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**ELECTRONIC MAIL**

June 17, 2022

Clean Environment Commission  
305-155 Carlton Street  
Winnipeg MB R3C 3H8

**RE: Vivian Sand Extraction Project (file # 6119.00) – Supplement Files #2 – Draft Follow Up Plans**

Dear Committee,

In response to inquires about Follow Up Plans for the Vivian Sand Extraction Project that are described in Section 8 Follow Up Plans in the Environment Act Proposal, please find attached copies of example draft Follow Up Plans for the following:

- Erosion and Sediment Control Plan – Example only
- Groundwater Monitoring and Impact Mitigation Plan -Draft Example
- Waste Characterization and Management plan – Draft Example
- Water Management Plan – Draft Example

At this time the Plans listed above are in preliminary draft stage only which illustrate at a high level the approaches to monitoring and management that Sio intends to implement for the Project. Final versions would be completed during the final design stage and prior to operations commencing. The final Plans will also incorporate any conditions as outlined in the Environment Act License and any other applicable authorizations, permits and approvals.

Other Plans that will be completed include an Environmental Emergency Response Plan, Revegetation Monitoring Plan, and Heritage Resources Protection Plan. These Plans are typically site specific and would follow the industry accepted practices. These types of Plans are often quite standard in their measures.

Finally, Sio is currently working with Mines Branch and third-party experts to develop a Closure Plan, which will provide the foundation of and inform the Progressive Well Abandonment Plan. A Closure Plan would also be in place prior to any operations.

Best Regards,

A handwritten signature in black ink that reads "Laura Weeden".

Laura Weeden P. Eng.  
VP Operations

# Vivian Sand Extraction Project

Erosion and Sediment Control Plan

Example Only

Project number: 60640258

## Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("AECOM") for the benefit of the Client ("Client") in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the "Agreement").

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## Quality information

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Erosion and sediment control will be applied to all aspects of the Project as required including development and operation of extraction wells, placement of slurry pipe, and any access trail and ditch construction. The implementation of environmental best management practices (BMP) to limit sediment introduced to streams, ditches and low-lying wet areas will require sound judgment by the contractor based on dialogue with CanWhite, AECOM, and regulators according to the natural conditions at each site. The general approach to the ESC Plan implementation will be to monitor construction activities, preserve the natural environment to the extent possible, minimize the extent of disturbance, implement the BMP measures to reduce the amount of erosion or sedimentation, and respond to concerns and additional measures required from a list of acceptable BMPs to prevent erosion or sedimentation.

The objective of the ESC Plan is to prevent, minimize and/or control the potential for erosion and sediment accumulation that transpire on site as a result of natural environmental occurrences or human induced events. The water that enters or leaves the Project site is to be controlled so that deleterious materials do not leave the site and sediments are not transported elsewhere and potentially cause further environmental damage.

### **1.1 Application of Erosion and Sedimentation Control Best Management Practices (BMP)**

The following list of BMPs are provided as a quick reference of measures to be implemented at all applicable sites regardless of proximity to watercourses, channel bed slope or soil type. These measures would be considered a first level of protection suitable in all locations and weather events.

- Adhere to the conditions of the Environment Act License and other applicable approvals.
- Modify work accordingly when seasonal and environmental influences increase the risk of wind and water erosion and sedimentation.
- Existing vegetation provides natural erosion and sedimentation control and these features should be maintained as much as possible. Make every reasonable effort to minimize disturbance by confining the work area to the predefined and staked area.
- Protect aquatic areas from sedimentation by installing and maintaining silt fences, energy dissipation and erosion control mats or other erosion control devices such as a straw blanket on disturbed slopes. Silt fences will need to be checked after rain events to ensure that they are still in place and functioning as intended.
- Replace topsoil and restore the area to the original condition (to the maximum extent possible) as soon as practical upon completion of construction using an appropriate seed mix or fast-growing cereal crops for late fall or spring germination.
- Maintain natural drainage patterns as much as possible and implement new drainage patterns as designed.
- Place excess material from the excