1400	0.0000	38.0900	61.9100	0.9400
StuC-REF-5	14612	16.0000	0.4700	0.4000	0.8700	30.1500	0.0000	0.0000	0.0000	19.0500	23.8200	0.0000	0.0000	0.0000	65.0800	0.0000	0	4.7600	6.3500	28.5700	65.0800	0.9300
PinR-EXP-1	8351	14.0000	0.7500	0.7100	0.9000	2.7800	11.1100	0.0000	0.0000	0.0000	63.8800	5.5600	8.3300	0.0000	59.8400	5.8100	8	5.8100	14.1400	17.4400	68.4200	0.9700
PinR-EXP-2	21582	18.0000	0.2500	0.8900	0.7700	64.4700	1.0700	0.0000	0.0000	0.0000	8.6000	3.2200	3.2200	2.1500	85.9600	5.3700	3	1.0700	7.5900	5.3700	84.8900	0.8200
PinR-EXP-3	4871	12.0000	0.4400	0.8500	0.8100	4.7600	0.0000	4.7600	0.0000	4.7600	23.8100	0.0000	42.8500	0.0000	33.3400	0.0000	43	0.0000	47.6100	23.8100	28.5800	0.8900
PinR-EXP-4	3014	4.0000	0.6700	0.8600	0.6300	46.1500	0.0000	0.0000	0.0000	0.0000	7.7000	0.0000	0.0000	38.4500	61.5500	38.4500	0	0.0000	0.0000	0.0000	61.5500	0.8400
PinR-EXP-5	4407	12.0000	0.6600	0.5600	0.8700	15.7900	2.6300	0.0000	0.0000	13.1600	55.2500	0.0000	0.0000	5.2600	60.5200	5.2600	0	0.0000	0.0000	31.5900	63.1500	0.9500

Station ID	Rainy LPL CA-1 (22.1%)	Rainy LPL CA 2 (15.2%)	Rainy LPL CA-3 (14.4%)	Rainy LPL CA-4 (12.9%)	Rainy LPL CA 5 (10.9%)	FL Number of Taxa	FL Simpson's D	FL Simpson's E	Flsimpek	FL BC Dissimilarity	Rainy FL CA-1 (23.1%)	Rainy FL CA-2 (21.3%)	Rainy FL CA 3 (19.5%)	Rainy FL CA-4 (12.3%)	Rainy FL CA-5 (10.4%)	Station Depth (m)	% Gravel	% Sand and Finer	% Organic	Temperature (°C; bottom)	Dissolved Oxygen (mg/L; bottom)	Dissolved Oxygen (% sat.; bottom)
StuC-REF-1	0.3500	-0.0900	0.3500	0.2600	0.1900	9.0000	0.6600	0.3300	0.7400	0.2800	-0.4100	-0.2000	0.4300	0.1700	0.1000	0.9600	0.0000	90.0000	10.0000	17.7000	3.7400	38.2000
StuC-REF-2	0.2000	-0.1800	-0.4100	0.5700	-0.2400	8.0000	0.7400	0.4800	0.8500	0.2200	-0.7500	0.4000	-0.6100	-0.1200	-0.4900	0.9800	0.0000	95.0000	5.0000	17.1000	4.1100	42.0000
StuC-REF-3	0.7400	-0.9200	0.0600	-0.9700	-0.4800	8.0000	0.6700	0.3800	0.7700	0.1800	-0.1100	-0.4300	-0.7800	0.3600	0.5700	0.9400	0.0000	90.0000	10.0000	16.2000	4.0200	41.1000
StuC-REF-4	0.3100	0.3400	0.2400	0.0200	0.5700	6.0000	0.6800	0.5100	0.8100	0.1400	-0.2300	-0.5100	0.4300	-0.4500	-0.0200	0.9400	0.0000	90.0000	10.0000	15.9000	3.3900	34.6000
StuC-REF-5	0.6000	-0.0400	-0.7700	0.2300	0.4600	7.0000	0.7800	0.6400	0.9100	0.2600	-0.1700	-0.1800	0.1800	-0.5000	0.2200	0.9800	0.0000	90.0000	10.0000	16.3000	4.2300	43.2000
PinR-EXP-1	-0.0800	-0.0900	1.1100	0.4800	-0.2100	7.0000	0.5600	0.3300	0.6600	0.5000	-0.0400	0.0000	0.5200	0.7500	-0.2700	0.9600	0.0000	80.0000	20.0000	12.0800	2.7000	25.2000
PinR-EXP-2	-0.8500	0.1400	0.1100	-0.6200	0.5900	9.0000	0.5400	0.2400	0.6100	0.7400	0.8100	0.2800	0.0000	-0.0800	0.0000	0.8200	0.0000	80.0000	20.0000	12.2200	3.1100	29.4000
PinR-EXP-3	-1.5000	-0.5800	-0.4500	0.3400	-0.4100	9.0000	0.7800	0.5000	0.8700	0.6900	0.0800	0.9600	0.1100	-0.0500	0.3000	0.9800	0.0000	75.0000	25.0000	12.5900	4.7300	44.6000
PinR-EXP-4	-0.3400	1.1900	-0.5400	-0.6000	-0.7400	4.0000	0.6300	0.6700	0.8400	0.6800	0.7900	-0.5000	-0.5200	-0.0700	-0.4500	0.9800	0.0000	80.0000	20.0000	12.6700	4.0800	38.5000
PinR-EXP-5	0.2300	1.1800	-0.0500	-0.1700	-0.6700	7.0000	0.6500	0.4000	0.7500	0.4000	0.4100	-0.3000	-0.0100	-0.0500	-0.2600	0.8200	0.0000	80.0000	20.0000	12.6600	4.1100	38.8000

Station ID	pH (bottom)	Conductivity (µS/cm; bottom)	Specific Conductance (µS/cm; bottom)	Moisture (%)	Total Kjeldahl Nitrogen (%)	Total Organic Carbon (%)	% Gravel (%)	% Sand (%)	% Silt (%)	% Clay (%)	FOC (log10 [mg/g])	Aluminum (log10 [ng/kg])	Antimony (log10 [ng/kg])	Arsenic (log10 [ng/kg])	Barium (log10 [ng/kg])	Beryllium (log10 [ng/kg])	Bismuth (log10 [ng/kg])	Boron (log10 [ng/kg])	Cadmium (log10 [ng/kg])	Calcium (log10 [ng/kg])	Chromium (log10 [ng/kg])	Cobalt (log10 [ng/kg])
StuC-REF-1	7.7700	280.8000	326.6000	62.5000	0.2400	3.1900	1.0000	27.3000	41.7000	31.0000	1.5000	6.0800	1.0000	2.3900	3.8500	1.6500	1.3000	2.8800	1.3800	5.8000	3.4300	2.9500
StuC-REF-2	7.5700	276.6000	325.7000	65.0000	0.3200	4.0100	1.0000	11.9000	50.5000	37.6000	1.6000	6.1800	1.0400	2.4600	3.9900	1.7500	1.3000	2.9400	1.5100	5.8700	3.5800	3.0300
StuC-REF-3	7.4400	272.7000	328.5000	51.5000	0.2000	2.7800	1.0000	30.9000	36.9000	32.2000	1.4400	6.0700	1.0000	2.3300	3.8400	1.7100	1.3000	2.8900	1.3300	5.8200	3.4400	2.9400
StuC-REF-4	7.3300	268.9000	325.5000	75.5000	0.3900	5.4900	1.0000	6.8000	51.9000	41.3000	1.7400	6.1800	1.1100	2.5200	4.0300	1.7900	1.3000	2.9800	1.5900	5.9000	3.6400	3.0700
StuC-REF-5	7.5000	270.3000	324.0000	59.0000	0.2300	3.1800	1.0000	22.3000	42.8000	34.8000	1.5000	6.1500	1.0000	2.3700	3.9500	1.7200	1.3000	2.8800	1.3000	5.8100	3.5200	2.9700
PinR-EXP-1	7.0200	421.2000	524.1000	81.8000	0.6100	7.8500	1.0000	8.3000	60.2000	31.5000	1.8900	6.2200	1.1500	2.6400	4.1100	1.7900	1.3000	3.0200	1.6500	6.1400	3.5400	3.0800
PinR-EXP-2	7.3000	408.2000	495.2000	76.5000	0.4300	6.0100	1.0000	16.0000	53.4000	30.5000	1.7800	6.1400	1.2800	2.5700	4.0800	1.8100	1.3000	3.0600	1.5100	6.3100	3.5600	3.0400
PinR-EXP-3	7.3600	412.3000	505.9000	85.5000	0.6900	8.9700	1.0000	2.4000	69.0000	28.6000	1.9500	6.1500	1.2000	2.6800	4.0500	1.7500	1.3000	3.0300	1.6000	6.2700	3.5300	3.0500
PinR-EXP-4	7.3100	391.3000	485.6000	53.5000	0.2400	3.4600	1.0000	30.8000	44.6000	24.6000	1.5400	5.9700	1.0400	2.3500	3.7900	1.6400	1.3000	2.8500	1.3000	6.0600	3.3300	2.8200
PinR-EXP-5	7.2600	392.4000	490.4000	72.6000	0.6400	9.3900	1.0000	10.7000	64.7000	24.6000	1.9700	6.1000	1.1800	2.4500	3.9700	1.7200	1.3000	2.8900	1.5600	6.0100	3.4300	2.8600

Station ID	Copper (log10 [ng/kg])	Iron (log10 [ng/kg])	Lead (log10 [ng/kg])	Lithium (log10 [ng/kg])	Magnesium (log10 [ng/kg])	Manganese (log10 [ng/kg])	Mercury (log10 [ng/kg])	Molybdenum (log10 [ng/kg])	Nickel (log10 [ng/kg])	Phosphorus (log10 [ng/kg])	Potassium (log10 [ng/kg])	Selenium (log10 [ng/kg])	Silver (log10 [ng/kg])	Sodium (log10 [ng/kg])	Strontium (log10 [ng/kg])	Sulphur (log10 [ng/kg])	Thallium (log10 [ng/kg])	Tin (log10 [ng/kg])	Titanium (log10 [ng/kg])	Tungsten (log10 [ng/kg])	Uranium (log10 [ng/kg])	Vanadium (log10 [ng/kg])
StuC-REF-1	2.9900	6.1300	2.8000	3.1500	5.6900	4.5000	0.5900	1.7100	3.2300	4.6900	5.1600	1.4300	1.0000	3.9400	3.3700	5.0000	1.1300	2.0000	4.1900	1.7000	2.1300	3.5100
StuC-REF-2	3.1000	6.2300	2.9000	3.2800	5.7500	4.5700	0.7100	2.0200	3.3700	4.7400	5.2500	1.5800	1.0000	4.0100	3.4200	5.0400	1.2200	2.0000	4.1800	1.7000	2.2600	3.6000
StuC-REF-3	2.9800	6.1200	2.8600	3.1700	5.6700	4.4200	0.6100	1.7300	3.2200	4.6700	5.1400	1.4300	1.0000	3.9300	3.3700	5.0000	1.1900	2.0000	4.2100	1.7000	2.1900	3.5000
StuC-REF-4	3.1600	6.2600	2.9600	3.2700	5.7800	4.6300	0.7900	2.1700	3.4300	4.7600	5.2900	1.6800	1.0000	4.0500	3.4800	5.1500	1.2700	2.0000	4.1700	1.7000	2.3400	3.6400
StuC-REF-5	3.0600	6.2000	2.8700	3.2100	5.7200	4.5400	0.6800	1.8000	3.3000	4.7100	5.2100	1.5300	1.0000	3.9800	3.3700	5.0000	1.1900	2.0000	4.1600	1.7000	2.1900	3.5600
PinR-EXP-1	3.2900	6.3000	2.9300	3.2600	5.9000	4.7800	0.8000	2.0100	3.3900	4.8900	5.2500	1.7500	1.0000	4.1700	3.5100	5.2300	1.2700	2.0000	4.0700	1.7000	2.2700	3.6300
PinR-EXP-2	3.2100	6.2600	2.9300	3.2100	6.0000	4.8200	0.7000	2.0900	3.4000	4.8100	5.2000	1.6500	1.0000	4.1200	3.5600	5.1500	1.2500	2.0000	4.1700	1.7000	2.1700	3.6000
PinR-EXP-3	3.2400	6.2600	2.8800	3.2500	6.0200	4.6400	0.7700	2.1600	3.4000	4.8900	5.2500	1.7900	1.0000	4.2300	3.5800	5.3800	1.2500	2.0000	4.1400	1.7000	2.3200	3.6100
PinR-EXP-4	2.9900	6.1000	2.8000	3.0900	5.8300	4.5000	0.6900	1.5400	3.1700	4.7000	5.0200	1.5300	1.0000	3.9800	3.3400	5.0000	1.0900	2.0000	4.1400	1.7000	2.0400	3.4000
PinR-EXP-5	3.1200	6.1800	2.8800	3.1400	5.6800	4.5600	0.7300	1.8800	3.2700	4.8300	5.1100	1.7200	1.0000	4.0500	3.5000	5.2000	1.1300	2.0000	3.9900	1.7000	2.3200	3.5300

Table D.3: Benthic Analyses: Index Values for Benthic Sample Stations, RRP Phase 1 EEM, 2017

Station ID	Zinc (log10 [ng/kg])	Zirconium (log10 [ng/kg])	Rainy River Sediment Metal PC-1 (69.7%)	Rainy River Sediment Metal PC-2 (16.2%)	Rainy River Sediment Metal PC-3 (6.2%)
StuC-REF-1	3.7900	2.7100	-1.0889	0.2666	0.3844
StuC-REF-2	3.9000	2.8200	0.1808	1.2275	-0.1703
StuC-REF-3	3.7700	2.7800	-1.0389	0.7194	0.2220
StuC-REF-4	3.9600	2.8600	0.8311	1.3090	-0.5819
StuC-REF-5	3.8300	2.7100	-0.4747	0.7841	-0.0640
PinR-EXP-1	3.9700	2.6900	1.2149	-0.2937	-0.2957
PinR-EXP-2	3.8800	2.7200	0.8672	-0.4241	1.7616
PinR-EXP-3	3.9500	2.5700	1.1371	-1.1209	0.4109
PinR-EXP-4	3.7000	2.6700	-1.4996	-1.2993	0.5233
PinR-EXP-5	3.8000	2.6900	-0.1290	-1.1686	-2.1904

Table D.4: Statistical Characteristics of Benthic Metrics and Supporting Measures at RRP Phase 1 EEM Areas, 2017

Variable	Area ID	n	Median	Mean	Standard Deviation	Standard Error	95% Confidence Interval		Minimum	Maximum
							Lower Bound	Upper Bound		
Density (Ind./m2)	StuC-REF	5	9,742	9,950	3,027	1,354	6,191	13,708	6,378	14,612
	PinR-EXP	5	4,871	8,445	7,602	3,400	-994	17,884	3,014	21,582
LPL Number of Taxa	StuC-REF	5	16.00	14.80	2.39	1.07	11.84	17.76	11.00	17.00
	PinR-EXP	5	12.00	12.00	5.10	2.28	5.67	18.33	4.00	18.00
LPL Simpson's D	StuC-REF	5	0.85	0.85	0.04	0.02	0.79	0.90	0.80	0.90
	PinR-EXP	5	0.81	0.80	0.11	0.05	0.66	0.93	0.63	0.90
LPL Simpson's E	StuC-REF	5	0.47	0.48	0.15	0.07	0.29	0.67	0.31	0.65
	PinR-EXP	5	0.66	0.55	0.21	0.09	0.30	0.81	0.25	0.75
LPL BC Dissimilarity	StuC-REF	5	0.330	0.334	0.095	0.042	0.216	0.452	0.210	0.450
	PinR-EXP	5	0.850	0.774	0.138	0.062	0.602	0.946	0.560	0.890
% Oligochaeta	StuC-REF	5	14.290	15.718	10.460	4.678	2.730	28.706	3.640	30.150
	PinR-EXP	5	15.790	26.790	27.283	12.201	-7.086	60.666	2.780	64.470
% Chironomidae	StuC-REF	5	41.82	38.834	14.915	6.670	20.315	57.353	22.980	55.550
	PinR-EXP	5	23.81	31.848	26.277	11.751	-0.779	64.475	7.700	63.880
% Metal Sensitive Chironomidae	StuC-REF	5	0.00	1.160	1.930	0.863	-1.236	3.556	0.000	4.450
	PinR-EXP	5	0.00	1.756	2.543	1.137	-1.401	4.913	0.000	5.560
% Bivalvia	StuC-REF	5	0.000	0.364	0.814	0.364	-0.647	1.375	0.000	1.820
	PinR-EXP	5	2.150	9.172	16.508	7.383	-11.326	29.670	0.000	38.450
% Gastropoda	StuC-REF	5	1.82	2.682	3.663	1.638	-1.866	7.230	0.000	8.890
	PinR-EXP	5	3.22	10.880	18.193	8.136	-11.710	33.470	0.000	42.850
% Ostracoda	StuC-REF	5	0.000	0.920	1.261	0.564	-0.646	2.486	0.000	2.380
	PinR-EXP	5	1.070	2.962	4.680	2.093	-2.850	8.774	0.000	11.110
% Ephemeroptera	StuC-REF	5	0.00	0.270	0.604	0.270	-0.480	1.020	0.000	1.350
	PinR-EXP	5	0.00	0.952	2.129	0.952	-1.691	3.595	0.000	4.760
% Trichoptera	StuC-REF	5	0.000	0.364	0.814	0.364	-0.647	1.375	0.000	1.820
	PinR-EXP	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
% Chaoboridae	StuC-REF	5	21.420	25.788	12.378	5.535	10.419	41.157	11.110	39.180
	PinR-EXP	5	0.000	3.584	5.736	2.565	-3.539	10.707	0.000	13.160
Rainy LPL CA-1 (29.0%)	StuC-REF	5	-0.440	-0.411	0.131	0.058	-0.573	-0.249	-0.526	-0.200
	PinR-EXP	5	0.269	0.445	0.720	0.322	-0.449	1.340	-0.266	1.570
Rainy LPL CA-2 (17.0%)	StuC-REF	5	-0.217	-0.168	0.278	0.124	-0.513	0.177	-0.447	0.294
	PinR-EXP	5	0.486	0.402	0.829	0.371	-0.628	1.431	-0.552	1.606
Rainy LPL CA-3 (16.4%)	StuC-REF	5	-0.046	-0.099	0.414	0.185	-0.613	0.415	-0.594	0.317
	PinR-EXP	5	-0.164	-0.027	0.663	0.297	-0.851	0.797	-0.864	0.918
Rainy LPL CA-4 (12.0%)	StuC-REF	5	0.21	0.130	0.277	0.124	-0.214	0.475	-0.260	0.450
	PinR-EXP	5	-0.38	-0.290	0.561	0.251	-0.987	0.406	-0.925	0.553
FL Number of Taxa	StuC-REF	5	8.00	7.60	1.14	0.51	6.18	9.02	6.00	9.00
	PinR-EXP	5	7.00	7.20	2.05	0.92	4.66	9.74	4.00	9.00
FL Simpson's D	StuC-REF	5	0.680	0.706	0.052	0.023	0.642	0.770	0.660	0.780
	PinR-EXP	5	0.630	0.632	0.095	0.042	0.514	0.750	0.540	0.780
FL Simpson's E	StuC-REF	5	0.48	0.468	0.121	0.054	0.318	0.618	0.330	0.640
	PinR-EXP	5	0.40	0.428	0.165	0.074	0.223	0.633	0.240	0.670
FL BC Dissimilarity	StuC-REF	5	0.22	0.216	0.057	0.026	0.145	0.287	0.140	0.280
	PinR-EXP	5	0.68	0.602	0.145	0.065	0.422	0.782	0.400	0.740
Rainy FL CA-1 (26.5%)	StuC-REF	5	-0.29	-0.326	0.252	0.113	-0.638	-0.013	-0.583	-0.025
	PinR-EXP	5	0.50	0.370	0.355	0.159	-0.071	0.811	-0.183	0.671
Rainy FL CA-2 (25.6%)	StuC-REF	5	0.05	0.023	0.272	0.122	-0.315	0.360	-0.361	0.300
	PinR-EXP	5	0.11	0.112	0.683	0.306	-0.737	0.960	-0.867	0.957
Rainy FL CA-3 (17.9%)	StuC-REF	5	-0.208	-0.211	0.350	0.156	-0.645	0.223	-0.637	0.196
	PinR-EXP	5	0.127	0.178	0.350	0.156	-0.257	0.612	-0.196	0.734
Rainy FL CA-4 (14.4%)	StuC-REF	5	0.083	-0.029	0.422	0.189	-0.554	0.495	-0.478	0.364
	PinR-EXP	5	-0.024	0.067	0.300	0.134	-0.305	0.439	-0.193	0.505

Table D.5: Summary of Benthic Invertebrate Community Characteristics and Statistical Comparisons Among Areas RRP Phase 1 EEM, 2017

Metric	Comparison	2-group ANOVA; Magnitude of Difference; Estimation of Effect Size				
	ANOVA Comparison	Significant Difference Among Areas?	(P-value)[a]	Power	Magnitude of Difference (# of SDs)[b]	Minimum Detectable Effect Size (# of SDs)[c]
Density (Ind./m2)	StuC-REF vs. PinR-EXP	NO	0.692	0.124	~	4.1
FL Number of Taxa	StuC-REF vs. PinR-EXP	NO	0.713	0.121	~	3.2
FL Simpson's D	StuC-REF vs. PinR-EXP	NO	0.164	0.405	~	3.2
FL Simpson's E	StuC-REF vs. PinR-EXP	NO	0.674	0.127	~	2.6
FL BC Dissimilarity	StuC-REF vs. PinR-EXP	YES	0.001	1.000	6.7	~
Rainy FL CA-1 (26.5%)	StuC-REF vs. PinR-EXP	YES	0.007	0.946	2.8	~
Rainy FL CA-2 (25.6%)	StuC-REF vs. PinR-EXP	NO	0.793	0.110	~	4.2
Rainy FL CA-3 (17.9%)	StuC-REF vs. PinR-EXP	NO	0.117	0.485	~	2.2
Rainy FL CA-4 (14.4%)	StuC-REF vs. PinR-EXP	NO	0.688	0.125	~	1.9
% Oligochaeta	StuC-REF vs. PinR-EXP	NO	0.421	0.200	~	4.3
% Ostracoda	StuC-REF vs. PinR-EXP	NO	0.374	0.223	~	5.9
% Ephemeroptera	StuC-REF vs. PinR-EXP	NO	0.510	0.167	~	5.6
% Trichoptera	StuC-REF vs. PinR-EXP	NO	0.347	0.238	~	1.5
% Chaoboridae	StuC-REF vs. PinR-EXP	YES	0.007	0.952	-1.8	~
% Chironomidae	StuC-REF vs. PinR-EXP	NO	0.619	0.138	~	3.1
% Metal Sensitive Chironomidae	StuC-REF vs. PinR-EXP	NO	0.687	0.125	~	2.5
% Gastropoda	StuC-REF vs. PinR-EXP	NO	0.352	0.235	~	7.8
% Bivalvia	StuC-REF vs. PinR-EXP	NO	0.268	0.293	~	31.2
% Collector Gatherers	StuC-REF vs. PinR-EXP	NO	0.211	0.347	~	2.0
% Filterers	StuC-REF vs. PinR-EXP	NO	0.214	0.344	~	13.2
% Scrapers	StuC-REF vs. PinR-EXP	NO	0.373	0.224	~	7.8
% Shredders	StuC-REF vs. PinR-EXP	YES	0.029	0.779	-1.3	~
% Clingers	StuC-REF vs. PinR-EXP	NO	0.874	0.104	~	3.2
% Sprawlers	StuC-REF vs. PinR-EXP	YES	0.014	0.886	-1.9	~
% Burrowers	StuC-REF vs. PinR-EXP	NO	0.227	0.330	~	2.3

[a] p-value obtained from 1-way ANOVA

[b] Magnitude calculated by comparing the difference between the reference and exposure area means to the reference area standard deviation (SD) [(exposure mean - reference mean) / standard deviation of the reference mean]

[c] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10. Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

Shading denotes significant interaction (P < 0.05).

Table D.6: Eigenvalues of Correspondence Analysis (CA) of Family Level (FL) Benthic Community Samples from RRP Phasee 1 EEM, 2017

	Rainy FL CA-1 (26.5%)	Rainy FL CA-2 (25.6%)	Rainy FL CA-3 (17.9%)	Rainy FL CA-4 (14.4%)
Eigenvalue	0.198	0.192	0.134	0.108
Relative Inertia (%)	26.48	25.58	17.85	14.35
Cumulative Inertia (%)	26.48	52.06	69.91	84.26

Table D.7a: Scores for Family Level (FL) Benthic Taxa from Correlation Analysis (CA), RRP Phase 1 EEM, 2017

	Rainy FL CA-1 (26.5%)	Rainy FL CA-2 (25.6%)	Rainy FL CA-3 (17.9%)	Rainy FL CA-4 (14.4%)
P. Nemata	0.0417	0.1368	-0.0142	0.0095
F. Naididae	0.0750	0.2010	-0.0670	-0.0338
Subcl. Acari	0.0273	-0.3436	-0.4367	-0.0267
O. Harpacticoida	-1.0952	0.1748	0.0603	-0.8697
Cl. Ostracoda	-0.2295	0.2481	0.8127	0.0146
F. Caenidae (Caenis)	0.4432	-1.4421	-0.8245	0.2033
F. Ceratopogonidae	0.4323	-0.2379	0.4700	-0.2383
F. Chaoboridae	-0.3601	-0.0373	-0.4255	-0.1365
F. Chironomidae	-0.0417	0.1107	-0.0025	0.0406
F. Ancylidae (Ferrissia)	-0.5399	-0.2323	-0.0156	1.0107
F. Hydrobiidae (Amnicola)	1.3036	-0.9407	0.2830	-0.5767
F. Planorbidae	-0.2670	-0.8113	0.8210	0.3988
F. Sphaeriidae	0.9306	1.0985	-0.1747	0.2674

Shading indicates an absolute Pearson Correlation r-value greater than 0.5.

Table D.7b: Scores for Lowest Practical Level (LPL) Benthic Taxa from Correlation Analysis (CA), RRP Phase 1 EEM, 2017

	Rainy LPL CA-1 (29.0%)	Rainy LPL CA-2 (17.0%)	Rainy LPL CA-3 (16.4%)	Rainy LPL CA-4 (12.0%)
P. Nemata	0.0138	0.2144	-0.0971	-0.1085
Dero digitata	-0.0360	0.2312	0.7829	0.4216
Nais alpina/simplex	-0.5775	-0.6485	-1.1060	0.0222
Aulodrilus pigueti	0.1900	0.8102	0.6101	1.2418
Limnodrilus udekemianus	0.1357	0.3659	-0.5386	-0.1708
immatures with hair chaetae	-0.6103	-0.6132	-1.1252	0.1065
immatures without hair chaetae	-0.1966	0.2778	-0.0824	0.3726
Subcl. Acari	0.1301	-0.4223	-0.3209	0.2724
O. Harpacticoida	-0.7131	-0.0633	0.0276	0.5762
Cl. Ostracoda	-0.1267	0.3677	0.7695	-0.0546
Caenis	1.1846	-1.0440	-0.7680	-0.4258
Bezzia	1.2287	-0.7491	0.6700	-0.8655
Dasyhelea	1.7883	-0.0683	-0.0280	0.5669
Chaoborus flavicans	1.1846	-1.0440	-0.7680	-0.4258
Chaoborus punctipennis	-0.6202	-0.1165	-0.2534	0.1420
Chironomus	0.0771	0.3113	-0.2792	-0.4996
Cladopelma	-0.8212	-0.4875	-0.6777	0.6042
Dicrotendipes	0.4409	0.2326	1.3453	-0.2650
Einfeldia	-0.5073	0.0048	0.1506	-0.1489
Endochironomus	-0.3175	-0.1303	-0.0054	0.5750
Glyptotendipes	-0.5520	-0.3362	0.1933	0.0261
Tanytarsus	0.0483	-0.1357	0.6207	-0.1835
Ablabesmyia	1.7883	-0.0683	-0.0280	0.5669
Guttipelopia	-0.4341	-0.2574	0.3247	-0.5267
Labrudinia	1.7883	-0.0683	-0.0280	0.5669
Procladius	-0.3717	0.0009	0.0742	0.1031
Ferrissia	-0.4193	-0.5759	0.4352	-0.4853
Amnicola	1.8376	-0.1433	-0.0681	0.5111
Gyraulus	0.5386	-0.6370	0.6398	-0.5660
Sphaerium (Musculium)	0.3938	1.9808	-0.6128	-0.6902

Shading indicates an absolute Pearson Correlation r-value greater than 0.5.

Table D.8: Number of Invertebrates (Family Level) per m^2, RRP Phase 1 EEM, 2017

Station	StuC-REF					PinR-EXP				
Replicate	1	2	3	4	5	1	2	3	4	5
ROUNDWORMS										
P. Nemata	464	580	348	464	2,783	928	3,942	232	232	232
ANNELIDS										
P. Annelida										
WORMS										
Cl. Oligochaeta										
F. Naididae	928	1,855	232	1,391	4,406	232	13,913	232	1,391	696
LEECHES										
Cl. Hirudinea										
F. Glossiphoniidae	0	116	0	0	0	0	0	0	0	0
ARTHROPODS										
P. Arthropoda										
MITES										
Cl. Arachnida										
Subcl. Acari	0	0	0	0	0	0	0	0	0	0
O. Trombidiformes										
F. Arrenuridae	0	0	0	0	0	0	0	232	0	0
F. Limnesiidae	0	116	116	0	232	0	232	0	0	0
F. Oxidae	0	0	116	0	0	0	0	0	0	0
F. Pionidae	232	116	0	0	0	0	0	0	0	0
F. Unionicolidae	0	116	116	0	232	0	0	0	0	0
HARPACTICOIDS										
O. Harpacticoida	696	0	0	696	464	0	0	0	0	0
SEED SHRIMPS										
Cl. Ostracoda	232	0	0	232	0	928	232	0	0	116
INSECTS										
Cl. Insecta										
MAYFLIES										
O. Ephemeroptera										
F. Caenidae	0	116	0	0	0	0	0	232	0	0
O. Odonata										
DRAGONFLIES										
F. Corduliidae	0	0	0	0	0	0	14	0	0	0
CADDISFLIES										
O. Trichoptera										
F. Hydroptilidae	0	0	116	0	0	0	0	0	0	0
TRUE FLIES										
O. Diptera										
BITING-MIDGE										
F. Ceratopogonidae	0	0	0	0	232	232	232	464	0	116
PHANTOM MIDGE										
F. Chaoboridae	1,159	3,362	2,435	2,087	2,783	0	0	232	0	580
MIDGES										
F. Chironomidae	5,797	1,971	2,667	4,870	3,478	5,333	1,855	1,159	232	2,435
MOLLUSCS										
P. Mollusca										
SNAILS										
Cl. Gastropoda										
F. Ancylidae	232	232	116	0	0	464	0	0	0	0
F. Hydrobiidae	0	0	0	0	0	0	696	1,855	0	0
F. Planorbidae	696	0	0	0	0	232	0	232	0	0
CLAMS										
Cl. Bivalvia										
F. Sphaeriidae	0	0	116	0	0	0	464	0	1,159	232
TOTAL NUMBER OF ORGANISMS	10,436	8,580	6,378	9,740	14,610	8,349	21,580	4,870	3,014	4,407

Table D.9: Statistical Comparisons of Benthic Invertebrate Community Characteristics (at the family level) Among Areas, RRP Phase 1 EEM, 2017

Metric	Comparison	2-group ANOVA; Magnitude of Difference; Estimation of Effect Size				
	ANOVA Comparison	Significant Difference Among Areas?	(P-value)[a]	Power	Magnitude of Difference (# of SDs)[b]	Minimum Detectable Effect Size (# of SDs)[c]
FL Number of Taxa	StuC-REF vs. PinR-EXP	NO	0.713	0.121	~	3.2
FL Simpson's D	StuC-REF vs. PinR-EXP	NO	0.164	0.405	~	3.2
FL Simpson's E	StuC-REF vs. PinR-EXP	NO	0.674	0.127	~	2.6
FL BC Dissimilarity	StuC-REF vs. PinR-EXP	YES	0.001	1.000	6.7	~
Rainy FL CA-1 (23.1%)	StuC-REF vs. PinR-EXP	YES	0.008	0.943	2.9	~
Rainy FL CA-2 (21.3%)	StuC-REF vs. PinR-EXP	NO	0.392	0.214	~	2.9
Rainy FL CA-3 (19.5%)	StuC-REF vs. PinR-EXP	NO	0.778	0.112	~	1.8
Rainy FL CA-4 (12.3%)	StuC-REF vs. PinR-EXP	NO	0.400	0.210	~	2.1

[a] p-value obtained from 1-way ANOVA

[b] Magnitude calculated by comparing the difference between the reference and exposure area means to the reference area standard deviation (SD) [(exposure mean - reference mean) / standard deviation of the reference mean]

[c] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10. Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

BENTHIC INVERTEBRATE COMMUNITY DATA

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Table D.10: Number of Macroinvertebrates per m^2, RRP Phase 1 EEM, 2017

Station	StuC-Ref					PinR-Exp				
Replicate	1	2	3	4	5	1	2	3	4	5
ROUNDWORMS										
P. Nemata	32	40	24	32	192	64	272	16	16	16
ANNELIDS										
P. Annelida										
WORMS										
Cl. Oligochaeta										
F. Naididae										
S.F. Naidinae										
Dero digitata	-	-	8	16	-	16	48	-	-	-
Dero nivea	32	-	-	-	-	-	-	-	-	-
Nais alpina/simplex	-	16	-	-	16	-	-	-	-	-
S.F. Tubificinae										
Aulodrilus piqueti	-	-	-	48	-	-	48	-	-	-
Limnodrilus udekemianus	16	88	8	-	208	-	288	16	96	24
immatures with hair chaetae	-	8	-	-	32	-	-	-	-	-
immatures without hair chaetae	16	16	-	32	48	-	576	-	-	24
LEECHES										
Cl. Hirudinea										
F. Glossiphoniidae										
Glossiphonia complanata	-	8	-	-	-	-	-	-	-	-
ARTHROPODS										
P. Arthropoda										
MITES										
Cl. Arachnida										
Subcl. Acari	-	-	-	-	-	-	16	-	-	-
O. Trombidiformes										
F. Arrenuridae										
Arrenurus	-	-	-	-	-	-	-	16	-	-
F. Limnesiidae										
Limnesia	-	8	8	-	16	-	-	-	-	-
F. Oxidae										
Oxus	-	-	8	-	-	-	-	-	-	-
F. Pionidae										
indeterminate	16	8	-	-	-	-	-	-	-	-
F. Unionicolidae										
Neumania	-	8	8	-	-	-	-	-	-	-
Unionicola	-	-	-	-	16	-	-	-	-	-
HARPACTICOIDS										
O. Harpacticoida	48	-	-	48	32	-	-	-	-	-
SEED SHRIMPS										
Cl. Ostracoda	16	-	-	16	-	64	16	-	-	8
INSECTS										
Cl. Insecta										
MAYFLIES										
O. Ephemeroptera										
F. Caenidae										
Caenis	-	8	-	-	-	-	-	16	-	-
O. Odonata										
DRAGONFLIES										
F. Corduliidae										
Epitheca	-	-	-	-	-	-	1	-	-	-
CADDISFLIES										
O. Trichoptera										
F. Hydroptilidae										
Oxyethira	-	-	8	-	-	-	-	-	-	-
TRUE FLIES										
O. Diptera										
BITING-MIDGE										
F. Ceratopogonidae										
Bezzia	-	-	-	-	-	16	-	16	-	-
Dasyhelea	-	-	-	-	-	-	16	16	-	-
Sphaeromias	-	-	-	-	16	-	-	-	-	-
pupae	-	-	-	-	-	-	-	-	-	8
PHANTOM MIDGE										
F. Chaoboridae										
Chaoborus flavicans	-	8	-	-	-	-	-	16	-	-
Chaoborus punctipennis	80	224	168	144	192	-	-	-	-	40
MIDGES										
F. Chironomidae										
chironomid pupae	-	-	-	-	-	**16**	-	-	-	-
S.F. Chironominae										
Chironomus	-	16	-	48	64	64	-	48	16	72
Cladopelma	-	-	16	-	16	-	-	-	-	-
Dicrotendipes	-	-	-	-	-	96	16	-	-	-

Table D.10: Number of Macroinvertebrates per m², RRP Phase 1 EEM, 2017

Station	StuC-Ref					PinR-Exp				
Replicate	1	2	3	4	5	1	2	3	4	5
Einfeldia	128	16	-	176	48	32	-	-	-	40
Endochironomus	96	-	16	-	16	-	16	-	-	-
Glyptotendipes	48	24	40	48	16	32	-	-	-	-
Parachironomus	-	-	-	-	-	32	-	-	-	-
Paratanytarsus	-	-	-	-	-	-	16	-	-	-
Polypedilum sordens	-	-	16	-	-	-	-	-	-	-
Tanytarsus	32	8	-	-	-	32	32	-	-	-
S.F. Orthocladiinae										
Cricotopus (Isocladius)	-	-	-	-	16	-	-	-	-	-
S.F. Tanypodinae										
Ablabesmyia	-	-	-	-	-	-	16	16	-	-
Guttipelopia	80	16	16	-	-	48	-	-	-	8
Labrudinia	-	-	-	-	-	-	16	16	-	-
Procladius	16	56	80	64	64	16	16	-	-	24
Psectrotanypus	-	-	-	-	-	-	-	-	-	16
Tanypus	-	-	-	-	-	-	-	-	-	8
MOLLUSCS										
P. Mollusca										
SNAILS										
Cl. Gastropoda										
F. Ancylidae										
Ferrissia	16	16	8	-	-	32	-	-	-	-
F. Hydrobiidae										
Amnicola	-	-	-	-	-	-	48	128	-	-
F. Planorbidae										
Gyraulus	32	-	-	-	-	16	-	16	-	-
immature	**16**	-	-	-	-	-	-	-	-	-
CLAMS										
Cl. Bivalvia										
F. Sphaeriidae										
Cyclocalyx	-	-	8	-	-	-	-	-	-	-
Sphaerium (Musculium)	-	-	-	-	-	-	32	-	80	16
TOTAL NUMBER OF ORGANISMS	720	592	440	672	1008	576	1489	336	208	304
TOTAL NUMBER OF TAXA [a]	16	19	16	11	17	14	18	12	4	13

[a] Bold entries excluded from taxa count

APPENDIX E
FISH COMMUNITY DATA

Fish Permit

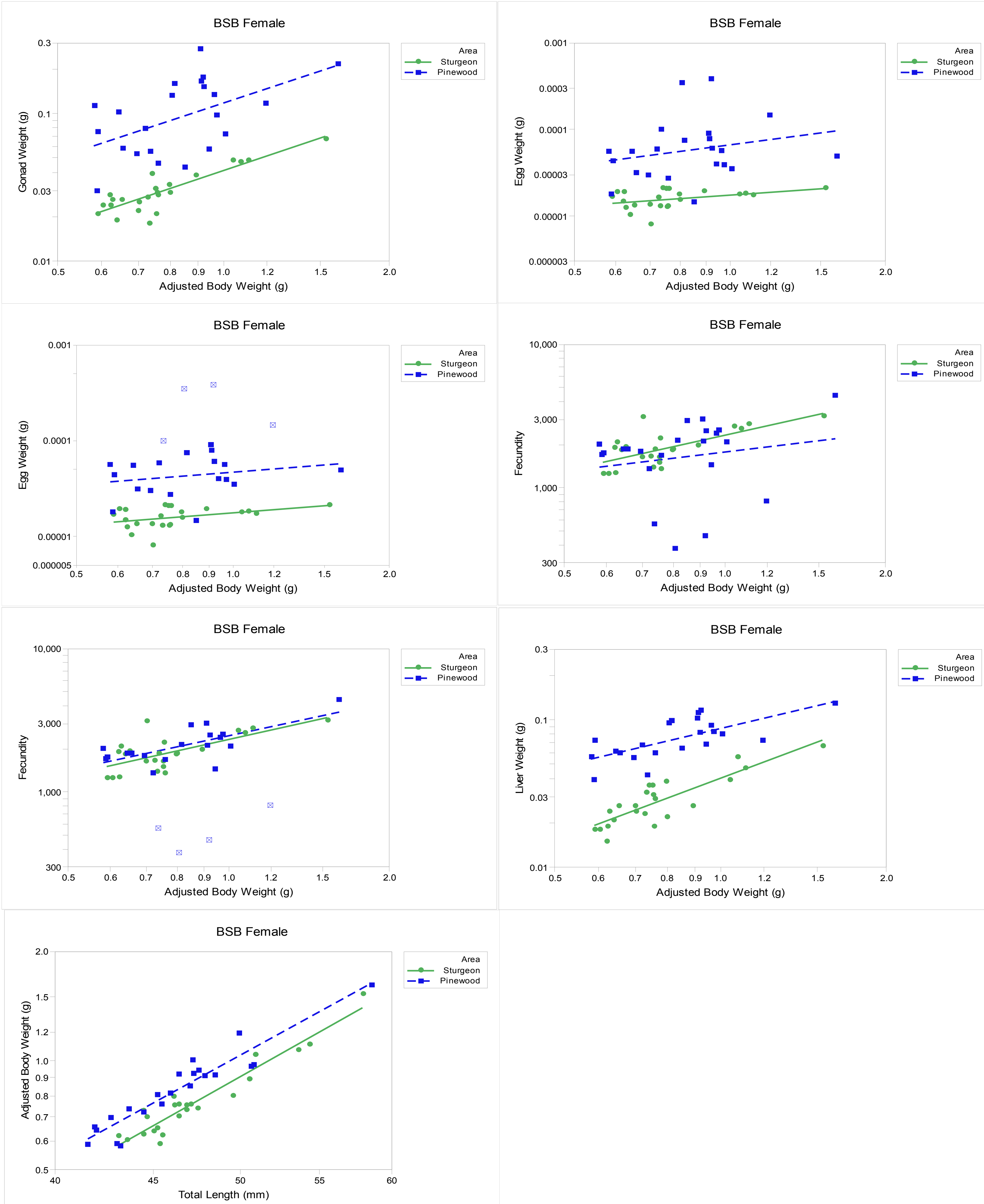

Figure E.1: Scatterplot and Linear Regressions For Female Brook Stickleback Health Endpoints For Pinewood River (Effluent-exposed) Compared to Sturgeon Creek (Reference), RRP Phase 1 EEM, 2017

Notes: outliers are plotted as open symbols with an × through them

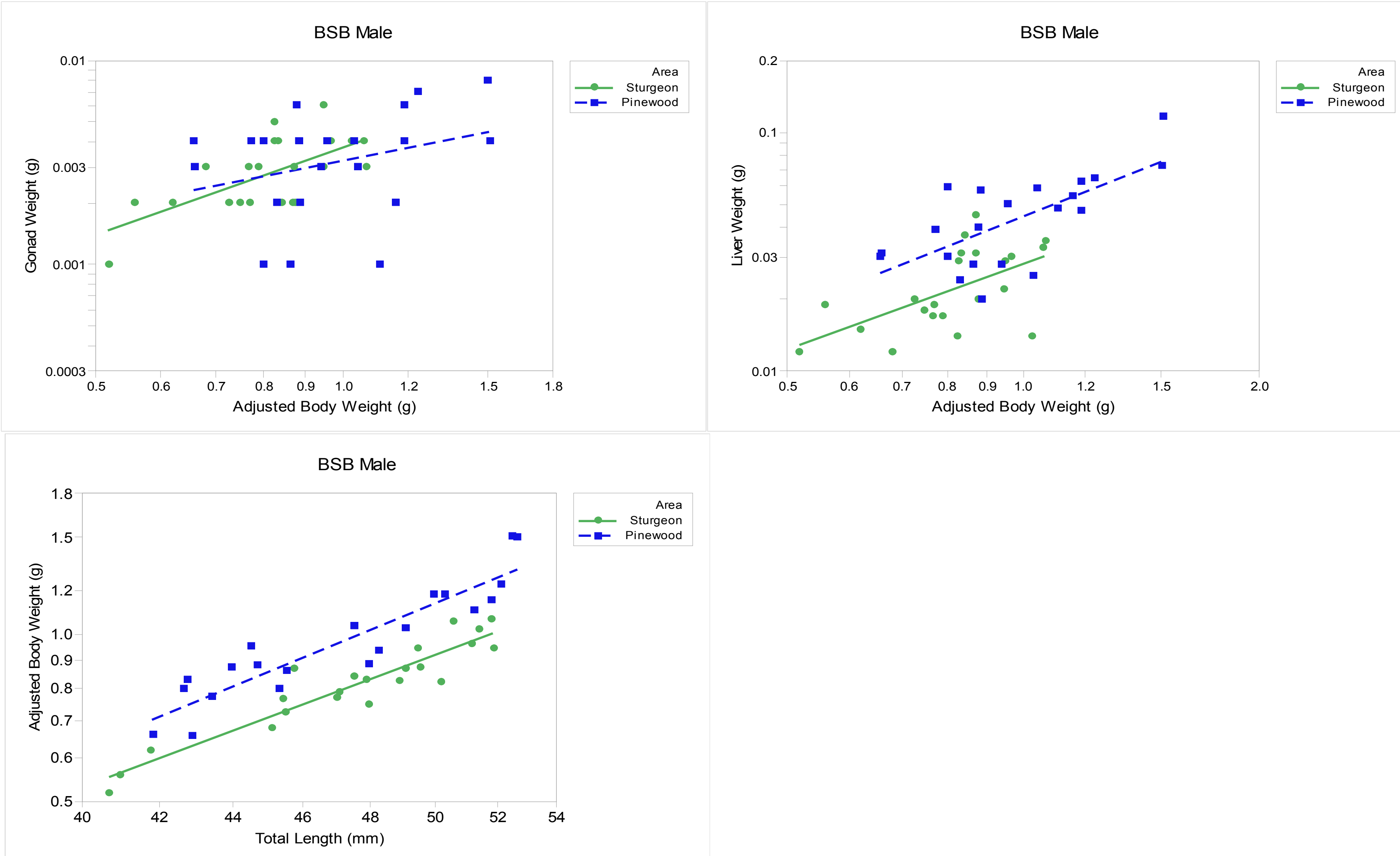

Figure E.2: Scatterplot and Linear Regressions For Male Brook Stickleback Health Endpoints For Pinewood River (Effluent-exposed) Compared to Sturgeon Creek (Reference), RRP Phase 1 EEM, 2017

Notes: outliers are plotted as open symbols with an × through them

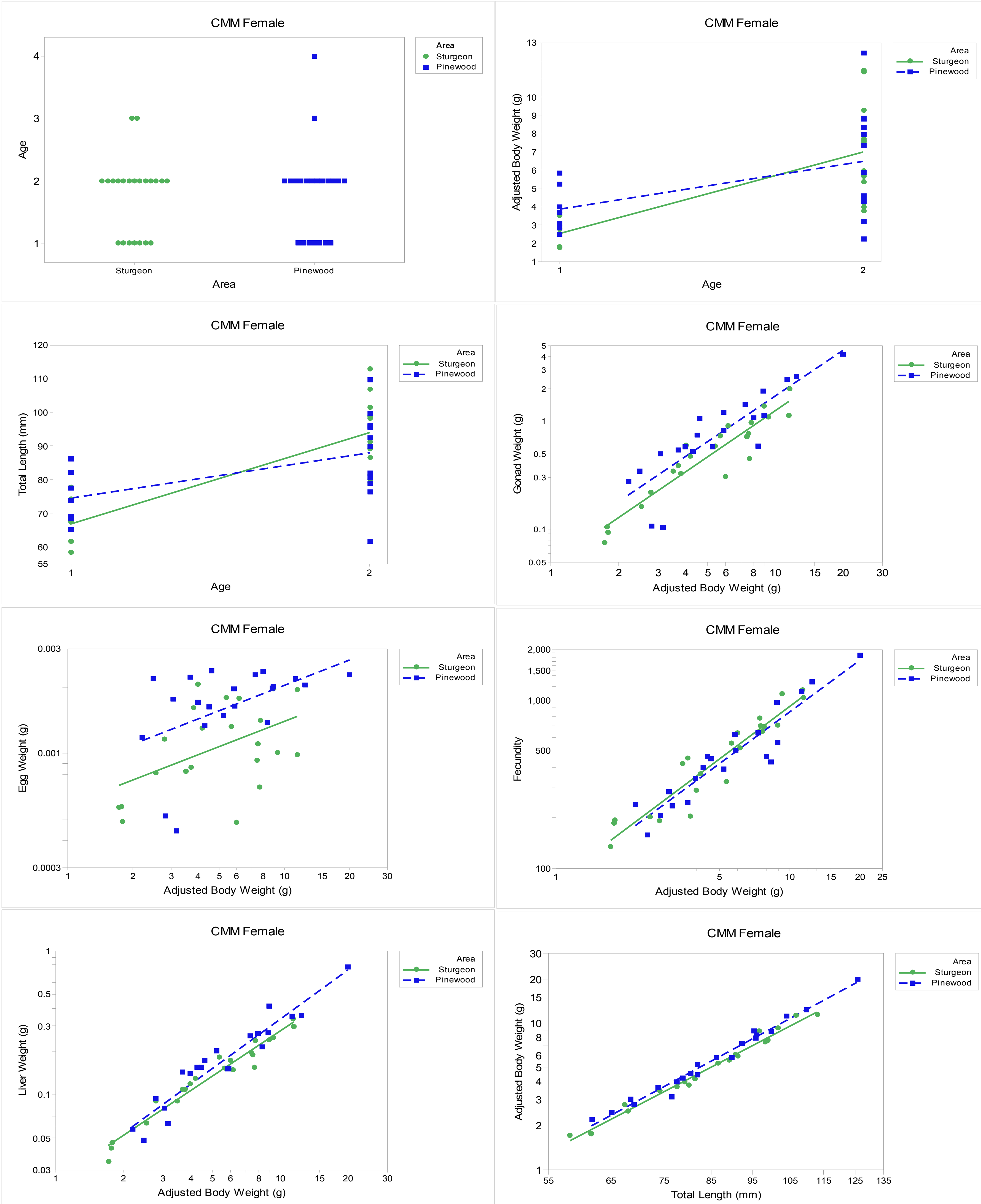

Figure E.3: Scatterplot and Linear Regressions For Female Central Mudminnow Health Endpoints For Pinewood River (Effluent-exposed) Compared to Sturgeon Creek (Reference), RRP Phase 1 EEM, 2017

Notes: outliers are plotted as open symbols with an × through them

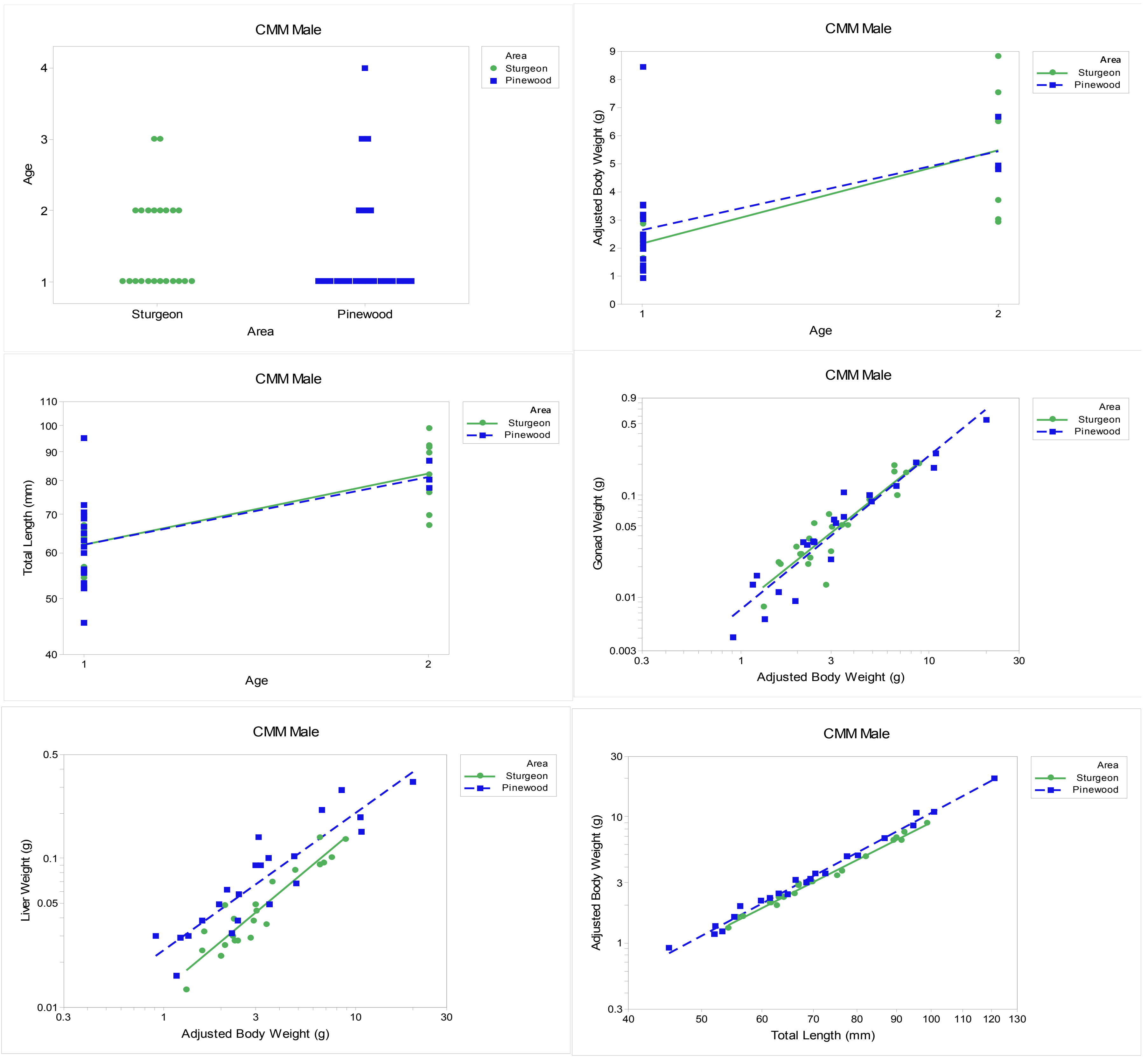

Figure E.4: Scatterplot and Linear Regressions For Male Central Mudminnow Health Endpoints For Pinewood River (Effluent-exposed) Compared to Sturgeon Creek (Reference), RRP Phase 1 EEM, 2017

Notes: outliers are plotted as open symbols with an × through them

Table E.1: Minnow Trapping Catch Records, RRP Phase 1 EEM, 2017

Effluent-exposed vs Reference	Area ID	Station ID	Location (dd mm ss.s)[a]		Set Date	Lift Date	Set Time	Lift Time	Trap Set Hours	Number of Traps	Effort (Total Trap Days)	Brook Stickleback					Central Mudminnow					Brown Bullhead				
			Latitude	Longitude								Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE
Mine-exposed	Pinewood River (PinR-EXP)	PinR-EXP-MT1	48 49 46.6	-94 03 51.8	21-Apr-17	22-Apr-17	18:30	10:00	15.50	14	9.04	184	50	0	134	20.4	10	10	0	0	1.11	0	0	0	0	0
		PinR-EXP-MT2	48 49 46.6	-94 03 51.8	22-Apr-17	23-Apr-17	10:20	8:30	22.17	14	12.9	296	0	0	296	22.9	2	2	0	0	0.15	0	0	0	0	0
		PinR-EXP-MT3	48 49 46.6	-94 03 51.8	23-Apr-17	24-Apr-17	9:40	9:10	23.50	14	13.7	498	0	0	498	36.3	12	12	0	0	0.88	1	0	0	1	0.07
		PinR-EXP-MT4	48 49 46.6	-94 03 51.8	24-Apr-17	25-Apr-17	9:10	9:00	23.83	14	13.9	222	0	0	222	16.0	10	10	0	0	0.72	0	0	0	0	0
		PinR-EXP-MT5	48 49 44.1	-94 03 51.8	24-Apr-17	25-Apr-17	9:30	9:20	23.83	15	14.9	134	0	0	134	9.0	14	14	0	0	0.94	0	0	0	0	0
		PinR-EXP-MT6	48 49 44.1	-94 03 51.8	25-Apr-17	25-Apr-17	9:30	12:30	3.00	15	1.88	27	0	0	27	14.4	0	0	0	0	0	0	0	0	0	0
		PinR-EXP-MT7	48 49 44.1	-94 03 51.8	25-Apr-17	26-Apr-17	9:50	12:45	26.92	12	13.5	20	0	0	20	1.49	0	0	0	0	0	0	0	0	0	0
										Total	**79.8**	**1,381**	**50**	**0**	**1,331**	**17.3**	**48**	**48**	**0**	**0**	**0.60**	**1**	**0**	**0**	**1**	**0.01**
Reference	Sturgeon Creek (StuC-REF)	StuC-REF-MT1	48 43 16.6	-93 57 08.3	21-Apr-17	22-Apr-17	19:20	8:50	13.50	15	8.44	129	50	0	79	15.3	56	56	0	0	6.64	0	0	0	0	0
		StuC-REF-MT2	48 43 16.6	-93 57 08.3	23-Apr-17	24-Apr-17	10:30	8:10	21.67	15	13.5	95	0	0	95	7.0	44	12	0	32	3.25	0	0	0	0	0
										Total	**22.0**	**224**	**50**	**0**	**174**	**10.2**	**100**	**68**	**0**	**32**	**4.55**	**0**	**0**	**0**	**0**	**0**

Note: CPUE = catch per unit effort (# fish per day per trap).
[a] d-degrees, m-minutes, s-seconds

Table E.1: Minnow Trapping Catch Records, RRP Phase 1 EEM, 2017

Effluent-exposed vs Reference	Area ID	Station ID	Location (dd mm ss.s)[a]		Brassy Minnow					Creek Chub					Finescale Dace					Johnny Darter					Lake Chub				
			Latitude	Longitude	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE
Mine-exposed	Pinewood River (PinR-EXP)	PinR-EXP-MT1	48 49 46.6	-94 03 51.8	1	0	0	1	0.11	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0.11	2	0	0	2	0.22
		PinR-EXP-MT2	48 49 46.6	-94 03 51.8	6	0	0	6	0.46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0.15
		PinR-EXP-MT3	48 49 46.6	-94 03 51.8	1	0	0	1	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PinR-EXP-MT4	48 49 46.6	-94 03 51.8	6	0	0	6	0.43	0	0	0	0	0	3	0	0	3	0.22	0	0	0	0	0	6	0	0	6	0.43
		PinR-EXP-MT5	48 49 44.1	-94 03 51.8	7	0	0	7	0.47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PinR-EXP-MT6	48 49 44.1	-94 03 51.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PinR-EXP-MT7	48 49 44.1	-94 03 51.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
					21	**0**	**0**	**21**	**0.26**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**3**	**0.04**	**1**	**0**	**0**	**1**	**0.01**	**10**	**0**	**0**	**10**	**0.13**
Reference	Sturgeon Creek (StuC-REF)	StuC-REF-MT1	48 43 16.6	-93 57 08.3	0	0	0	0	0	7	0	0	7	0.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		StuC-REF-MT2	48 43 16.6	-93 57 08.3	6	0	6	0	0.44	4	0	4	0	0.30	2	0	2	0	0.15	0	0	0	0	0	3	0	3	0	0.22
					6	**0**	**6**	**0**	**0.27**	**11**	**0**	**4**	**7**	**0.50**	**2**	**0**	**2**	**0**	**0.09**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**3**	**0**	**0.14**

Note: CPUE = catch per unit effort (# fish per day per trap).
[a] d-degrees, m-minutes, s-seconds

Table E.1: Minnow Trapping Catch Records, RRP Phase 1 EEM, 2017

Effluent-exposed vs Reference	Area ID	Station ID	Location (dd mm ss.s)[a]		Pearl Dace					Northern Redbelly Dace					White Sucker					Total (all species)	
			Latitude	Longitude	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	No. Captured	CPUE
Mine-exposed	Pinewood River (PinR-EXP)	PinR-EXP-MT1	48 49 46.6	-94 03 51.8	0	0	0	0	0	1	0	0	1	0.11	4	0	0	4	0.44	203	22.5
		PinR-EXP-MT2	48 49 46.6	-94 03 51.8	0	0	0	0	0	16	15	0	1	1.24	0	0	0	0	0	322	24.9
		PinR-EXP-MT3	48 49 46.6	-94 03 51.8	3	0	0	3	0.22	5	0	0	5	0.36	1	0	0	1	0.07	521	38.0
		PinR-EXP-MT4	48 49 46.6	-94 03 51.8	1	0	0	1	0.07	5	0	0	5	0.36	2	0	0	2	0.14	255	18.3
		PinR-EXP-MT5	48 49 44.1	-94 03 51.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	155	10.4
		PinR-EXP-MT6	48 49 44.1	-94 03 51.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	14.4
		PinR-EXP-MT7	48 49 44.1	-94 03 51.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	1.49
					4	**0**	**0**	**4**	**0.05**	**27**	**15**	**0**	**12**	**0.34**	**7**	**0**	**0**	**7**	**0.09**	**1,503**	**18.8**
Reference	Sturgeon Creek (StuC-REF)	StuC-REF-MT1	48 43 16.6	-93 57 08.3	0	0	0	0	0	43	0	0	43	5.10	0	0	0	0	0	235	27.9
		StuC-REF-MT2	48 43 16.6	-93 57 08.3	0	0	0	0	0	5	0	5	0	0.37	0	0	0	0	0	159	11.7
					0	**0**	**0**	**0**	**0**	**48**	**0**	**5**	**43**	**2.18**	**0**	**0**	**0**	**0**	**0**	**394**	**17.9**

Note: CPUE = catch per unit effort (# fish per day per trap).
[a] d-degrees, m-minutes, s-seconds

Table E.2: Seine Net Catch Records, RRP Phase 1 EEM, 2017

Effluent-exposed vs Reference	Area ID	Station ID	Location (dd mm ss.s)[a]		Date	Time	Length (m)	Distance (m)	# of Hauls	Area Seined (m^2)	Brook Stickleback					Central Mudminnow					Brassy Minnow (juvenile)				
			Latitude	Longitude							Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE
Effluent-exposed	Pinewood River (PinR-EXP)	SN-1a	48 49 46.6	-94 03 51.8	23-Apr-17	16:00	5	2	1	10	7	0	0	7	0.70	8	8	0	0	0.80	0	0	0	0	0
		SN-1b					6	4	1	24	5	0	0	5	0.21	3	3	0	0	0.13	0	0	0	0	0
		SN-1c					6	4	1	24	6	0	0	6	0.25	0	0	0	0	0	0	0	0	0	0
		SN-2a	48 49 44.6	-94 03 55.7	23-Apr-17	16:30	10	5	1	50	4	0	0	4	0.08	0	0	0	0	0	0	0	0	0	0
		SN-2b					7	7	1	49	4	0	0	4	0.08	0	0	0	0	0	0	0	0	0	0
		SN-3	48 49 44.1	-94 03 57.9	23-Apr-17	17:00	8	8	1	64	350	0	0	350	5.5	2	2	0	0	0.03	70	0	0	70	1.1
									Total	**221**	**376**	**0**	**0**	**376**	**1.7**	**13**	**13**	**0**	**0**	**0.06**	**70**	**0**	**0**	**70**	**0.32**

Note: Total CPUE = # of fish / m^2.

[a] d-degrees, m-minutes, s-seconds

Table E.2: Seine Net Catch Records, RRP Phase 1 EEM, 2017

Effluent-exposed vs Reference	Area ID	Station ID	Location (dd mm ss.s)[a]		Date	Time	Length (m)	Distance (m)	# of Hauls	Area Seined (m^2)	Dace spp. (juvenile)					Johnny Darter					White Sucker					Total (all species)	
			Latitude	Longitude							Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	No. Captured	CPUE
Effluent-exposed	Pinewood River (PinR-EXP)	SN-1a	48 49 46.6	-94 03 51.8	23-Apr-17	16:00	5	2	1	10	1	0	0	1	0.10	0	0	0	0	0	0	0	0	0	0	16	1.6
		SN-1b					6	4	1	24	3	0	0	3	0.13	0	0	0	0	0	0	0	0	0	0	11	0.5
		SN-1c					6	4	1	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0.3
		SN-2a	48 49 44.6	-94 03 55.7	23-Apr-17	16:30	10	5	1	50	0	0	0	0	0	1	0	0	1	0.02	0	0	0	0	0	5	0.1
		SN-2b					7	7	1	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.1
		SN-3	48 49 44.1	-94 03 57.9	23-Apr-17	17:00	8	8	1	64	100	0	0	100	1.6	0	0	0	0	0	2	0	0	2	0.03	524	8.2
									Total	**221**	**104**	**0**	**0**	**104**	**0.47**	**1**	**0**	**0**	**1**	**0**	**2**	**0**	**0**	**2**	**0.01**	**566**	**2.6**

Note: Total CPUE = # of fish / m^2.

[a] d-degrees, m-minutes, s-seconds

Table E.3: Backpack Electrofishing Catch Records, RRP Phase 1 EEM, 2017

Effluent-exposed vs Reference	Area ID	Station ID	Location (dd mm ss.s)[a] Starting Location		Date	Electrofisher Settings			Effort (seconds)	Fish Species [b] Central Mudminnow					Total (all species)	
			Latitude	Longitude		Output Voltage (volts)	Cycle Freq. (Hz)	Duty Cycle (%)		Total Catch	Number Retained	Additional Mortalities	Number Released Alive	CPUE	No. Captured	CPUE
Effluent-exposed	Pinewood River (PinR-EXP)	PinR-EXP-EF	48 49 47.1	-94 03 49.4	25-Apr-17	400	30	12	756	20	12	0	8	1.6	20	1.6
								Total	**756**	**20**	**12**	**0**	**8**	**1.6**	**20**	**1.6**

Note: CPUE = catch per unit effort (# fish per electrofishing minute).

[a] d-degrees, m-minutes, s-seconds

[b] Targeted fishing for central mudminnow. Brook stickleback, dace spp., and white sucker also observed but not captured.

Table E.4: Female Brook Stickleback Meristic Data from Sturgeon Creek, RRP Phase 1 EEM, 2017

Processing Date	Species	Fish ID Number	Total Length (mm)	Fork Length (mm)	Body Weight (g)	Age Structure Collected	Sex	Age	Gonad Weight (g)	Gonad Subsample Weight (g)	Liver Weight (g)	Fecundity	Egg Weight (g)	Abnormalities / Comments
22-Apr-17	BSB	StuC-BSB-01	46.38	-	0.751	whole body	F	1	0.025	-	0.024	3,114	0	-
22-Apr-17	BSB	StuC-BSB-02	53.57	-	1.174	whole body	F	1	0.047	-	0.056	2,584	0	-
22-Apr-17	BSB	StuC-BSB-05	54.29	-	1.202	whole body	F	1	0.048	-	0.047	2,768	0	-
22-Apr-17	BSB	StuC-BSB-06	57.90	-	1.663	whole body	F	1	0.067	-	0.066	3,146	0	-
22-Apr-17	BSB	StuC-BSB-07	50.87	-	1.127	whole body	F	1	0.048	-	0.039	2,667	0	-
22-Apr-17	BSB	StuC-BSB-08	46.38	-	0.804	whole body	F	1	0.029	-	0.019	2,204	0	-
22-Apr-17	BSB	StuC-BSB-15	43.15	-	0.664	whole body	F	1	0.028	-	0.015	1,894	0	-
22-Apr-17	BSB	StuC-BSB-16	44.64	-	0.747	whole body	F	1	0.022	-	0.026	1,636	0	-
22-Apr-17	BSB	StuC-BSB-17	45.51	-	0.665	whole body	F	1	0.024	-	0.019	1,266	0	-
22-Apr-17	BSB	StuC-BSB-18	45.20	-	0.704	whole body	F	1	0.026	-	0.026	1,936	0	-
22-Apr-17	BSB	StuC-BSB-20	45.37	-	0.629	whole body	F	1	0.021	-	0.018	1,253	0	-
22-Apr-17	BSB	StuC-BSB-22	44.46	-	0.776	whole body	F	1	0.027	-	0.023	1,662	0	-
22-Apr-17	BSB	StuC-BSB-23	46.83	-	0.782	whole body	F	1	0.018	-	0.032	1,388	0	worm
22-Apr-17	BSB	StuC-BSB-24	46.09	-	0.866	whole body	F	1	0.033	-	0.038	1,840	0	worm
22-Apr-17	BSB	StuC-BSB-25	49.52	-	0.850	whole body	F	1	0.029	-	0.022	1,865	0	worm
22-Apr-17	BSB	StuC-BSB-28	43.60	-	0.646	whole body	F	1	0.024	-	0.018	1,256	0	-
22-Apr-17	BSB	StuC-BSB-31	46.84	-	0.805	whole body	F	1	0.021	-	0.031	1,636	0	-
22-Apr-17	BSB	StuC-BSB-32	47.47	-	0.815	whole body	F	1	0.039	-	0.036	1,857	0	-
22-Apr-17	BSB	StuC-BSB-34	46.17	-	0.819	whole body	F	1	0.031	-	0.036	1,497	0	-
22-Apr-17	BSB	StuC-BSB-37	45.00	-	0.679	whole body	F	1	0.019	-	0.021	1,841	0	-
22-Apr-17	BSB	StuC-BSB-39	50.53	-	0.954	whole body	F	1	0.038	-	0.026	1,971	0	-
22-Apr-17	BSB	StuC-BSB-41	44.46	-	0.677	whole body	F	1	0.026	-	0.024	2,091	0	-
22-Apr-17	BSB	StuC-BSB-43	47.06	-	0.816	whole body	F	1	0.028	-	0.029	1,350	0	-
		n	**23**	**-**	**23**	**-**	**-**	**23**	**23**	**-**	**23**	**23**	**23**	**-**
		min	**43.15**	**-**	**0.629**	**-**	**-**	**1**	**0.018**	**-**	**0.015**	**1253**	**0.000008**	**-**
		max	**57.90**	**-**	**1.663**	**-**	**-**	**1**	**0.067**	**-**	**0.066**	**3,146**	**0.000021**	**-**
		mean	**47.45**	**-**	**0.853**	**-**	**-**	**1.000**	**0.031**	**-**	**0.030**	**1,944**	**0.000016**	**-**
		median	**46.38**	**-**	**0.804**	**-**	**-**	**1.000**	**0.028**	**-**	**0.026**	**1,857**	**0.000017**	**-**
		standard deviation	**3.716**	**-**	**0.239**	**-**	**-**	**0.000**	**0.012**	**-**	**0.013**	**568**	**0.000004**	**-**
		standard error	**0.775**	**-**	**0.050**	**-**	**-**	**0.000**	**0.002**	**-**	**0.003**	**118.40**	**0.000001**	**-**

Notes: BSB = Brook Stickleback; F = Female.

Table E.5: Female Brook Stickleback Meristic Data from the Pinewood River, RRP Phase 1 EEM, 2017

Processing Date	Species	Fish ID Number	Total Length (mm)	Fork Length (mm)	Body Weight (g)	Age Structure Collected	Sex	Age	Gonad Weight (g)	Gonad Subsample Weight (g)	Liver Weight (g)	Fecundity	Egg Weight (g)	Abnormalities / Comments
22-Apr-17	BSB	PinR-BSB-02	48.47	-	1.186	whole body	F	1	0.165	-	0.111	2,117	0.00008	-
22-Apr-17	BSB	PinR-BSB-03	47.19	-	1.157	whole body	F	1	0.072	-	0.080	2,070	0.00003	-
22-Apr-17	BSB	PinR-BSB-04	45.20	-	1.031	whole body	F	1	0.131	-	0.095	379	0.00035	-
22-Apr-17	BSB	PinR-BSB-05	46.37	-	1.173	whole body	F	1	0.175	-	0.082	461	0.00038	-
22-Apr-17	BSB	PinR-BSB-06	45.93	-	1.069	whole body	F	1	0.158	-	0.098	2,127	0.00007	-
22-Apr-17	BSB	PinR-BSB-07	47.20	-	1.185	whole body	F	1	0.150	-	0.115	2,494	0.00006	-
22-Apr-17	BSB	PinR-BSB-09	53.31	-	1.160	whole body	F	1	0.035	-	0.035	-	-	undeveloped female
22-Apr-17	BSB	PinR-BSB-10	47.88	-	1.280	whole body	F	1	0.271	-	0.102	3,022	0.00009	-
22-Apr-17	BSB	PinR-BSB-11	43.70	-	0.832	whole body	F	1	0.055	-	0.042	558	0.00010	-
22-Apr-17	BSB	PinR-BSB-12	47.03	-	0.955	whole body	F	1	0.043	-	0.064	2,944	0.00001	-
22-Apr-17	BSB	PinR-BSB-13	41.92	-	0.773	whole body	F	1	0.058	-	0.059	1,861	0.00003	-
22-Apr-17	BSB	PinR-BSB-15	58.52	-	1.954	whole body	F	2	0.216	-	0.129	4,383	0.00005	-
22-Apr-17	BSB	PinR-BSB-16	45.44	-	0.863	whole body	F	1	0.046	-	0.059	1,683	0.00003	-
22-Apr-17	BSB	PinR-BSB-17	49.89	-	1.380	whole body	F	2	0.117	-	0.072	805	0.00015	-
22-Apr-17	BSB	PinR-BSB-18	42.01	-	0.806	whole body	F	1	0.102	-	0.061	1,852	0.00006	-
22-Apr-17	BSB	PinR-BSB-21	44.45	-	0.866	whole body	F	1	0.079	-	0.067	1,353	0.00006	-
22-Apr-17	BSB	PinR-BSB-22	43.04	-	0.738	whole body	F	1	0.075	-	0.072	1,735	0.00004	-
22-Apr-17	BSB	PinR-BSB-23	42.76	-	0.802	whole body	F	1	0.053	-	0.055	1,785	0.00003	-
22-Apr-17	BSB	PinR-BSB-24	50.77	-	1.151	whole body	F	1	0.097	-	0.083	2,502	0.00004	-
22-Apr-17	BSB	PinR-BSB-26	43.22	-	0.749	whole body	F	1	0.112	-	0.056	2,004	0.00006	-
22-Apr-17	BSB	PinR-BSB-27	41.58	-	0.656	whole body	F	1	0.030	-	0.039	1,695	0.00002	-
22-Apr-17	BSB	PinR-BSB-28	47.51	-	1.064	whole body	F	1	0.057	-	0.068	1,449	0.00004	-
22-Apr-17	BSB	PinR-BSB-29	50.60	-	1.186	whole body	F	1	0.134	-	0.091	2,388	0.00006	-
		n	**23**	**-**	**23**	**-**	**-**	**23**	**23**	**-**	**23**	**22**	**22**	**-**
		min	**41.58**	**-**	**0.656**	**-**	**-**	**1**	**0.030**	**-**	**0.035**	**-**	**-**	**-**
		max	**58.52**	**-**	**1.954**	**-**	**-**	**2**	**0.271**	**-**	**0.129**	**-**	**-**	**-**
		mean	**46.70**	**-**	**1.044**	**-**	**-**	**1.087**	**0.106**	**-**	**0.075**	**-**	**-**	**-**
		median	**46.37**	**-**	**1.064**	**-**	**-**	**1.000**	**0.097**	**-**	**0.072**	**-**	**-**	**-**
		standard deviation	**4.055**	**-**	**0.282**	**-**	**-**	**0.288**	**0.062**	**-**	**0.025**	**-**	**-**	**-**
		standard error	**0.846**	**-**	**0.059**	**-**	**-**	**0.060**	**0.013**	**-**	**0.005**	**-**	**-**	**-**

Notes: BSB = Brook Stickleback; F = Female.

Table E.6: Male Brook Stickleback Meristic Data from Sturgeon Creek, RRP Phase 1 EEM, 2017

Processing Date	Species	Fish ID Number	Total Length (mm)	Fork Length (mm)	Body Weight (g)	Age Structure Collected	Sex	Age	Gonad Weight (g)	Liver Weight (g)	Abnormalities / Comments
22-Apr-17	BSB	StuC-BSB-03	51.78	-	1.102	whole body	M	1	0.003	0.035	worms in body cavity
22-Apr-17	BSB	StuC-BSB-04	48.87	-	0.858	whole body	M	1	0.005	0.029	-
22-Apr-17	BSB	StuC-BSB-09	49.04	-	0.902	whole body	M	1	0.003	0.031	-
22-Apr-17	BSB	StuC-BSB-10	46.96	-	0.788	whole body	M	1	0.002	0.019	-
22-Apr-17	BSB	StuC-BSB-11	49.51	-	0.895	whole body	M	1	0.002	0.020	-
22-Apr-17	BSB	StuC-BSB-12	51.16	-	0.996	whole body	M	1	0.004	0.030	-
22-Apr-17	BSB	StuC-BSB-13	47.84	-	0.865	whole body	M	1	0.004	0.031	-
22-Apr-17	BSB	StuC-BSB-14	45.40	-	0.785	whole body	M	1	0.003	0.017	-
22-Apr-17	BSB	StuC-BSB-19	40.67	-	0.530	whole body	M	1	0.001	0.012	-
22-Apr-17	BSB	StuC-BSB-21	41.75	-	0.635	whole body	M	1	0.002	0.015	worm in body cavity
22-Apr-17	BSB	StuC-BSB-26	50.17	-	0.840	whole body	M	1	0.004	0.014	-
22-Apr-17	BSB	StuC-BSB-27	47.05	-	0.808	whole body	M	1	0.003	0.017	worm
22-Apr-17	BSB	StuC-BSB-29	49.43	-	0.977	whole body	M	1	0.003	0.029	-
22-Apr-17	BSB	StuC-BSB-30	51.40	-	1.040	whole body	M	1	0.004	0.014	-
22-Apr-17	BSB	StuC-BSB-33	45.46	-	0.747	whole body	M	1	0.002	0.020	-
22-Apr-17	BSB	StuC-BSB-35	45.71	-	0.914	whole body	M	1	0.002	0.045	large worm
22-Apr-17	BSB	StuC-BSB-36	47.48	-	0.880	whole body	M	1	0.002	0.037	-
22-Apr-17	BSB	StuC-BSB-38	51.85	-	0.972	whole body	M	1	0.006	0.022	-
22-Apr-17	BSB	StuC-BSB-40	47.93	-	0.766	whole body	M	1	0.002	0.018	-
22-Apr-17	BSB	StuC-BSB-42	45.09	-	0.694	whole body	M	1	0.003	0.012	-
22-Apr-17	BSB	StuC-BSB-44	40.94	-	0.578	whole body	M	1	0.002	0.019	-
22-Apr-17	BSB	StuC-BSB-45	50.55	-	1.095	whole body	M	1	0.004	0.033	-
		n	**22**	**-**	**22**	**-**	**-**	**22**	**22**	**22**	**-**
		min	**40.67**	**-**	**0.530**	**-**	**-**	**1**	**0.001**	**0.012**	**-**
		max	**51.85**	**-**	**1.102**	**-**	**-**	**1**	**0.006**	**0.045**	**-**
		mean	**47.55**	**-**	**0.849**	**-**	**-**	**1.000**	**0.003**	**0.024**	**-**
		median	**47.89**	**-**	**0.862**	**-**	**-**	**1.000**	**0.003**	**0.020**	**-**
		standard deviation	**3.348**	**-**	**0.154**	**-**	**-**	**0.000**	**0.001**	**0.009**	**-**
		standard error	**0.714**	**-**	**0.033**	**-**	**-**	**0.000**	**0.000**	**0.002**	**-**

Notes: BSB = Brook Stickleback; M = Male.

Table E.7: Male Brook Stickleback Meristic Data from the Pinewood River, RRP Phase 1 EEM, 2017

Processing Date	Species	Fish ID Number	Total Length (mm)	Fork Length (mm)	Body Weight (g)	Age Structure Collected	Sex	Age	Gonad Weight (g)	Liver Weight (g)	Abnormalities / Comments
22-Apr-17	BSB	PinR-BSB-01	52.10	-	1.302	whole body	M	1	0.007	0.064	-
22-Apr-17	BSB	PinR-BSB-08	52.65	-	1.577	whole body	M	1	0.008	0.072	-
22-Apr-17	BSB	PinR-BSB-14	52.49	-	1.625	whole body	M	1	0.004	0.116	-
22-Apr-17	BSB	PinR-BSB-19	49.93	-	1.235	whole body	M	1	0.004	0.047	-
22-Apr-17	BSB	PinR-BSB-20	49.06	-	1.057	whole body	M	1	0.004	0.025	-
22-Apr-17	BSB	PinR-BSB-25	42.64	-	0.858	whole body	M	1	0.001	0.059	scale tared before weight
22-Apr-17	BSB	PinR-BSB-30	50.29	-	1.252	whole body	M	1	0.006	0.062	-
22-Apr-17	BSB	PinR-BSB-31	47.92	-	0.905	whole body	M	1	0.002	0.020	worm in body cavity
22-Apr-17	BSB	PinR-BSB-32	44.49	-	1.006	whole body	M	1	0.004	0.050	-
22-Apr-17	BSB	PinR-BSB-33	42.73	-	0.855	whole body	M	1	0.002	0.024	-
22-Apr-17	BSB	PinR-BSB-34	43.95	-	0.920	whole body	M	1	0.006	0.040	-
22-Apr-17	BSB	PinR-BSB-35	51.80	-	1.210	whole body	M	1	0.002	0.054	-
22-Apr-17	BSB	PinR-BSB-36	47.46	-	1.099	whole body	M	1	0.003	0.058	-
22-Apr-17	BSB	PinR-BSB-37	43.39	-	0.814	whole body	M	1	0.004	0.039	-
22-Apr-17	BSB	PinR-BSB-38	44.64	-	0.942	whole body	M	1	0.004	0.057	-
22-Apr-17	BSB	PinR-BSB-39	45.28	-	0.833	whole body	M	1	0.004	0.030	-
22-Apr-17	BSB	PinR-BSB-40	41.80	-	0.692	whole body	M	1	0.003	0.031	-
22-Apr-17	BSB	PinR-BSB-41	45.51	-	0.889	whole body	M	1	0.001	0.028	-
22-Apr-17	BSB	PinR-BSB-42	42.87	-	0.690	whole body	M	1	0.004	0.030	-
22-Apr-17	BSB	PinR-BSB-43	51.23	-	1.155	whole body	M	1	0.001	0.048	-
22-Apr-17	BSB	PinR-BSB-44	48.21	-	0.968	whole body	M	1	0.003	0.028	-
		n	**21**	**-**	**21**	**-**	**-**	**21**	**21**	**21**	**-**
		min	**41.80**	**-**	**0.690**	**-**	**-**	**1**	**0.001**	**0.020**	**-**
		max	**52.65**	**-**	**1.625**	**-**	**-**	**1**	**0.008**	**0.116**	**-**
		mean	**47.16**	**-**	**1.042**	**-**	**-**	**1.000**	**0.004**	**0.047**	**-**
		median	**47.46**	**-**	**0.968**	**-**	**-**	**1.000**	**0.004**	**0.047**	**-**
		standard deviation	**3.710**	**-**	**0.255**	**-**	**-**	**0.000**	**0.002**	**0.022**	**-**
		standard error	**0.810**	**-**	**0.056**	**-**	**-**	**0.000**	**0.000**	**0.005**	**-**

Notes: BSB = Brook Stickleback; M = Male.

Table E.8: Female Central Mudminnow Meristic Data from Sturgeon Creek, RRP Phase 1 EEM, 2017

Processing Date	Species	Fish ID Number	Total Length (mm)	Fork Length (mm)	Body Weight (g)	Age Structure Collected	Sex	Age	Gonad Weight (g)	Gonad Subsample Weight (g)	Liver Weight (g)	Fecundity	Egg Weight (g)	Abnormalities / Comments
22-Apr-17	CMM	StuC-CMM-02	60.10	-	2.064	whole body	F (I)	-	-	-	-	-	-	-
22-Apr-17	CMM	StuC-CMM-04	98.19	-	8.476	whole body	F	2	0.764	-	0.189	699	0.0011	-
22-Apr-17	CMM	StuC-CMM-05	65.75	-	2.564	whole body	F (I)	-	-	-	-	-	-	-
22-Apr-17	CMM	StuC-CMM-13	98.08	-	8.319	whole body	F	2	0.713	-	0.196	775	0.0009	-
22-Apr-17	CMM	StuC-CMM-15	67.95	-	2.750	whole body	F	1	0.162	-	0.063	201	0.0008	-
22-Apr-17	CMM	StuC-CMM-17	98.87	-	8.244	whole body	F	2	0.451	-	0.153	646	0.0007	-
22-Apr-17	CMM	StuC-CMM-19	89.13	-	6.525	whole body	F	2	0.726	-	0.152	552	0.0013	-
22-Apr-17	CMM	StuC-CMM-21	61.51	-	1.914	whole body	F	1	0.105	-	0.042	185	0.0006	-
22-Apr-17	CMM	StuC-CMM-22	61.43	-	1.922	whole body	F	1	0.093	-	0.046	192	0.0005	-
22-Apr-17	CMM	StuC-CMM-23	106.65	-	12.819	whole body	F	2	1.121	-	0.335	1,144	0.0010	-
22-Apr-17	CMM	StuC-CMM-24	112.82	-	13.750	whole body	F	2	1.996	-	0.294	1,027	0.0019	worms
22-Apr-17	CMM	StuC-CMM-27	67.28	-	3.089	whole body	F	1	0.219	-	0.089	190	0.0012	-
22-Apr-17	CMM	StuC-CMM-29	79.89	-	4.206	whole body	F	2	0.328	-	0.108	204	0.0016	-
22-Apr-17	CMM	StuC-CMM-31	98.86	-	8.938	whole body	F	2	0.971	-	0.236	694	0.0014	-
22-Apr-17	CMM	StuC-CMM-34	77.52	-	4.171	whole body	F	1	0.388	-	0.108	452	0.0009	-
22-Apr-17	CMM	StuC-CMM-35	91.11	-	6.441	whole body	F	2	0.306	-	0.173	637	0.0005	-
22-Apr-17	CMM	StuC-CMM-36	64.03	-	2.224	whole body	F (I)	-	-	-	-	-	-	-
22-Apr-17	CMM	StuC-CMM-39	58.17	-	1.826	whole body	F	1	0.075	-	0.034	133	0.0006	-
22-Apr-17	CMM	StuC-CMM-40	86.54	-	6.113	whole body	F	2	0.583	-	0.182	326	0.0018	-
24-Apr-17	CMM	StuC-CMM-42	90.44	-	7.200	whole body	F	3	0.912	-	0.148	517	0.0018	-
24-Apr-17	CMM	StuC-CMM-43	79.06	-	4.689	whole body	F	2	0.595	-	0.118	291	0.0020	-
24-Apr-17	CMM	StuC-CMM-44	101.45	-	10.604	whole body	F	2	1.089	-	0.247	1,086	0.0010	-
24-Apr-17	CMM	StuC-CMM-45	81.34	-	4.764	whole body	F	2	0.470	-	0.129	364	0.0013	-
24-Apr-17	CMM	StuC-CMM-46	74.01	-	3.916	whole body	F	1	0.342	-	0.090	417	0.0008	missing part of caudal fin
24-Apr-17	CMM	StuC-CMM-47	96.53	-	10.462	whole body	F	3	1.377	-	0.239	705	0.0020	-
		n	**25**	**-**	**25**	**-**	**-**	**22**	**22**	**-**	**22**	**22**	**22**	**-**
		min	**58.17**	**-**	**1.826**	**-**	**-**	**1**	**0.075**	**-**	**0.034**	**133**	**0.000480**	**-**
		max	**112.82**	**-**	**13.750**	**-**	**-**	**3**	**1.996**	**-**	**0.335**	**1,144**	**0.002045**	**-**
		mean	**82.67**	**-**	**5.920**	**-**	**-**	**1.773**	**0.627**	**-**	**0.153**	**520**	**0.001161**	**-**
		median	**81.34**	**-**	**4.764**	**-**	**-**	**2.000**	**0.527**	**-**	**0.150**	**485**	**0.001048**	**-**
		standard deviation	**16.381**	**-**	**3.536**	**-**	**-**	**0.612**	**0.476**	**-**	**0.082**	**306**	**0.000506**	**-**
		standard error	**3.276**	**-**	**0.707**	**-**	**-**	**0.130**	**0.102**	**-**	**0.017**	**65.26**	**0.000108**	**-**

Notes: CMM = Central Mudminnow; F = Female; I = Immature.

Table E.9: Female Central Mudminnow Meristic Data from the Pinewood River, RRP Phase 1 EEM, 2017

Processing Date	Species	Fish ID Number	Total Length (mm)	Fork Length (mm)	Body Weight (g)	Age Structure Collected	Sex	Age	Gonad Weight (g)	Gonad Subsample Weight (g)	Liver Weight (g)	Fecundity	Egg Weight (g)	Abnormalities / Comments
22-Apr-17	CMM	PinR-CMM-02	95.32	-	10.371	head	F	2	1.123	-	0.408	559	0.0020	-
22-Apr-17	CMM	PinR-CMM-03	81.90	-	5.339	whole body	F	2	0.743	-	0.154	460	0.0016	-
22-Apr-17	CMM	PinR-CMM-05	89.66	-	6.820	whole body	F	2	0.817	-	0.151	502	0.0016	-
22-Apr-17	CMM	PinR-CMM-07	68.37	-	3.626	whole body	F	1	0.497	-	0.080	284	0.0018	-
22-Apr-17	CMM	PinR-CMM-08	86.09	-	7.201	whole body	F	1	1.213	-	0.150	620	0.0020	-
22-Apr-17	CMM	PinR-CMM-10	65.01	-	2.857	whole body	F	1	0.341	-	0.048	157	0.0022	-
23-Apr-17	CMM	PinR-CMM-11	92.24	-	8.989	whole body	F	2	1.429	-	0.253	631	0.0023	-
23-Apr-17	CMM	PinR-CMM-12	68.43	-	3.414	whole body	F	-	-	-	-	-	-	-
24-Apr-17	CMM	PinR-CMM-14	81.92	-	5.985	whole body	F	1	0.574	-	0.201	388	0.0015	-
24-Apr-17	CMM	PinR-CMM-16	95.97	-	9.099	whole body	F	2	0.588	-	0.214	428	0.0014	-
24-Apr-17	CMM	PinR-CMM-17	69.05	-	2.995	whole body	F	1	0.106	-	0.093	206	0.0005	-
24-Apr-17	CMM	PinR-CMM-18	76.31	-	3.306	whole body	F	2	0.103	-	0.062	234	0.0004	-
24-Apr-17	CMM	PinR-CMM-20	95.59	-	9.280	whole body	F	2	1.071	-	0.263	458	0.0023	-
24-Apr-17	CMM	PinR-CMM-21	103.90	-	14.018	whole body	F	4	2.442	-	0.348	1,120	0.0022	worms
25-Apr-17	CMM	PinR-CMM-23	99.59	-	10.939	whole body	F	2	1.893	-	0.268	961	0.0020	-
25-Apr-17	CMM	PinR-CMM-28	80.33	-	5.805	whole body	F	2	1.055	-	0.172	446	0.0024	-
25-Apr-17	CMM	PinR-CMM-31	125.70	-	24.841	whole body	F	3	4.163	-	0.766	1,834	0.0023	-
25-Apr-17	CMM	PinR-CMM-33	69.44	-	2.992	whole body	F	-	-	-	-	-	-	-
25-Apr-17	CMM	PinR-CMM-34	61.63	-	2.531	whole body	F	2	0.278	-	0.057	238	0.0012	-
25-Apr-17	CMM	PinR-CMM-35	73.61	-	4.335	whole body	F	1	0.535	-	0.142	243	0.0022	-
25-Apr-17	CMM	PinR-CMM-43	77.37	-	4.675	whole body	F	1	0.580	-	0.139	341	0.0017	-
25-Apr-17	CMM	PinR-CMM-45	109.49	-	15.336	whole body	F	2	2.595	-	0.353	1,272	0.0020	-
25-Apr-17	CMM	PinR-CMM-46	78.77	-	4.923	whole body	F	2	0.520	-	0.153	394	0.0013	-
		n	**23**	**-**	**23**	**-**	**-**	**21**	**21**	**-**	**21**	**21**	**21**	**-**
		min	**61.63**	**-**	**2.531**	**-**	**-**	**1**	**0.103**	**-**	**0.048**	**157**	**0.000440**	**-**
		max	**125.70**	**-**	**24.841**	**-**	**-**	**4**	**4.163**	**-**	**0.766**	**1,834**	**0.002365**	**-**
		mean	**84.60**	**-**	**7.377**	**-**	**-**	**1.810**	**1.079**	**-**	**0.213**	**561**	**0.001750**	**-**
		median	**81.90**	**-**	**5.805**	**-**	**-**	**2.000**	**0.743**	**-**	**0.154**	**446**	**0.001956**	**-**
		standard deviation	**15.917**	**-**	**5.237**	**-**	**-**	**0.750**	**0.986**	**-**	**0.162**	**415**	**0.000552**	**-**
		standard error	**3.319**	**-**	**1.092**	**-**	**-**	**0.164**	**0.215**	**-**	**0.035**	**90.56**	**0.000120**	**-**

Notes: CMM = Central Mudminnow; F = Female.

Table E.10: Male Central Mudminnow Meristic Data from Sturgeon Creek, RRP Phase 1 EEM, 2017

Processing Date	Species	Fish ID Number	Total Length (mm)	Fork Length (mm)	Body Weight (g)	Age Structure Collected	Sex	Age	Gonad Weight (g)	Liver Weight (g)	Abnormalities / Comments
22-Apr-17	CMM	StuC-CMM-01	64.00	-	2.324	whole body	M	1	0.021	0.030	-
22-Apr-17	CMM	StuC-CMM-03	89.85	-	6.958	whole body	M	3	0.098	0.093	-
22-Apr-17	CMM	StuC-CMM-06	98.79	-	9.147	whole body	M	2	0.203	0.133	-
22-Apr-17	CMM	StuC-CMM-07	66.95	-	2.868	whole body	M	1	0.013	0.029	-
22-Apr-17	CMM	StuC-CMM-08	54.18	-	1.335	whole body	M	1	0.008	0.013	-
22-Apr-17	CMM	StuC-CMM-09	69.56	-	3.091	whole body	M	2	0.028	0.049	-
22-Apr-17	CMM	StuC-CMM-10	81.90	-	4.978	whole body	M	2	0.090	0.083	-
22-Apr-17	CMM	StuC-CMM-11	92.15	-	7.791	whole body	M	2	0.165	0.101	-
22-Apr-17	CMM	StuC-CMM-12	69.84	-	3.125	whole body	M	1	0.048	0.044	-
22-Apr-17	CMM	StuC-CMM-14	75.10	-	3.498	whole body	M	3	0.050	0.036	-
22-Apr-17	CMM	StuC-CMM-16	61.61	-	2.154	whole body	M	1	0.026	0.048	-
22-Apr-17	CMM	StuC-CMM-18	91.42	-	6.739	whole body	M	2	0.169	0.091	-
22-Apr-17	CMM	StuC-CMM-20	89.30	-	6.809	whole body	M	2	0.194	0.138	-
22-Apr-17	CMM	StuC-CMM-25	66.07	-	2.514	whole body	M	1	0.053	0.028	-
22-Apr-17	CMM	StuC-CMM-26	63.12	-	2.374	whole body	M	1	0.037	0.039	-
22-Apr-17	CMM	StuC-CMM-28	63.52	-	2.383	whole body	M	1	0.024	0.028	-
22-Apr-17	CMM	StuC-CMM-30	62.73	-	2.030	whole body	M	1	0.031	0.022	-
22-Apr-17	CMM	StuC-CMM-32	76.38	-	3.806	whole body	M	2	0.050	0.069	-
22-Apr-17	CMM	StuC-CMM-33	61.41	-	2.121	whole body	M	1	0.026	0.026	-
22-Apr-17	CMM	StuC-CMM-37	56.56	-	1.675	whole body	M	1	0.021	0.032	-
22-Apr-17	CMM	StuC-CMM-38	55.56	-	1.629	whole body	M	1	0.022	0.024	-
22-Apr-17	CMM	StuC-CMM-41	66.88	-	3.018	whole body	M	2	0.064	0.038	-
		n	**22**	**-**	**22**	**-**	**-**	**22**	**22**	**22**	**-**
		min	**54.18**	**-**	**1.335**	**-**	**-**	**1**	**0.008**	**0.013**	**-**
		max	**98.79**	**-**	**9.147**	**-**	**-**	**3**	**0.203**	**0.138**	**-**
		mean	**71.68**	**-**	**3.744**	**-**	**-**	**1.545**	**0.066**	**0.054**	**-**
		median	**66.92**	**-**	**2.943**	**-**	**-**	**1.000**	**0.043**	**0.039**	**-**
		standard deviation	**13.252**	**-**	**2.266**	**-**	**-**	**0.671**	**0.061**	**0.036**	**-**
		standard error	**2.825**	**-**	**0.483**	**-**	**-**	**0.143**	**0.013**	**0.008**	**-**

Notes: CMM = Central Mudminnow; M= Male.

Table E.11: Male Central Mudminnow Meristic Data from the Pinewood River, RRP Phase 1 EEM, 2017

Processing Date	Species	Fish ID Number	Total Length (mm)	Fork Length (mm)	Body Weight (g)	Age Structure Collected	Sex	Age	Gonad Weight (g)	Liver Weight (g)	Abnormalities / Comments
22-Apr-17	CMM	PinR-CMM-01	63.04	-	2.548	whole body	M	1	0.034	0.057	-
22-Apr-17	CMM	PinR-CMM-04	61.35	-	2.319	whole body	M	1	0.032	0.031	-
22-Apr-17	CMM	PinR-CMM-06	64.72	-	2.493	whole body	M	1	0.035	0.038	-
22-Apr-17	CMM	PinR-CMM-09	62.25	-	2.283	whole body	M	1	-	0.059	not developed - immature?
23-Apr-17	CMM	PinR-CMM-13	66.36	-	3.316	whole body	M	1	0.057	0.137	-
24-Apr-17	CMM	PinR-CMM-15	80.16	-	5.053	whole body	M	2	0.085	0.067	-
24-Apr-17	CMM	PinR-CMM-19	86.74	-	6.984	whole body	M	2	0.122	0.209	-
24-Apr-17	CMM	PinR-CMM-22	59.75	-	2.229	whole body	M	1	0.034	0.061	-
25-Apr-17	CMM	PinR-CMM-24	94.76	-	8.918	whole body	M	1	0.206	0.287	-
25-Apr-17	CMM	PinR-CMM-25	70.40	-	3.678	whole body	M	1	0.106	0.049	-
25-Apr-17	CMM	PinR-CMM-26	95.54	-	10.933	whole body	M	3	0.181	0.187	-
25-Apr-17	CMM	PinR-CMM-27	121.02	-	20.732	whole body	M	4	0.544	0.323	-
25-Apr-17	CMM	PinR-CMM-29	77.54	-	4.988	whole body	M	2	0.098	0.103	-
25-Apr-17	CMM	PinR-CMM-30	56.04	-	2.002	whole body	M	1	0.009	0.049	-
25-Apr-17	CMM	PinR-CMM-32	172.48	-	3.649	whole body	M	1	0.061	0.100	-
25-Apr-17	CMM	PinR-CMM-36	68.59	-	3.107	whole body	M	1	0.023	0.089	-
25-Apr-17	CMM	PinR-CMM-37	69.29	-	3.318	whole body	M	1	0.053	0.089	-
25-Apr-17	CMM	PinR-CMM-38	52.12	-	1.381	whole body	M	1	0.006	0.030	-
25-Apr-17	CMM	PinR-CMM-39	55.15	-	1.628	whole body	M	1	0.011	0.038	-
25-Apr-17	CMM	PinR-CMM-40	53.11	-	1.259	whole body	M	1	0.016	0.029	-
25-Apr-17	CMM	PinR-CMM-41	51.85	-	1.191	whole body	M	1	0.013	0.016	-
25-Apr-17	CMM	PinR-CMM-42	45.24	-	0.939	whole body	M	1	0.004	0.030	-
25-Apr-17	CMM	PinR-CMM-44	100.76	-	11.145	whole body	M	3	0.253	0.150	-
		n	**25**	**-**	**25**	**-**	**-**	**23**	**22**	**23**	**-**
		min	**45.24**	**-**	**0.939**	**-**	**-**	**1**	**0.004**	**0.016**	**-**
		max	**172.48**	**-**	**20.732**	**-**	**-**	**4**	**0.544**	**0.323**	**-**
		mean	**74.65**	**-**	**4.500**	**-**	**-**	**1.435**	**0.090**	**0.097**	**-**
		median	**68.43**	**-**	**3.107**	**-**	**-**	**1.000**	**0.044**	**0.061**	**-**
		standard deviation	**27.015**	**-**	**4.406**	**-**	**-**	**0.843**	**0.122**	**0.084**	**-**
		standard error	**5.403**	**-**	**0.881**	**-**	**-**	**0.176**	**0.026**	**0.017**	**-**

Notes: CMM = Central Mudminnow; M= Male.

Table E.12: Sample Size Calculations for Endpoints with a Minimum Detectable Difference < 25% (or 10% for Condition) for Brook Stickleback Health Endpoints For Pinewood River (Effluent-exposed) Compared to Sturgeon Creek (Reference) Areas, RRP Phase 1 EEM, 2017

Species	Sex	Indicator	Endpoint	Variables		Sample Size		Test	S[a]	COV (%)[b]	Minimum Sample Size to Detect an Effect Size (% Increase/Decrease Relative to Reference) with α=β=0.1									
				Response	Covariate	Reference	Effluent-exposed				ANCOVA	d=5%	d=10%	d=20%	d=25%	d=30%	d=33%	d=40%	d=50%	d=100%
												d=-5%	d=-9%	d=-17%	d=-20%	d=-23%	d=-25%	d=-29%	d=-33%	d=-50%
											T-test/M-W	d=±5%	d=±10%	d=±20%	d=±25%	d=±30%	d=±33%	d=±40%	d=±50%	d=±100%
Central Mudminnow	Female	Survival	Age	Age	-	22	21	M-W	-	38.50	M-W	1,178	296	76	49	34	29	20	13	5
		Energy Usage	Weight-at-age (Age 1 and 2 fish)	log[Adjusted Body Weight (g)]	Age	20	19	ANCOVA	0.18174	-	ANCOVA	1,261	331	91	61	45	37	28	19	8
			Relative Gonad Weight	log[Gonad Weight (g)]	log[Adjusted Body Weight (g)]	22	21	ANCOVA	0.17503	-	ANCOVA	1,170	307	85	57	42	35	26	18	7
	Male	Survival	Age	Age	-	22	22	M-W	-	30.76	M-W	752	189	49	32	22	19	13	10	4
		Energy Usage	Weight-at-age (Age 1 and 2 fish)	log[Adjusted Body Weight (g)]	Age	20	19	ANCOVA	0.18438	-	ANCOVA	1,298	341	94	63	46	38	28	20	8
			log[Gonad Weight (g)]	log[Adjusted Body Weight (g)]	Age	20	19	ANCOVA	0.16833	-	ANCOVA	1,082	284	79	53	39	32	24	17	7
		Energy Storage	Relative Liver Weight	log[Liver Weight (g)]	log[Adjusted Body Weight (g)]	22	22	ANCOVA	0.131779	-	ANCOVA	664	175	49	33	24	20	15	11	5
Brook Stickleback	Female	Energy Usage	Relative Gonad Weight	log[Gonad Weight (g)]	log[Adjusted Body Weight (g)]	23	22	ANCOVA	0.15985	-	ANCOVA	976	257	71	48	35	29	22	15	6
		Energy Storage	Relative Liver Weight	log[Liver Weight (g)]	log[Adjusted Body Weight (g)]	23	22	ANCOVA	0.09759	-	ANCOVA	364	96	27	19	14	12	9	7	3
	Male	Energy Usage	Relative Gonad Weight	log[Gonad Weight (g)]	log[Adjusted Body Weight (g)]	22	21	ANCOVA	0.20397	-	ANCOVA	1,588	417	115	77	56	47	35	24	9
		Energy Storage	Relative Liver Weight	log[Liver Weight (g)]	log[Adjusted Body Weight (g)]	23	22	ANCOVA	0.14004	-	ANCOVA	749	197	55	37	27	23	17	12	5

Samples size required to detect a 25% increase relative to reference

[a] Pooled standard deviation of the regression residuals

[b] Coefficient of variation (pooled standard deviation/reference mean)×100%

FISH COMMUNITY DATA

Fish Permits

Ontario | Ministry of Natural Resources | Ministère des Richesses naturelles

Licence to Collect Fish for Scientific Purposes
Permis pour faire la collecte de poissons à des fins scientifiques

Licence No. / Nº de permis	1086615
Local Reference No. / Nº de référence local	2017-2245
Issuer Account No. / Nº de compte du délivreur de permis.	10003046

This licence is issued under Part I of the Fish Licensing Regulation made under the Fish and Wildlife Conservation Act, 1997 to:

Ce permis est délivré en vertu de la Partie I du règlement sur la délivrance de permis de pêche formulé conformément à la Loi sur la protection du poisson et de la faune de 1997 à:

Name of Licencee / Nom du titulaire du permis

Last Name / Nom de famille	First Name / Prénom	Middle Name / Second Prénom
Mrs. Tester	Jess	

Name of Business/Organization/Affiliation (If applicable) / Nom de l'entreprise/de l'organisme/de l'affiliation (le cas échéant)

Minnow Enviromental Inc.

Mailing address of Licencee / Adresse postale du titulaire du permis

Street Name & No./PO Box/RR#/Gen. Del./ Nº rue/C.P./R.R./poste restante

2 Lamb Street

City/Town/Municipality / Ville/village/municipalité	Province/State Province/État	Postal Code/Zip Code Code Postal/Zip
Georgetown	ON	L7G 3M9

to collect the species, size and quantites of fish from the waters as set out below.
Pour faire la collecte des espèces suivantes (stade et nombre indiqués ci-dessous):

Species Espèces	Eggs Oeuf X	Juvenile Fretin X	Adults Adulte X	Numbers Nombre	Name of Waterbody Nom de l'étendue d'eau
SMALL BODIED SPECIES			X	50	Pineewood River
SMALL BODIED SPECIES			X	50	Sturgeon Creek or Kishkakoesis River

Yes/Oui ☐ Additional species/Waterbody list attached / Liste d'espèces/d'étendue d'eau additionnelles ci-jointe

Purpose of collection / But de la collecte Fish population survey

Licence Dates / Dates du permis

Effective Date / Date d'entrée en vigueur (YYYY-MM-DD)	Expiry Date / Date d'expiration (YYYY-MM-DD)
2017-04-18	2017-05-31

Licence conditions / Conditions du permis This licence is subject to the conditions contained in Schedule A if included. / Ce permis doit respecter les conditions de l'annexe A si celle-ci est jointe.

Yes/Oui ☒ No/Non ☐ Schedule A included. / Annexe A ci-jointe

Issued by (please print) Délivré par (veuillez écrire en caractères d'imprimerie)	Signature of issuer / Signature du délivreur	Date of Issue/Date de délivrance (YYYY-MM-DD)
Matt Myers		2017-05-04

Signature of Licencee / Signature du titulaire du permis	Date (YYYY-MM-DD)
Jess Tester	2017-05-05

Personal information contained on this form is collected under the authority of the Fish and Wildlife Conservation Act, 1997 and will be used for the purpose of licencing, identification, enforcement, resource management and customer service surveys. Please direct further inquiries to the District Manager of the MNR issuing district.

Les renseignements personnels dans ce formulaire sont recueillis conformément à la Loi sur la protection du poisson de la faune, 1997 , et ils seront utilisés aux fins de délivrance de permis, d'identification, d'application des règlements, de gestion des ressources et de sondage sur les services a la clientèle. Veuillez communiquer avec le chef du district du MRN qui délivré le permis si vous avez des questions.

Ontario

Licence to Collect Fish for Scientific Purposes
Schedule A – Licence Conditions

Licence No. 1086615
Local Reference No. 2017-2245
Issuer Account No. 10003046

This licence is subject to the conditions listed below.

1. Mandatory report forms documenting the sampling conducted under this licence must be submitted to the licence issuer within 30 days of the termination date, but in no case later than January 31 next following the year of issue. The digital Mandatory Report form (Part 1) must be completed for each Sampling Program and the digital Site Collection Reports (Part 2) must be completed for each collection site. A separate map clearly indicating the location of each collection site must be attached to the Site Collection Reports. Submit Mandatory Report forms to the Fort Frances District MNRF office. The submission of a satisfactory report is a prerequisite to any subsequent renewals.

2. Sampling locations must be reported using GPS location data using: Projection: Universal Transverse Mercator (UTM); Datum: North American 1983 (NAD83), Canadian Transformation (CNT); Zone: 15 N; Units: metres.

3. Before carrying out any operation under this licence, any person authorized under this licence is required to consult with the Fort Frances Ministry of Natural Resources District Manager at least one week prior to anticipated start of sampling and obtain approval from the respective Manager for the proposed sampling activity. Also, any person authorized under this licence must advise the respective Manager of the date, time and location of all sampling.

4. A copy of the signed original licence must be carried by the licenced person when working at the designated sites. An assistant of the licenced person who is carrying out activities under this licence during the absence of the licenced person shall carry the licence on his or her person.

5. All collection gear shall be clearly marked with the licenced person's and the organization's name.

6. This licence is not valid in Provincial Parks, park reserves, Conservation Authority property or National Parks without written permission from the authorized person in charge of the area concerned. http://www.ontarioparks.com/email/research

7. Capture gear shall be inspected regularly and live holding traps must be inspected at least once daily.

8. This licence does not allow access to any property without permission of the landowner.

9. The licensee shall follow the best management practices for the collection, handling, transportation and holding of fish identified in **FPS Technical Bulletin (Dec. 15, 2011)** included with the licence in order to minimize the risk of spreading aquatic invasive species and diseases.

10. All field equipment must be de-contaminated prior to use on each water body in order to prevent the spread of exotic species and disease.

11. This licence does not authorize any activity that is prohibited under the federal ***Species at Risk Act*** or the provincial ***Endangered Species Act.***

12. All SAR fish and mussels must also be reported to the OMNR Natural Heritage Information Centre on the appropriate form at: http://nhic.mnr.gov.on.ca/MNR/nhic/species/species_report.cfm

13. This licence does not authorize the possession of specially protected fish under the ***Ontario Fishery Regulations.***

14. This licence does not authorize the collection of any species of fish protected under the ***Species at Risk Act, Endangered Species Act, or Ontario Fishery Regulations.*** If these species are accidentally captured they must be returned to the water immediately.

15. **This licence ONLY allows for the following capture gear to be used:**

    Minnow traps, seine nets, mini hoop nets, backpack electrofishing

16. **Persons authorized under this licence include the following:**

    Jess Tester, Kevin Martens, Katharina Batchelar, Tyler Nash, Tyrell Worrall, Mike White

17. ***The following MNRF Class Animal Care Protocols will be adhered to as appropriate for the project activity:***
    - ***Capture Methods- Electrofishing***
    - ***Capture Methods- Seining***
    - ***Capture Methods- Impounding Gear***
    - ***Handling and Marking- Biological Sampling***
    - ***Containment- Short term Containment***

Signature of Licensee

x Jess Tester

Date

5 - MAY - 2017

OFFSET PLAN FOR FISHERIES ACT SECTION 35(2)(b) AUTHORIZATION
2017 ANNUAL MONITORING REPORT

VERSION 0

Date	Rev. #	Revision(s)	Originator
December 11, 2017	Version A	Issued to NG	MR, Amec Foster Wheeler
December 19, 2017	Version 0	Issued to NG	MR, Amec Foster Wheeler

December 2017
TC111504

newgold Rainy River Project

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EXECUTIVE SUMMARY

The construction and development of New Gold Inc's (New Gold) Rainy River Mine (RRM) resulted in the unavoidable, but planned, serious harm to a commercial, recreational, or aboriginal fishery, or to fish that support such a fishery. This serious harm to fish required an Authorization from Fisheries and Oceans Canada (DFO) as per Section 35(2)(b) of the *Fisheries Act*. In order for DFO to authorize the serious harm to fish, development and implementation of a fishery offset measures was necessary to ensure that overall fish production is maintained or enhanced (no reduction of fisheries productivity). In the case of the RRM, the impacted fishery, and therefore target fishery of the offset measures are baitfish (primarily minnow) species that inhabit the small creek systems associated with the site. A detailed No Net Loss Plan for the Section 35 fishery impacts (AMEC 2014) was prepared for the Mine and circulated to stakeholders during the Environmental Assessment process. The Offset Plan (New Gold 2015) for monitoring the performance and measuring success of the offsetting measures was accepted by DFO, and *Fisheries Act* Authorization No. 15-HCAA-00039 was issued June 4, 2015. The purpose of this document is to summarize the 2017 monitoring results for the offsetting measures and provide comparison to the success criteria and conditions of the Authorization.

Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler) was retained by New Gold to conduct the year-one performance monitoring to evaluate the success of the offsetting measures implemented under the Offset Plan and the Authorization. Implementation and effectiveness of the measures are determined by confirming that Teeple Pond and outlet channel have been constructed as per the approved plans and are functioning as intended using the success criteria in the Offset Plan.

The 2017 performance monitoring results showed the physical construction of offset measures achieved the required success criteria (due December 31, 2016) as follows:

- As-built survey demonstrates the offset measures are constructed as per the approved plans; and
- The area of replacement habitat is greater than the required 8.41 ha;

Achieving the success criteria related to the physical function/structure stability and fisheries components of the Offset Plan are anticipated in 2019 and by 2021. The 2017 performance monitoring results for these components are ahead of schedule and are on track for this monitoring period as described below:

- The outlet channel allows for fish passage under normal and high flow conditions and the Teeple Pond water levels are consistent with those specified in the design;

- Constructed habitat remains stable and in place. Shorelines and graded offset features are stable, and riparian vegetation cover and plantings have achieved moderate to good coverage, but are not yet at the target 80% success criteria;

- Seven fish species are present in the offset measures (success criteria target nine species);

- Multiple year classes of several species, and many young-of-the year fish were encountered in the offset measures demonstrating full fish life cycle usage; and,

- Overall catch-per-unit-effort for all species combined was highest for seine netting; and meeting all gear-specific success criteria targets is anticipated before 2021.

Biological systems such as Teeple Pond outlet channel are dynamic and will likely require several years to develop biological communities that meet the success criteria; however, the year-one monitoring results show very good progress toward these targets.

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1.0 INTRODUCTION

The construction and development of New Gold Inc's (New Gold) Rainy River Mine (RRM) resulted in the unavoidable, but planned, serious harm to a commercial, recreational, or aboriginal fishery, or to fish that support such a fishery. This serious harm to fish required an Authorization from Fisheries and Oceans Canada (DFO) as per Section 35(2)(b) of the *Fisheries Act*. In order for DFO to authorize the serious harm to fish, development and implementation of a fishery offset measures was necessary to ensure that overall fish production is maintained or enhanced (no reduction of fisheries productivity). In the case of the RRM, the impacted fishery, and therefore target fishery of the offset measures are baitfish (primarily minnow) species that inhabit the small creek systems associated with the site. A detailed No Net Loss Plan for the Section 35 fishery impacts (AMEC 2014) was prepared for the Mine and circulated to stakeholders during the Environmental Assessment process. The Offset Plan (New Gold 2015) for monitoring the performance and measuring success of the offsetting measures was accepted by DFO and *Fisheries Act* Authorization No. 15-HCAA-00039 was issued June 4, 2015.

Teeple Pond and outlet channel are the offset measures constructed per the Offset Plan. Construction of Teeple Pond was completed in early 2016 and construction of the Teeple Pond outlet channel was completed between the fall of 2015 and early winter 2016. The Teeple Pond and outlet channel as-constructed report was submitted December 2016 (Amec Foster Wheeler 2016a). The purpose of this 2017 annual monitoring report is to summarize the first year of performance monitoring for the Teeple Pond and outlet channel per conditions 3.1 where it relates to measures and standards in condition 3, and condition 5.2.2 of the Authorization.

2.0 MONITORING CRITERIA THAT RELATE TO MEASURES AND STANDARDS TO AVOID OR MITIGATE SERIOUS HARM TO FISH

Condition 3.1 of the Authorization states:

> *Monitoring of avoidance and mitigation measures: The Proponent shall monitor the implementation of avoidance and mitigation measures referred to in condition 2 of this authorization and report to DFO, by March 31 following the year being reported on and indicated whether the measures and standards to avoid and mitigate serious harm to fish were conducted according to the conditions of this authorization.*

The as-constructed report for Teeple Pond and outlet channel (as per condition 5.2.1 of the Authorization) issued December 19, 2016 (Amec Foster Wheeler 2016a) describes many of the measures and standards required per condition 3.1 of the Authorization. A summary of the as-constructed report contents is provided in Section 4.0 of this document.

Monitoring criteria that relate to measures or standards to avoid or mitigate serious harm to fish not described in the Teeple Pond and outlet channel as-constructed report are as follows:

- "Ramp up and down" flow takings in Pinewood River at intake and monitor and adjust water takings to avoid stranding of fish (condition 2.2.3 of the Authorization);

- Implement plan to monitor fish community in Pinewood River between the existing West Creek and Loslo Creek to confirm that the fish community and fish passage are maintained (condition 2.2.4 of the Authorization); and

- Screen or use other deterrents at any water intakes or outlet pipes to prevent entrainment or impingement of fish (condition 2.2.5 of the Authorization).

Further to the above, PTTW #8776-9W2QN2 Condition 4.1.3 issued on August 31, 2015, required that a biological monitoring plan be prepared for the Pinewood River:

> *The Permit Holder shall submit a Biological Monitoring plan to the Director for approval within 180 days of issuance of this permit and prior to direct water taking from the Pinewood River. The plan shall include, at minimum, the following:*
>
> *a) Methods for monitoring and identifying fish kills and fish stranding that are acceptable to the Director.*
>
> *b) A contingency plan to address adverse conditions defined in Condition 4.1.3 a), including investigation into the adequacy of minimum flow thresholds to minimize impacts to aquatic communities.*

The 2017 monitoring results and associated monitoring plans for the RRM related to the above measures or standards to avoid or mitigate serious harm to fish are described below

- New Gold followed flow ramping protocols established to avoid stranding of fish during water taking from the Pinewood River as follows:

  - Immediately after the water taking pumps were energized, the recorded water level at the permanent hydrometric station was monitored to evaluate the rate of reduction;

  - A number of accessible locations downstream of the intake with broad floodplain-type riparian areas (susceptible to forming isolated pool conditions) were inspected for evidence of fish standing or death; and

  - Periodic monitoring of these locations continued until the pumps were ramped up to a steady level and the pinewood River water level had adducted to the reduced flow, as determined by the hydrometric station instruments, during the water taking activities.

- The pump house intake structure includes fine-mesh screen around the intake channel to deter and prevent entrainment or impingement of fish as discussed in the hydraulics analysis technical memorandum (Amec Foster Wheeler 2015); and

- Monitoring of the Pinewood River fish community between the existing West Creek and Loslo Creek to confirm that the fish community and fish passage are maintained is addressed under the Pinewood River Biological Monitoring Plan per Environmental Compliance Approval (ECA) #5781-9VJQ2J, condition 10(5) and ECA #5178-6TUPD9, condition 8(7) (Amec Foster Wheeler 2016b). The 2017 results from the above biological monitoring plan will be submitted to the Ministry of Environment and Climate Change (MOECC) and DFO by March 31, 2018 per condition 3.1 of this Authorization, but a summary of the observed results are provided in Section 7.3.

3.0 MONITORING CRITERIA TO ASSESS OFFSETTING MEASURES

Condition 5.2 of the Authorization was modified to align the RRM offsetting measures construction and commissioning schedule with the DFO Fisheries Protection Program monitoring (DFO 2016), which states;

> *List of reports to be provided to DFO: The Proponent shall report to DFO on whether the offsetting measures were conducted according to the conditions of this authorization by providing the following*
>
> *5.2.1 As-constructed report due on or before March 31, 2016.*
>
> *5.2.2 Annual monitoring report due on or before December 31 for 5 year post construction (2017-2021).*

Implementation and effectiveness of the offset measures is determined by confirming that Teeple Pond and its outlet channel have been constructed as per the approved plans and are functioning as intended using the prescribed monitoring criteria presented below.

Criteria and Dates to Assess Offsetting Measures Implementation and Effectiveness Success

Attribute	Success Criteria	Date
Physical construction of offset measures	• As-built survey demonstrates that measures are constructed as per the approved plans • Area of replacement habitat is equal to or greater than 8.41 ha	December 31, 2016
Physical function of offset measures	• Water levels are consistent with those specified in the design • The outlet channel and pond allows for passage of fish	December 31, 2019
Stability of structures	• Constructed habitat features remain in place (log and boulder structures in place) • Shorelines and graded offset features are stable and not eroding (greater than 80% of features are considered stable) • Riparian vegetation cover and plantings achieve 80% coverage of	December 31, 2019

Attribute	Success Criteria	Date
	area, and or survival of planted stock	
Species presence	• Minimum of 9 species of fish are present in the offset measure.	December 31, 2021
Full life cycle usage	• Multiple year classes including young of the year fish are present in the offset feature.	December 31, 2021
Fish abundance	• Overall Catch per Unit Effort (CPUE) for all species combined, for at least two of following capture methods (electrofishing, Minnow Traps, Seine Nets). Minimum success criteria are: • Minnow Trap CPUE ≥ 2 fish per trap hour • Seine Net CPUE ≥ to 16 fish per 15 m net pull • Electrofishing CPUE ≥ 44 fish per 1000 seconds	December 31, 2021

Source: Table 5, New Gold 2015; includes revision of success criteria due dates per DFO 2016.

The 2017 monitoring results to assess offsetting measures are presented in the following sections as described below:

- Physical construction of offset measures;
- Physical function of offset measures;
- Stability of structures; and
- Fish community metrics including species presence, abundance, and full life cycle usage.

4.0 PHYSICAL CONSTRUCTION OF OFFSET MEASURES

An as-constructed report for Teeple Pond and outlet channel (as per condition 5.2.1 of the Authorization) was issued December 19, 2016 (Amec Foster Wheeler). The as-constructed report provides the following:

- A summary of upset conditions and contingency response associated with the DFO Authorization;
- Comparisons between design parameters and as-constructed conditions of Teeple Pond;
- Comparisons between design parameters and as-constructed depths of Teeple Pond;
- A summary of deviations from design and recommended monitoring for Teeple Pond outlet channel; and
- Comparisons between design areas and as-constructed habitat area of Teeple Pond and outlet channel.

Comparison of the constructed habitat to the approved plan confirmed that 9.86 hectares (ha) area of replacement habitat was constructed, which is greater than the proposed minimum area of 8.41 ha of offsetting measures. The as-constructed report demonstrated that the offset structures (pond and outlet channel) specified in DFO in Authorization 15-HCAA-00039 and the associated Offset Plan were met, in that minor deviations noted were not expected to impact the overall success of the plan.

5.0 PHYSICAL FUNCTION OF OFFSET MEASURES

5.1 Physical Function of Teeple Pond

Teeple Pond was built to include permanent deeper water refuge pools, log and boulder structures, and highly productive emergent wetland margins with a normal water level of 378.50 metres above sea level (masl). The overwintering and summer refuge habitat were constructed to provide between 2.0 and 2.5 m of total water depth at static pond water level design elevation. Monitoring the physical function of Teeple Pond included:

- Installation of a Solinst 3001 LT Levelogger Edge, M10 water level logger with a direct read cable on June 10, 2017 (Figure 1, Appendix A);

- Installation of a Reconyx PC800 Hyperfire Professional Semi-Covert Camera with security enclosure to document Teeple Pond and outlet channel conditions using time lapse photo series (Figure 1, Appendix B); and

- Manual water depth measurements of the overwintering and summer refuge habitat during the summer (Table 1, Appendix C).

The Teeple Pond water level logger pressure sensor malfunctioned shortly after installation and the recorded data were unusable. Clark Creek Pond is connected via the Clark Creek Diversion Channel that flows approximately 1.2 kilometers (km) with an elevation difference of approximately 1.25 m to its outlet into Teeple Pond, and as such provides a suitable proxy to represent the Teeple Pond water level. Figure 2 shows the Clark Creek Pond water level data, recorded via a Solinst 3001 LT Levelogger Edge M10 water level logger, as well as the manually surveyed water level data for both Teeple and Clark Creek Ponds, thereby demonstrating comparable water levels were maintained in both waterbodies throughout this period (June to September 2017). An assessment of frequency of flow within the diversion channel was not possible due to malfunction of the water level logger and periodic damming of the pond outlet at the fan, which impeded flows by temporarily raising the outlet elevation. The Fort Frances precipitation record is also presented to illustrate water level fluctuations of these waterbodies in response to precipitation events.

The time-lapse camera was programed to store one image at 06:00, 09:00, 12:00, 15:00, 18:00 and 21:00 each day throughout the year, and was positioned at the edge of tree line near the pond outlet into the constructed outlet channel and fan area. Appendix B contains a photo record illustrating weekly water level and vegetation growth conditions in the Teeple Pond and outlet fan (June to September 2017). The photo record primarily includes photos taken at 15:00, as this time of day appeared to be most consistent with regard to brightness, clarity and ability to distinguish changes in site condition with minimal influence from shadows and light intensity. Other supporting photos document wildlife observations (e.g., bald eagle, waterfowl), site work related to re-establishment of design conditions (e.g., trapper activities, heavy equipment), and notable changes in water level with comparisons of photos before and after substantial rainfall events. This time lapse photo record confirms static water levels were maintained within Teeple Pond throughout the observation period.

As specified in the Offset Plan, water depth measurements of the pond area are to be conducted once per year during the monitoring period to confirm refuge areas are maintained. The Offset Plan as-constructed report for Teeple Pond (Amec Foster Wheeler 2016a) confirmed refuge areas were established per the design and in-field water depth checks during the 2017 summer field studies confirmed that these areas maintained appropriate water depths of 1.5 m to 2.6 m within the refuge pool and connecting channels (Table 1; Appendix C).

The physical function of Teeple Pond performance monitoring results show pond water levels were maintained per design throughout the 2017 monitoring period as documented by the water level logger data, manually surveyed water levels, time lapse photo documentation and manually measured water depths throughout the pond.

5.2 Physical Function of Teeple Outlet Channel

The Offset Plan physical function performance monitoring criteria require water depth and velocity measurements in the outlet channel are collected in pools, flats and riffles during at least one low flow period and one high flow period each year (for 3yrs). Teeple Pond outlet channel performance monitoring was initiated in June 2017, as such, depth and velocity measurements were not collected during the spring (March-April) 2017 high flow conditions.

Amec Foster Wheeler Erosion and Sediment Control (ESC) site staff qualitatively documented high flow conditions on April 10, 2017 during spring freshet however, water depth and velocity measurements per the Offset Plan performance monitoring criteria are scheduled for the spring 2018 freshet period, immediately after ice-off (Amec Foster Wheeler 2017a). The observed conditions during April 2017 show sufficient water depth existed during spring freshet to maintain fish passage between Teeple Pond and the outlet channel. The photo record provided in Appendix A.2 (Plate A.2-1) illustrates water level conditions throughout the channel during April.

The low flow monitoring event on June 10, 2017 was conducted by Amec Foster Wheeler biological field staff. Wetted widths, total depths and water velocity in pools, flats and riffles were measured (where possible) throughout the pre-determined channel stability stations shown on Figure 1. Outlet channel reaches with flat and pool morphology maintained sufficient water depth to provide fish habitat; however the riffle areas were likely barriers to fish passage during low flow conditions since water was observed flowing through the riffles (around the base of cobbles) with minimal passable flow above the aggregates (less than 0.02 m total depth). This potential barrier to fish passage is natural to the system during periods of intermittency, and 2017 represented drier than average conditions. Fish were found in all sampled pools, demonstrating the fish are passing through the channel. Similar isolated pool conditions were observed further downstream in the remnant Teeple Drain channel as discussed in Section 6.2. The in-field channel stability station measurements are presented in Table 2, with photo examples of these observations provided in Appendix A (Plate A.2-2 to A.2-5).

General monitoring events throughout the year were conducted by Amec Foster Wheeler ESC site staff and aquatic studies field staff. The ESC staff documented some areas of erosion in the low flow channel and inlet fan immediately downstream of the Teeple Pond outlet (Amec Foster Wheeler 2017a). The eroded material was subsequently deposited in the channel bottom and margins of the downstream low flow channel. Accumulation of fine sediments immediately downstream of boulders was also observed. These areas of erosion were observed during the June 2017 channel stability assessment, as well as some areas with displaced riffle cobble and surface erosion outside of the low flow channel. Photo examples of the above observations are provided in Appendix A.3. Design conditions were re-established by the contractor between August 17 and 24, 2017 during dry conditions (Amec Foster Wheeler 2017b and 2017c).

Beaver activity within Teeple Pond temporarily impacted function of the outlet by reducing flow into the outlet channel due to the placement of mud and sticks across the outlet channel. The pond outlet was periodically checked and beaver debris was removed to maintain connectivity . Initially the beaver activity is being managed to ensure the channel and habitats stabilize and naturalize according to plan, but over time it is expected that beaver activity will be allowed to persist as it does in any natural system. Representative photos of the blocked outlet and removed debris are provided in Appendix A.

5.3 Physical Function Monitoring Recommendations

The following action items and recommendations are provided to improve physical function monitoring of Teeple Pond and outlet channel:

- Reinstallation of the Teeple Pond water level logger immediately after ice-off conditions (early March 2018) to ensure open water conditions are monitored per the Offset Plan criteria. Reinstallation of the logger during winter is not recommended as it is likely that the level data recorded during the winter under ice conditions will not be reliable (New Gold 2016)

- Ensure the water level logger data are downloaded more frequently to detect failures sooner;

- Continue to utilize the 2017 hydraulic habitat monitoring transects/stations (wetted width, total depth and velocity) where possible to continue to monitor conductions in the outlet under high and low flow conditions.

6.0 STABILITY OF STRUCTURES

The stability of structures monitoring included a dedicated site assessment between June 10 and 13, 2017, installation of a time lapse camera to monitor long-term water level conditions, as well as opportunistic observations throughout the year to document vegetation cover and plantings, repair activities and general condition. Observations of the offset measures stability were conducted during the low flow monitoring period as this timing provided the best visibility to assess whether the constructed features were in place and functional. Photo vantage points were established along the perimeter of Teeple Pond and along the outlet channel to document stability of these features at consistent locations (Figure 1). Three channel stability stations were also established within the constructed outlet channel to further assess and document channel condition. An additional two channel stability stations were established downstream of Teeple Road in natural channel reaches to document channel condition further afield.

6.1 Teeple Pond

Photo stations P1, P2 and P3 were established to document the nearshore areas and open-water habitat of Teeple Pond (Figure 1). Appendix B (Plates B.1-1 to B.1-3) provides a photo record of these stations and the constructed habitat features.

The shoreline, as well as the observed constructed habitat features (tree piles and boulder clusters) appeared (where visible) to remain in place as identified in the as-constructed report i.e., stable. The boulder clusters and most tree piles were submerged, with the exception of two tree piles positioned near the southwest corner of the pond. The exposed tree piles are meant to provide fish habitat subsurface, as well as perching areas for avian wildlife and basking structures suitable for turtles and other herptiles. Shorelines and graded offset features were stable and not eroding. Riparian vegetation was well established at most areas surrounding Teeple Pond, with the lowest percent ground coverage observed near the outlet fan area discussed in Section 5.2. Overall, these areas have approximately 70% coverage and will likely meet the future success criteria of 80% coverage within the next performance monitoring period.

6.2 Teeple Pond Outlet Channel

Photo stations P5, P6 and P7 and channel stability stations CSS-1, CSS-2 and CSS-3 were established to document stability of the outlet channel and immediately downstream of the constructed channel (Figure 1). Photo stations P8 to P11, as well as channel stability station CSS-4 and CSS-5 were established to document channel conditions further downstream of the constructed outlet channel in the original Teeple Channel. Appendix B (Plates B.1-3 to B.1-9) contain a photo record of these stations and constructed habitat features. Overall these areas have approximately 60% riparian vegetation coverage, with plantings showing good survival and are anticipated to meet the future success criteria of 80% vegetative coverage within the next few years as the existing vegetation and newly seeded areas become established.

Photo station P7 was positioned immediately downstream of the constructed outlet channel and remnant Teeple Drain channel confluence. During the dry summer conditions little flow was observed from either the constructed outlet or remnant channels, with slightly more flow coming from the remnant channel. This is not unexpected given the dry summer and small watershed. Further site investigation of the remnant channel upstream of this confluence did not identify any obvious seepage areas or sources of flow other than the natural pool habitat present throughout this reach.

As noted in section 5.2, the shallow conditions under very low flow are considered typical during periods of intermittency, and 2017 represented drier than average conditions. Photo station P8 was positioned immediately upstream of the Teeple Road culvert crossing, and includes two bedrock controls within the natural channel alignment. These features had less than 0.01 m flow over the rocks at the time of assessment, thereby posing a potential barrier to fish passage under very low flow conditions. Again, isolated pools are expected under very low flows such as those observed during the summer of 2017. No evidence of erosion was observed between the constructed outlet channel confluence with the original Teeple Drain and photo station P8. These observations demonstrate the outlet channel is providing flow to the original Teeple Drain within the natural variability of flow conditions for this system.

The original Teeple Drain, downstream of Teeple Road, is in an actively used cattle pasture. Consequently, the cattle have trampled the channel near station P9 causing severe bank erosion and degradation. The flow path transitions to a broad wet meadow downgradient of this location. Station P10 was located in the wet meadow with surface drainage through the grasses, and no discernable surface channel. These wet meadow conditions exist further downstream until a channelized flow path enters a woodlot at station P11. No observable channel erosion or instability from the realigned channel flows were noted.

6.3 Contingency Measures for Structure Stability

The Offset Plan and condition 3.1.2 requires that New Gold will implement contingency measures and associated monitoring if the offsetting measures are not constructed or do not function according to the success criteria (Section 8.4; New Gold 2015).

The following observations of Teeple Pond and outlet channel measures that were not functioning according to the success criteria included:

- Riparian vegetation throughout the constructed outlet channel was well established, but with notable areas of sparse cover in the constructed Teeple outlet fan area; and

- The Teeple Pond outlet and sections of the channel experienced bank erosion and some displacement of riffle cobble after spring freshet flow.

Consequently, site work to reinstate design specifications included removal of accumulated sediments (eroded material), placement of topsoil and ESC blankets. Topsoil was placed and seeded in the riparian areas of the channel and in selected areas of poor seed take on the east and west benches of the fan. Subsequent performance monitoring will assess the function of these repaired areas and continue to identify any other areas requiring contingency measure as needed.

7.0 FISH COMMUNITY METRICS

Fish community sampling was conducted during July 2017, meeting or exceeding the minimum gear-specific effort specified in Table 7 of the Offset Plan performance monitoring criteria for pond and channel habitats (New Gold 2015). These sampling activities documented species presence, relative abundance and confirmed presence of multiple fish life stages for some species. Fish community results are discussed below for each offset measure habitat type. The comparison of year-one Teeple Pond and outlet channel performance monitoring results to the Offset Plan success criteria are presented in Table 3, with detailed gear-specific results discussed below.

7.1 Teeple Pond Fish Community Monitoring Results

Teeple Pond was fished using the prescribed non-lethal methods including; minnow traps, seine net and a backpack electrofisher, with gear-specific and catch-per-unit effort (CPUE) results presented in Table 4. Seven fish species were encountered in Teeple Pond, many of which were young-of-the-year (YOY) cyprinids. The YOY individuals were likely members of the *Phoxinus* genus but were too small to non-lethally confirm species. Most fish were captured by the fine mesh of the seine net, the majority of which were YOY individuals. Consequently, the high proportion of YOY individuals within Teeple Pond influenced the CPUE of the gear-specific catch results since those smaller individuals were only catchable using seine netting.

A subsample of individuals from each species, from each gear type were measured for fork length, or total length for those species with rounded caudal fins (e.g., Brook Stickleback and Central Mudminnow). Species-specific results of these measurements, where a minimum of 100 individuals were measured, are presented in Figure 3 illustrating multiple age classes of Brook Stickleback, Fathead Minnow and Northern Redbelly Dace were found in the pond. The abundant presence of YOY *Phoxinus* sp. indicates a high likelihood that multiple age classes of Finescale Dace are also present. These results confirm that Teeple Pond functions as overwintering and summer refuge, spawning, rearing and foraging habitat for these species.

The 2017 RRM fish salvage program released fish into Teeple Pond that were relocated from habitat within the Tailings Management Area and Constructed Wetland in August and September. The released individuals were not included in the year-one performance monitoring results since the performance monitoring field studies were completed in July, prior to the release of salvaged fish.

The 2017 year-one performance monitoring results were not expected to meet all success criteria targets but show the physical habitat supports all life history stages for the fish species present and the offsetting measures are progressing as expected for this monitoring period.

7.2 Teeple Pond Outlet Channel Fish Community Monitoring Results

All available habitat within the Teeple outlet channel was fished using baited minnow traps and a backpack electrofisher, mostly fishing pools and flats where sufficient depth allowed sampling. Low water levels during this sampling event concentrated fish into these refuges, but also reduced the overall sampling area. The relatively small sample area required that both fish collection gear types were used throughout the entire outlet channel to satisfy the minimum sampling efforts per the Offset Plan. Gear-specific and catch-per-unit effort (CPUE) results for the outlet channel are presented in Table 4.

Minnow trapping was conducted first, and the captured individuals were released into Teeple Pond to avoid re-capture of those individuals using electrofishing. Electrofishing was conducted after minnow trapping and captured far fewer fish, which was expected due to the removal of fish by minnow trapping thereby understating the actual electrofishing CPUE. The electrofished individuals were also released into Teeple Pond, since low water conditions were likely to persist through August and further limit available habitat within the outlet channel (as observed in the natural Teeple Drain channel). The same seven fish species encountered in Teeple Pond were also found in Teeple outlet channel, including a few YOY cyprinids (likely *Phoxinus* sp.).

7.3 Monitoring of the Pinewood River Fish Community

The Pinewood River Biological Monitoring Plan per ECA #5781-9VJQ2J, condition 10(5) and ECA #5178-6TUPD9, condition 8(7) samples the Pinewood River fish community at four study areas, including the reaches between the existing West Creek and Loslo Creek (Area 2). The results of this monitoring plan will be presented under a separate cover and a summary of these results are provided here to demonstrate that the fish community species composition and fish passage among areas are maintained per condition 2.3.2 of the Authorization. The geographic extents of each study area of the Pinewood River are described below:

- **Area 1** upstream of existing (original) West Creek inflow;
- **Area 2** between existing (original) West Creek and Loslo Creek inflows;
- **Area 3** positioned downstream of Loslo Creek inflow; and
- **Area 4** positioned upstream of Mine inflows, downstream of the Pinewood River crossing at Heatwole Road.

The Pinewood River Biological Monitoring Plan fish community studies were conducted within two habitat types per Area; type 1 habitat represents flowing, not impounded channelized reaches, and type 2 habitat represents pond-like, impounded habitat with deeper total depths that provide overwinter habitat. Relative percent abundance and species richness for each area and respective habitat types per the 2017 study results are provided in Table 6.

The 2017 Pinewood River Biological Monitoring Plan fish community study results show similar species richness between Areas 1 and 2, with high relative community proportions of Creek Chub, Northern Redbelly Dace, Common Shiner and Brook Stickleback, as well as Brassy Minnow, Golden Shiner and Pearl Dace (Table 6). These results confirm the Pinewood River fish communities in the study areas are not appreciably different, and that fish passage was maintained between the existing West Creek and Loslo Creek (allowing fish movement among areas), per condition 2.3.2 of this Authorization.

8.0 CRITERIA TO ASSESS OFFSETTING MEASURES IMPLEMENTATION AND EFFECTIVENESS SUCCESS

Implementation and effectiveness of the compensation measures are determined by confirming that the pond and outlet channel have been constructed as per the approved plans and are functioning as intended using the success criteria and dates in Table 5 of the Offset Plan (New Gold 2015). Biological systems such as Teeple Pond and the outlet channel are dynamic and will likely require several years to develop full biological communities that meet the success criteria; however, the year-one monitoring results show very good progress toward these targets.

Further to the above, the fish catch results show thousands of YOY cyprinid individuals (seine netting catch), which will likely substantively improve the species-specific CPUE for each gear type in future studies as these individuals grow and mature into larger, spawning individuals within the population. It is anticipated that the majority of these fish will survive overwinter in refuge pools, and as such will help the population sooner attain the carrying capacity and productivity of this habitat. The 2017 performance monitoring results comparison to success criteria are summarized in Table 7.

9.0 REFERENCES

AMEC. 2014. Fish Habitat No Net Loss Plan Section 35(2) Waterbodies, Version 0, November 2014.

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Amec Foster Wheeler. 2016a. Offset Plan *Fisheries Act* Paragraph 35(2)(b) Authorization As-Constructed Report: Teeple Road Pond and Diversion Channel, Version 1, December 19, 2016.

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Amec Foster Wheeler. 2017a. ESC and Diversion Inspection Form – Inlet Fan. April 10.

Amec Foster Wheeler. 2017b. ESC and Diversion Inspection Form – Diversion Channel, Inlet Fan, Old Dam Borrow Pit. July 8.

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New Gold Inc. (New Gold). 2016. Pinewood River Biological Monitoring Plan per Environmental Compliance Approvals #5781-9VJQ2J Condition 10(5) and #5178-6TUPD9 Condition 8(7). Version 2. December 13.

10.0 CLOSURE

This monitoring report was prepared by Amec Foster Wheeler for the sole benefit of New Gold Inc. for specific application to the Rainy River Mine. The quality of information, conclusions and estimates contained herein are consistent with the level of effort involved in Amec Foster Wheeler's services and based on: i) information available at the time of preparation, and ii) the assumptions, conditions and qualifications set forth in this document. This report is intended to be used by New Gold Inc. only, and its nominated representatives, subject to the terms and conditions of its contract with Amec Foster Wheeler. Any other use of, or reliance on, this report by any third party is at that party's sole risk. This report has been prepared in accordance with generally accepted industry-standard. No other warranty, expressed or implied, is made.

Sincerely,
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Table 1: Teeple Pond 2017 Water Depth Measurement Summary

Location No.	Design Water Depth	Total Water Depth (m)	UTM Easting (m)	UTM Northing (m)	Location/ Observations
1	1.5-2.0	1.55	429,795	5,409,016	NW channel, abundant macrophyte nearshore
2	2.0	2.05	429,769	5,409,036	NW refuge pool
3	2.0-2.5	2.32	429,802	5,408,984	W refuge pool, abundant macrophytes nearshore
4	2.0-2.5	2.45	429,810	5,408,966	W refuge pool
5	2.0-2.5	2.40	429,828	5,408,978	W refuge pool
6	1.5-2.0	2.37	429,904	5,408,994	NE channel
7	1.5-2.0	2.28	429,958	5,409,003	NE channel
8	1.5-2.0	1.60	429,985	5,409,028	NE channel, tree piles observed
9	2.0-2.5	2.15	430,013	5,409,080	NE refuge pool
10	1.5-2.0	2.28	429,836	5,408,919	SW channel
11	2.0-2.5	2.60	430,017	5,408,896	SE refuge pool
12	2.0-2.5	1.95	430,146	5,408,887	E refuge pool

Notes:

1. Data collected June 15, 2017 by Amec Foster Wheeler field staff
2. UTM – Universal Transverse Mercator, Zone 15U, NAD 83
3. Locations accurate to approximately 3 metres, design water depth ranges provided per relative sample location within design drawings
4. Appendix C includes Attachment No.1 showing the as-built conditions of Teeple Pond and 2017 manual water depth measurement locations

Table 2: Teeple Outlet Channel 2017 Low Flow Stability Monitoring Summary

Channel Stability Station ID	Morphology	Wetted Width (m)	Total Depth (m)			Velocity (m/s)			Comments
			Left	Centre	Right	Left	Centre	Right	
CSS-1	Flat	1.20	0.095	0.170	0.110	0	0	0	downstream extent
	Pool	1.56	0.195	0.250	0.230	0	0	0	mid-downstream pool
	Pool	1.72	0.135	0.180	0.180	0	0	0	mid-upstream pool
	Pool	1.70	0.050	0.235	0.195	0	0	0	upstream extent
	Riffle	N/A	0.000	0.020	0.000	N/A	N/A	N/A	water depth <0.02 m; too shallow for velocity measurement
CSS-2	Flat	0.87	0.080	0.100	0.100	0	0	0	downstream extent of CSS
	Riffle	N/A	0.000	0.020	0.000	N/A	N/A	N/A	water depth <0.02 m; too shallow for velocity measurement
	Pool	2.04	0.195	0.210	0.200	0	0	0	upstream of boulder in downstream pool
	Pool	2.93	0.215	0.210	0.195	0	0	0	pool at bottom of rock
	Flat	1.30	0.075	0.090	0.080	0	0	0	upstream extent, immediately upstream of riffle
	Riffle	N/A	0.000	0.020	0.000	N/A	N/A	N/A	water depth <0.02 m; too shallow for velocity measurement
	Flat	1.36	0.100	0.130	0.110	0	0	0	upstream extent
CSS-3	Flat	0.20	0.058	0.037	0.037	N/A	0.045	N/A	upstream of remnant channel confluence
	Pool	0.97	0.300	0.295	0.155	0.015	N/A	N/A	first pool downstream of confluence
	Flat	0.75	0.120	0.110	0.050	0	0.025	0.08	mid-upstream flat
	Pool	1.30	0.160	0.220	0.190	0	0.003	0	mid-downstream pool

Notes:
1. Data collected June 10, 2017 by Amec Foster Wheeler field staff
2. N/A – value not able to be recorded
3. Velocity measurements collected using a Marsh McBirney FloMate Model 2000 portable velocity meter
4. Pool and flat stream morphology was only encountered throughout the CSS-3 station reach

Table 3: Teeple Pond and Outlet Channel 2017 Fish Species Presence Summary

Expected Species[1] Clark Creek (Teeple Drain) Sub-watershed	Teeple Pond Year-one (Success Target of 9 Species)	Teeple Pond Outlet Channel Year-One (Success Target of 9 Species)
Blacknose Dace		
Blackside Darter		
Brassy Minnow		
Brook Stickleback	X	X
Central Mudminnow	X	X
Common Shiner	X	X
Creek Chub		
Emerald Shiner		
Fathead Minnow[2]	X	X
Finescale Dace	X	X
Golden Shiner		
Lake Chub		
Northern Redbelly Dace	X	X
Pearl Dace	X	X
Spottail Shiner		
White Sucker		
Species Richness	**7**	**7**

Notes:

1. List of expected species from the Fish Habitat No Net Loss Plan Section 35(2) Waterbodies, Table 3-3 (AMEC 2015)
2. Fathead Minnow were not previously listed to occur within the sub-watershed, but were encountered during the year-one performance monitoring studies.

Table 4: Teeple Pond 2017 Fish Community Monitoring Results Summary

Gear	Sample ID	Sample Date (DD/MM/YY)	No. of Gear	Total Effort	Species Specific Catch and CPUE										
					Brook Stickleback	Central Mudminnow	Common Shiner	Fathead Minnow	Finescale Dace	Northern Redbelly Dace	Pearl Dace	YOY Cyprinid	2017 (Year 1) Catch Total (n)	2017 (Year 1) Catch CPUE	Ultimate (5-year) Target CPUE
Minnow Trap	TCP-MT1	12/07/17	75	1,550	243	26	0	413	14	84	1	0			
	Gear-Specific Total			**1,550**	**243**	**26**	**0**	**413**	**14**	**84**	**1**	**0**	**781**	**0.504**	**>2**
Seine Net	TCP-SN1	12/07/17	1	3	72	0	2	0	1	9	8	320			
	TCP-SN2	13/07/17	1	7	8	1	9	5	17	8	0	1,700			
	Gear-Specific Total			10	**80**	**1**	**11**	**5**	**18**	**17**	**8**	**2,020**	**2,160**	**216**	**>16**
Electrofishing	TCP-EF1	13/07/17	1	5,018	2	2	0	3	5	1	0	32			
	TCP-EF2	14/07/17	1	5,005	3	2	0	0	5	0	1	2			
	Gear-Specific Total			**10,023**	**5**	**4**	**0**	**3**	**10**	**1**	**1**	**34**	**58**	**5.8**	**>44**
All-Gear Catch Total					**328**	**31**	**11**	**421**	**42**	**102**	**10**	**2,054**	**2,999**		

Notes:
1. CPUE = catch-per-unit-effort, expressed as the number of fish caught per gear-specific effort type
2. Minnow trap effort presented as the number of fish caught per minnow trap hour; Offset Plan minimum effort required for monitoring (1,500 hours)
3. Seine net effort presented as the number of fish caught per 15 metre net haul; Offset Plan minimum effort required for monitoring (10 individual 15 m net hauls)
4. Backpack electrofishing effort presented as the number of fish caught per 1,000 electrofishing seconds; Offset Plan minimum effort required for monitoring (10,000 seconds)
5. All gear-specific minimum required efforts were met or exceeded

Table 5: Teeple Pond Outlet Channel 2017 Fish Community Monitoring Results Summary

Gear	Sample ID	Sample Date (DD/MM/YY)	No. of Gear	Total Effort	Species Specific Catch and CPUE										
					Brook Stickleback	Central Mudminnow	Common Shiner	Fathead Minnow	Finescale Dace	Northern Redbelly Dace	Pearl Dace	YOY Cyprinid	2017 (Year 1) Catch Total (n)	2017 (Year 1) Catch CPUE	Ultimate (5-year) Target CPUE
Minnow Trap	TCD-MT1	13/07/17	13	374.8	109	4	0	1	0	4	3	0	121	0.323	>2
	Gear-Specific Total			**374.8**	**109**	**4**	**0**	**1**	**0**	**4**	**3**	**0**			
Electrofishing	TCD-EF1	14/07/17	1	1,036	16	10	1	0	1	0	0	15	43	4.3	>44
	Gear-Specific Total			**1,036**	**16**	**10**	**1**	**0**	**1**	**0**	**0**	**15**			
All-Gear Catch Total					**125**	**14**	**1**	**1**	**1**	**4**	**3**	**15**	**164**	**-**	**-**

Notes:
1. CPUE = catch-per-unit-effort, expressed as the number of fish caught per gear-specific effort type.
2. Minnow trap effort presented as the number of fish caught per minnow trap hour; Offset Plan minimum effort required for monitoring (250 hours).
3. Backpack electrofishing effort presented as the number of fish caught per 1,000 electrofishing seconds; Offset Plan minimum effort required for monitoring (1,000 seconds).
4. All gear-specific minimum required efforts were exceeded.

Table 6: Pinewood River Biological Monitoring Plan Fish Community Summary Results

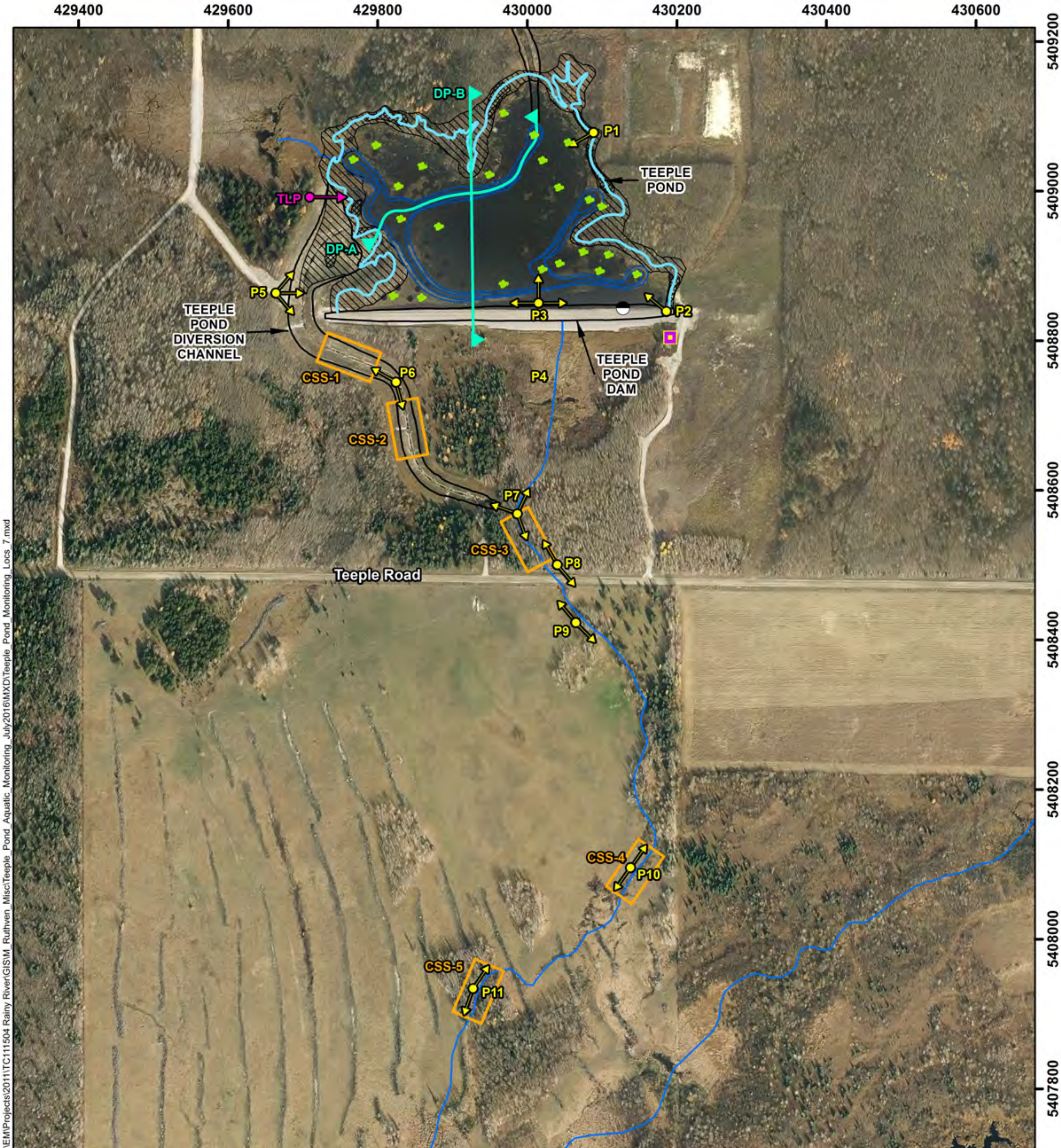
Species	Area 1 Upstream of existing West Creek inflow		Area 2 Between existing West Creek and Loslo Creek inflows		Area 3 Downstream of Loslo Creek inflow		Area 4 Upstream of Mine area inflows	
	Habitat Type 1	Habitat Type 2	Habitat Type 1	Habitat Type 2	Habitat Type 1	Habitat Type 2	Habitat Type 1	Habitat Type 2
Blackside Darter	0.3	0.3	-	-	-	-	0.4	-
Brassy Minnow	8.5	5.6	9.0	**13.1**	-	-	**10.8**	-
Brook Stickleback	**10.5**	5.6	**15.0**	**21.6**	**29.2**	**54.2**	**10.6**	**26.1**
Central Mudminnow	0.3	1.6	5.2	1.6	**29.2**	**16.7**	1.7	**19.8**
Common Shiner	**16.7**	**12.8**	**29.2**	**15.1**	**16.7**	**25.0**	**28.7**	-
Creek Chub	**25.9**	**17.4**	1.5	8.0	4.2	-	**11.7**	8.1
Fathead Minnow	5.2	3.7	**24.2**	6.4	8.3	-	**11.7**	-
Finescale Dace	6.9	-	1.1	-	0.0	-	-	5.4
Golden Shiner	-	6.5	0.2	**11.8**	8.3	-	-	-
Hornyhead Chub	1.3	5.0	-	-	-	-	-	-
Johnny Darter	-	0.0	0.2	0.2	-	4.2	1.9	-
Northern Redbelly Dace	**20.3**	**35.2**	4.3	5.6	-	-	**10.4**	6.3
Pearl Dace	2.3	5.0	3.9	**12.2**	-	-	8.5	**32.4**
White Sucker	1.0	-	2.6	0.7	4.2	-	1.5	-
YOY Cyprinid	0.7	1.2	3.6	3.8	0.0	-	2.3	1.8
Richness	**12**	**11**	**12**	**11**	**7**	**4**	**11**	**6**

Notes:
1. Values represent relative percent community composition from cumulative total catch results for all collection gear used per habitat types 1 and 2 in each area
2. '-' represents fish were not collected within that habitat type from that species
3. Bolded values identify species that contribute relative community proportions greater than 10% to show most abundance species per the 2017 catch results
4. Shaded values identify species that contribute the highest relative community proportions per the 2017 catch results
5. Richness is the total number of species caught in habitat types 1 and 2 in each area, excluding YOY cyprinids

Table 7: Comparison of 2017 Performance Monitoring Results to Success Criteria

Attribute and Due Date	Success Criteria	Teeple Pond (Year-one)	Teeple Pond Outlet Channel (Year-one)	Ultimate (5-year) Post Monitoring Success Criteria
Physical Construction of Offset measures (December 31, 2016)	As-built survey demonstrates that measures are constructed as per the approved plans	Yes	Yes	**Achieved**
	Area of replacement habitat is equal to or greater than 8.41 ha	Yes	Yes	**Achieved**
Physical Function of Offset Measures (December 31, 2019)	Water levels are consistent with those specified in the design	Yes	Yes	**Achieved**
	The outlet channel and pond allows for passage of fish	Yes	Yes	**Achieved**
Stability of Structures (December 31, 2019)	Constructed habitat features remain in place (log and boulder structures in place)	Yes	Yes	**Achieved**
	Shorelines and graded offset features are stable and not eroding (greater than 80% of features are considered stable)	>80%	>80%	**Achieved**
	Riparian vegetation cover and plantings achieve 80% coverage of area, and or survival of planted stock	Approx.70%	Approx. 60%	On track
Species Presence (December 31, 2021)	Minimum of 9 species of fish are present in the offset measure.	7	7	On track
Full Life Cycle Usage (December 31, 2021)	Multiple year classes including young of the year fish are present in the offset feature.	Yes	Yes	**Achieved**
Fish Abundance (December 31, 2021)	Overall Catch per Unit Effort (CPUE) for all species combined, for at least two of following capture methods (electrofishing, Minnow Traps, Seine Nets). Minimum success criteria are:			
	Minnow Trap CPUE ≥ 2 fish per trap hour	0.504	0.323	On track
	Seine Net CPUE ≥ to 16 fish per 15 m net pull	216	N/A	**Achieved**
	Electrofishing CPUE ≥ 44 fish per 1,000 seconds	5.8	4.3	On track

Notes:
1. CPUE = catch-per-unit-effort, expressed as the number of fish caught per gear-specific effort type
2. Achieved = planned success criteria already achieved
3. On track = within the expected progress for the performance monitoring period
4. High proportion of YOY individuals within Teeple Pond influenced CPUE of gear-specific results since those fish were only catchable using seine netting



P:\EM\Projects\2011\TC111504 Rainy River\GIS\M_Ruthven_Misc\Teeple_Pond_Aquatic_Monitoring_July2016\MXD\Teeple_Pond_Monitoring_Locs_7.mxd

LEGEND

- TLP Time Lapse Photo Station
- P# Photo Station
- Depth Profiles
- CSS-# Channel Stability Station
- Teeple Pond Extent
- Dam / Diversion Channel
- In Pond Channels
- Tree Pile
- Boulder Clusters
- Emergent Wetland
- Scrub / Shrub Wetland
- Water Level Logger
- Barometric Pressure Logger
- Watercourse

0 50 100 200 300 400 500 Metres

NOTES:
- Aerial imagery - October 2017

Datum: NAD83
Projection: UTM Zone 15N

N E S W

newgold Rainy River Project

amec foster wheeler

RAINY RIVER MINE

Teeple Pond and Outlet Channel Monitoring Locations

PROJECT N^{o}: TC111504	**FIGURE: 1**
SCALE: 1:7,000	DATE: December 2017

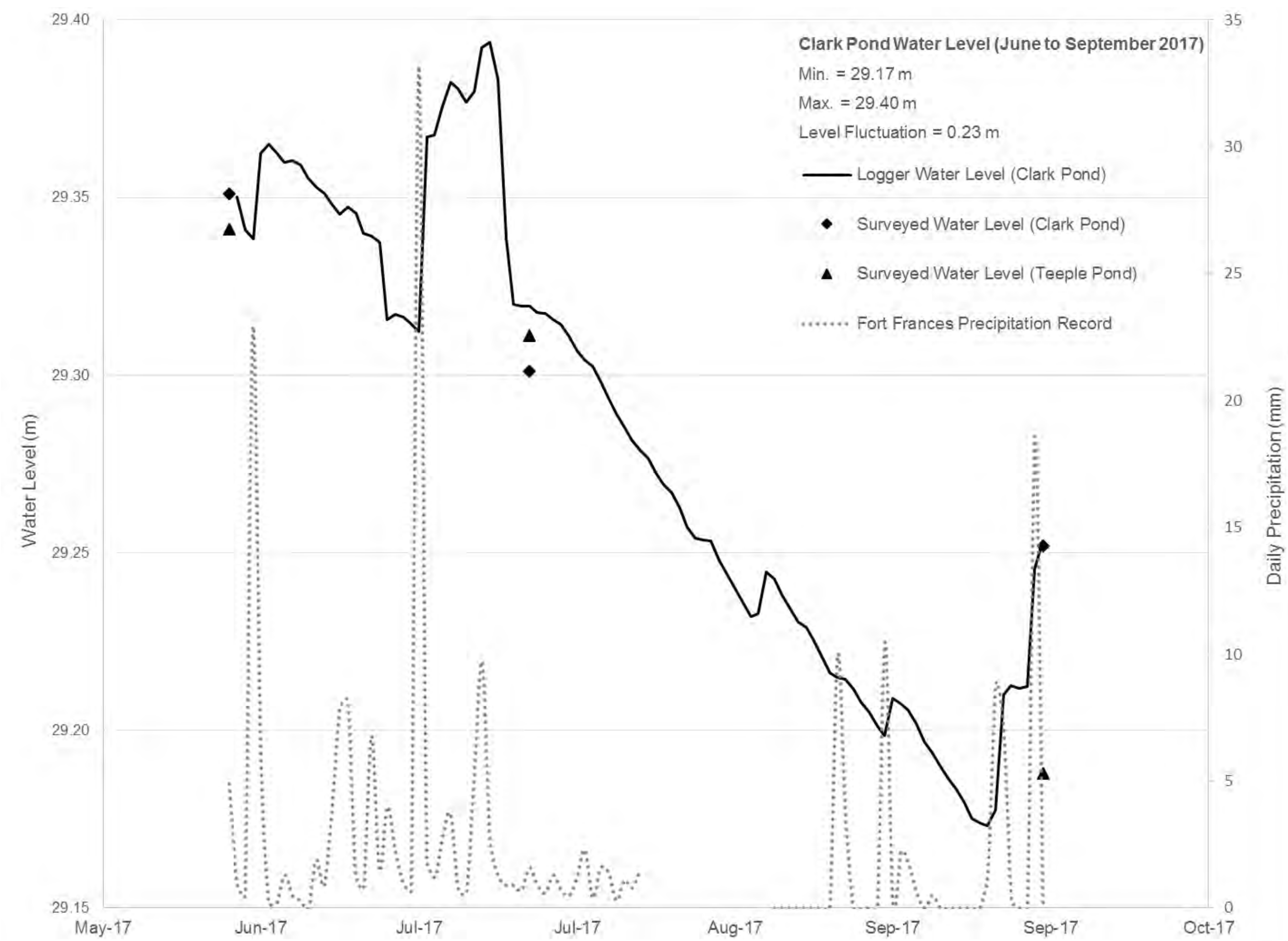


Figure 2: Clark Pond Water Level Data with Teeple Pond Survey Data

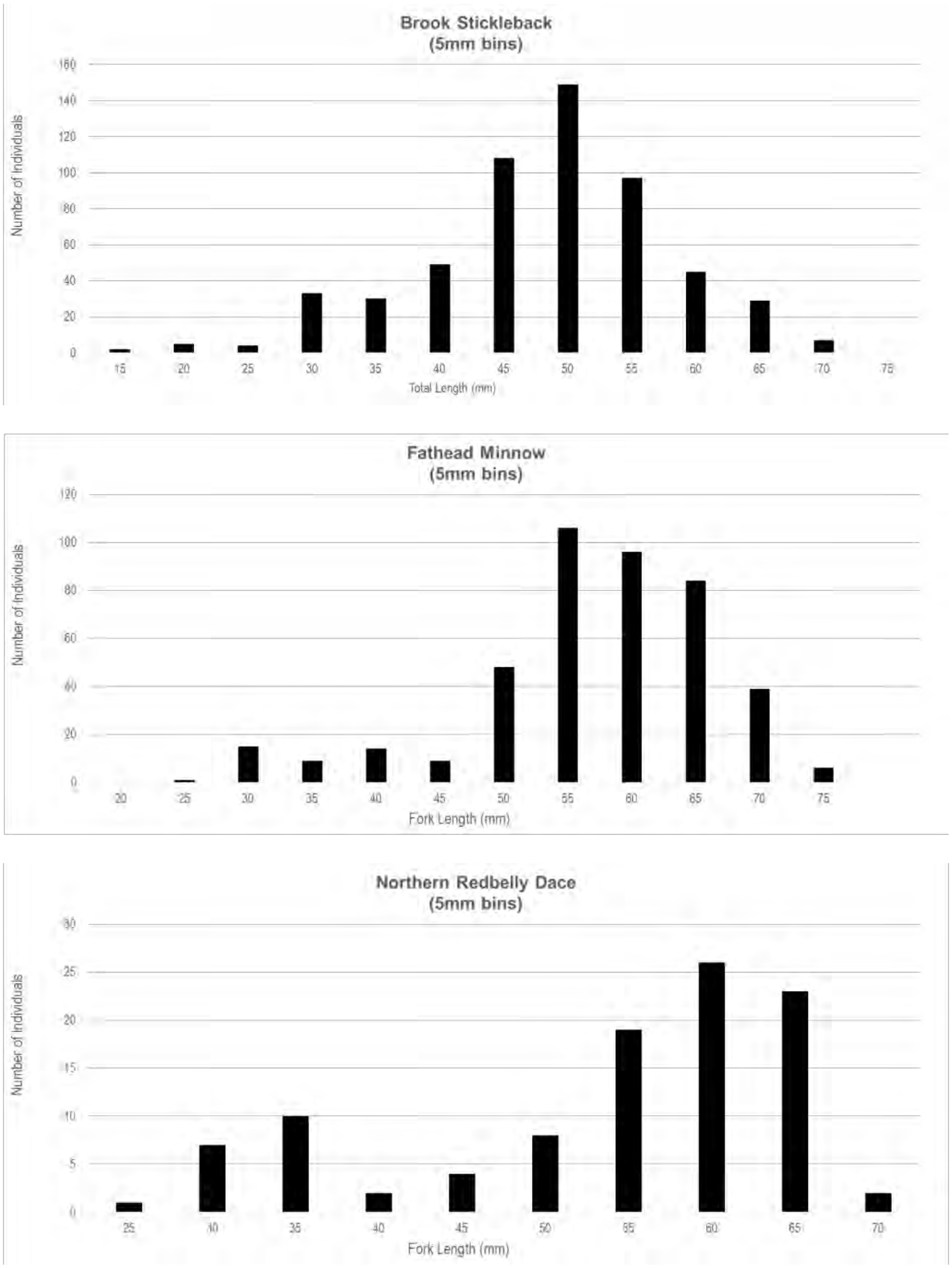


Figure 3: Teeple Pond Species-Specific Length-Frequency Summary

APPENDIX A

PHYSICAL FUNCTION OF OFFSET MEASURES PHOTO RECORD

A.1 TEEPLE POND

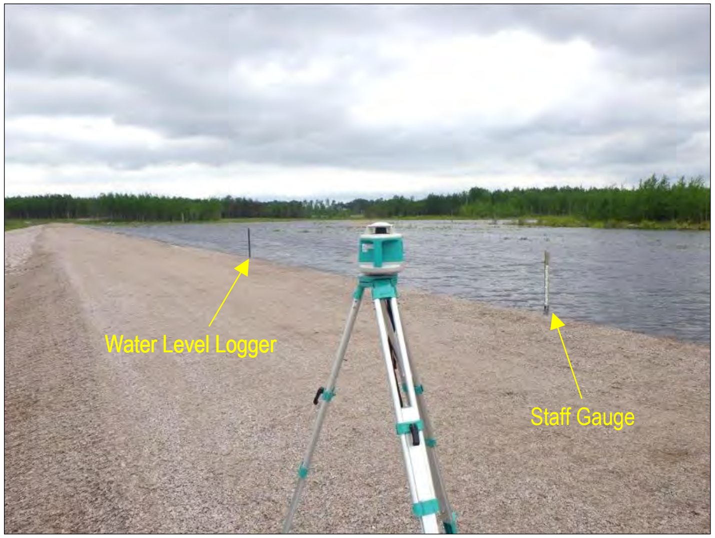
A.2 TEEPLE DIVERSION CHANNEL

APPENDIX A.1

TEEPLE POND

Water level logger facing west on dam (June 10, 2017)

Water level logger facing east on dam (June 10, 2017)



Water level logger facing northwest (June 10, 2017)

Barometric pressure logger mounted on tree (June 10, 2017)

Plate A.1-1: Teeple Pond Water Level Logger Installation

APPENDIX A.2

TEEPLE DIVERSION CHANNEL


Teeple Pond outlet facing upstream (April 10, 2017)


Riffle No.5 facing upstream in Teeple fan (April 10, 2017)


Pool in CSS-1, facing downstream (April 10, 2017)


Diversion channel outlet to natural channel (April 10, 2017)

Plate A.2-1: Teeple Diversion Channel – High Flow Monitoring


Beaver dam debris reduced Teeple Pond outflow (June 9, 2017)


Pool downstream of Teeple fan, low flow (June 9, 2017)


Riffle with <0.02 m depth of water through cobble (June 10, 2017)


Riffle/Run in CSS-1, very little flow (June 10, 2017)

Plate A.2-2: Teeple Diversion Channel – Low Flow Monitoring

Riffle/Run in CSS-2, very little flow (June 10, 2017)

Pool in CSS-2 facing upstream (June 10, 2017)

Pool in CSS-2 facing upstream (June 10, 2017)

Riffle/Run in CSS-2 facing downstream (June 10, 2017)

Plate A.2-3: Teeple Diversion Channel – Low Flow Monitoring


Last pool of diversion channel upstream of CSS-3 (June 13, 2017)


Riffle at diversion channel outlet, at CSS-3 (June 13, 2017)


Natural channel in CSS-3 reach, note P7 stake (June 10, 2017)


Natural channel facing upstream in CSS-3 (June 10, 2017)

Plate A.2-4: Teeple Diversion Channel – Low Flow Monitoring

CSS-4 in cattle pasture, note pink flag at station P10 (June 13, 2017)

Undefined surface flow through grasses at CSS-4 (June 13, 2017)

CSS-5 in woodlot, facing upstream (June 13, 2017)

CSS-5 in woodlot, facing downstream (June 13, 2017)

Plate A.2-5: Teeple Diversion Channel – Low Flow Monitoring

APPENDIX B

STABILITY OF STRUCTURES PHOTO RECORD

B.1 PHOTO STATIONS

B.2 TIME LAPSE PHOTO SERIES

APPENDIX B.1

PHOTO STATIONS

Station P1 facing southwest (June 9, 2017)

Station P1 facing south (June 9, 2017)

Station P2 facing west (April 10, 2017)

Station P2 facing west; note well established vegetation (July 8, 2017)

Plate B.1-1: Stability of Structures Photo Stations P1 and P2

Station P2 facing west from stake (June 9, 2017)

Station P3 facing north (June 9, 2017)

Station P3 facing west (June 9, 2017)

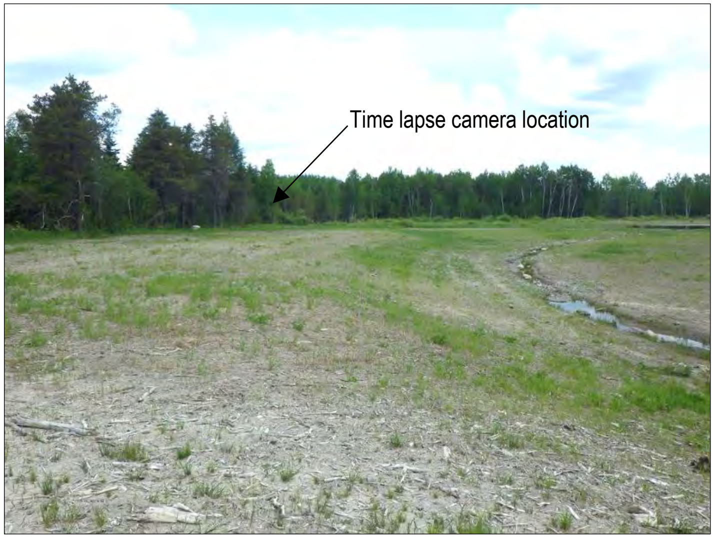
Station P3 facing east (June 9, 2017)

Plate B.1-2: Stability of Structures Photo Stations P2 and P3

Photo taken west of P3 showing tree piles (June 9, 2017)

Station P4 facing north to dam (June 9, 2017)

Station P4 facing south away from dam (June 9, 2017)



Station P5, facing north showing upland fan vegetation (June 9, 2017)

Plate B.1-3: Stability of Structures Photo Stations P3, P4 and P5


Station P5 facing northeast; high flow condition (April 10, 2017)


Station P5 facing northeast; low flow condition (July 8, 2017)


Station P5 facing east; high flow condition (April 10, 2017)


Station P5 facing east; low flow condition (June 9, 2017)

Plate B.1-4: Stability of Structures Photo Station P5

Station P5 facing southeast; high flow condition (April 10, 2017)

Station P5 facing southeast; low flow condition (July 8, 2017)

Station P6 facing northwest; upstream (June 10, 2017)

Station P6 facing northwest; downstream (June 10, 2017)

Plate B.1-5: Stability of Structures Photo Stations P5 and P6


Last pool in diversion channel; upstream of P7 (June 10, 2017)


Station P7, diversion outlet facing northwest; upstream (June 10, 2017)


Station P7, remnant outlet stream facing upstream (June 10, 2017)


Station P7, natural channel facing south; downstream (June 10, 2017)

Plate B.1-6: Stability of Structures Photo Station P7

Station P8 facing southeast; downstream (June 10, 2017)

Station P8 upstream bedrock control, <0.01 m depth (June 10, 2017)

Station P8 downstream rock control, <0.01 m depth (June 10, 2017)

Station P9; natural channel trampled by cattle (June 13, 2017)

Plate B.1-7: Stability of Structures Photo Stations P8 and P9

Station P9 facing northwest; upstream (June 13, 2017)

Station P9 facing southeast; downstream (June 13, 2017)

Station P10 facing northeast; up-gradient (June 13, 2017)

Station P10 facing southwest; down-gradient (June 13, 2017)

Plate B.1-8: Stability of Structures Photo Stations P9 and P10


Wet meadow upstream of Station P11 (June 13, 2017)


Channelized section in wet meadow upstream of P11 (June 13, 2017)


Station P11 facing northeast; up-gradient (June 13, 2017)


Station P11 facing southwest; down-gradient (June 13, 2017)

Plate B.1-9: Stability of Structures Photo Station P11

APPENDIX B.2

TIME LAPSE PHOTO SERIES

Teeple Pond outlet (June 11, 2017)

Teeple Pond outlet (June 16, 2017)

Teeple Pond outlet (June 23, 2017)

Teeple Pond outlet (June 30, 2017)

Plate B.2-1: Time Lapse Photo Series (June 2017)

Teeple Pond outlet (July 7, 2016)

Teeple Pond outlet (July 14, 2017)

Teeple Pond outlet (July 21, 2017)

Teeple Pond outlet (July 28, 2017)

Plate B.2-2: Time Lapse Photo Series (July 2017)

Teeple Pond outlet (August 4, 2017)

Teeple Pond outlet (August 11, 2017)

Teeple Pond outlet; note debris mound removed (August 18, 2017)

Teeple Pond outlet (August 24, 2017)

Plate B.2-3: Time Lapse Photo Series (August 2017)

Teeple Pond outlet (September 2, 2017)

Teeple Pond outlet; note large white birds on pond (September 8, 2017)

Teeple Pond outlet (September 15, 2017)

Teeple Pond outlet (September 21, 2017)

Plate B.2-4: Time Lapse Photo Series (September 2017)

Teeple Pond outlet; note geese in foreground (June 12, 2017)

Teeple Pond outlet; unknown animal/object at outlet (July 6, 2017)

Teeple Pond outlet; water level before 22 mm rain (June 13, 2017)

Teeple Pond outlet; water level after 22 mm rain (June 14, 2017)

Plate B.2-5: Time Lapse Photo Series (Other Supporting Photos)

Teeple Pond outlet; rain in distance (June 25, 2017)

Teeple Pond outlet; example of shadow/lighting influence (June 25, 2017)

Teeple Pond outlet; water level before 33 mm rain (July 4, 2017)

Teeple Pond outlet; water level after 33 mm rain (July 5, 2017)

Plate B.2-6: Time Lapse Photo Series (Other Supporting Photos)

Teeple Pond outlet; trapper (July 10, 2017)

Teeple Pond outlet; trapper working near outlet (July 18, 2017)

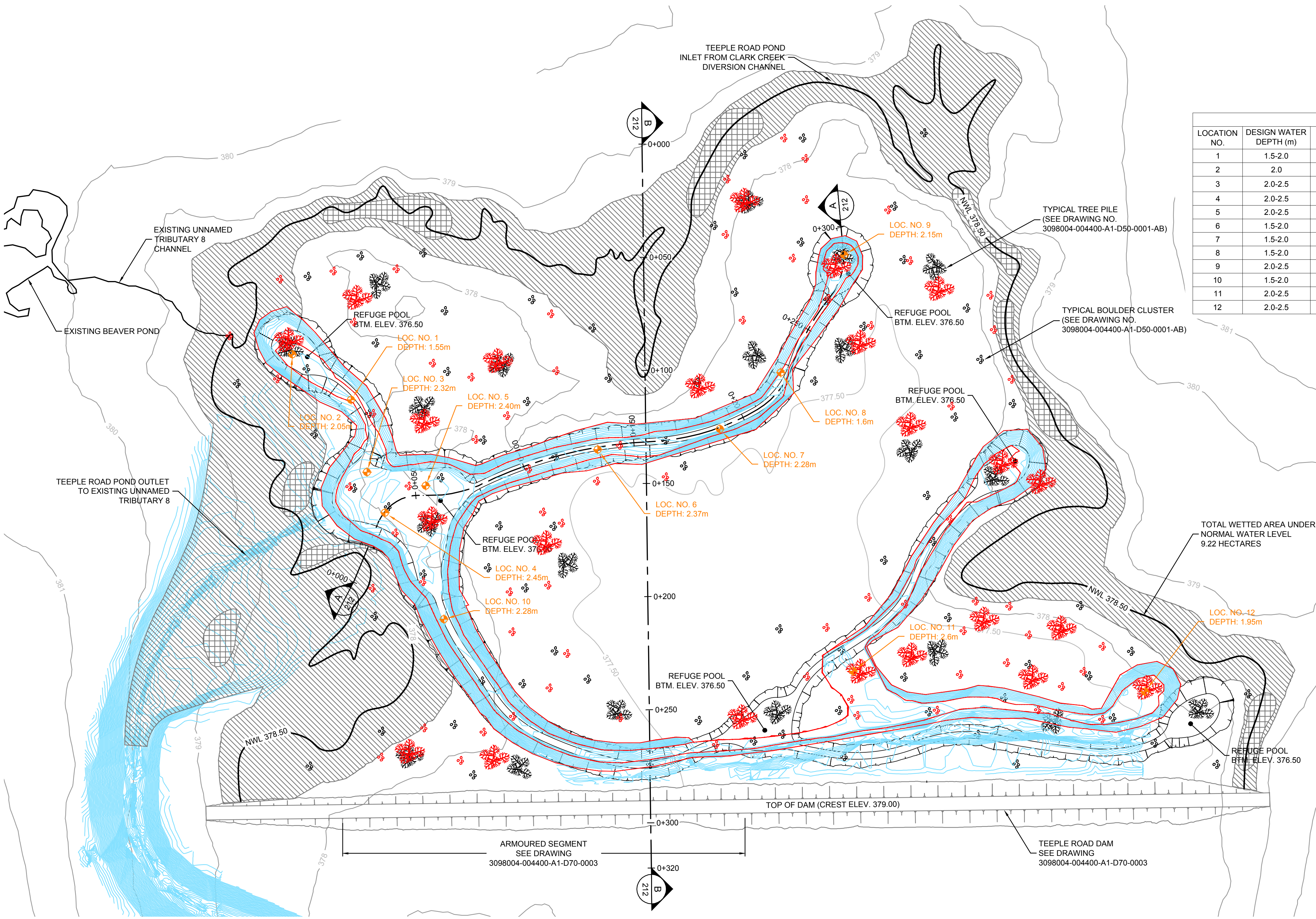
Teeple Pond outlet repairs; note machinery (August 18, 2017)

Teeple Pond outlet; Bald Eagle on outlet debris mound (July 21, 2017)

Plate B.2-7: Time Lapse Photo Series (Other Supporting Photos)

APPENDIX C

ATTACHMENTS



LEGEND

- BOULDER CLUSTER
- TREE PILE
- NWL NORMAL WATER LEVEL
- ZONE A - SCRUB-SHRUB WETLAND - 3,248 m^2
- ZONE B - EMERGENT WETLAND - 34,693 m^2

2017 MANUAL WATER DEPTH MEASUREMENTS					
LOCATION NO.	DESIGN WATER DEPTH (m)	TOTAL WATER DEPTH (m)	UTM EASTING (m)	UTM NORTHING (m)	LOCATION/OBSERVATION
1	1.5-2.0	1.55	429,795	5,409,016	NW CHANNEL, ABUNDANT MACROPHYTE NEARSHORE
2	2.0	2.05	429,769	5,409,036	NW REFUGE POOL
3	2.0-2.5	2.32	429,802	5,408,984	W REFUGE POOL, ABUNDANT MACROPHYTES NEARSHORE
4	2.0-2.5	2.45	429,810	5,408,966	W REFUGE POOL
5	2.0-2.5	2.40	429,828	5,408,978	W REFUGE POOL
6	1.5-2.0	2.37	429,904	5,408,994	NE CHANNEL
7	1.5-2.0	2.28	429,958	5,408,003	NE CHANNEL
8	1.5-2.0	1.60	429,985	5,409,028	NE CHANNEL, TREE PILES OBSERVED
9	2.0-2.5	2.15	430,013	5,409,080	NE REFUGE POOL
10	1.5-2.0	2.28	429,836	5,408,919	SW CHANNEL
11	2.0-2.5	2.60	430,017	5,408,896	SE REFUGE POOL
12	2.0-2.5	1.95	430,146	5,408,887	E REFUGE POOL

TEEPLE ROAD POND PLAN VIEW

SCALE : 1:1000

0m 10 20 30 40
1 : 1000

3098004-004400-A1-D50-0006

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	DES.	APPR
A	18	12	2017	AS-BUILT	NSH	MCR

Client Logo: newgold Rainy River Project

Client: NEW GOLD INC.

AMEC Foster Wheeler
Environment & Infrastructure
160 Traders Boulevard East
Mississauga, Ontario, Canada L4Z 3K7

DRAWN BY: NSH
DESIGNED BY: NSH
CHECKED BY: MCR
REVIEWED BY: MCR
APPROVED BY: MCR

PROJECT: RAINY RIVER PROJECT DETAILED DESIGN

TITLE: TEEPLE ROAD POND PLAN VIEW

PROJECT NO.: TC133921
REVISION NO.: A
DATE: DEC. 2017
SCALE: AS SHOWN
ATTACHMENT NO.: 1

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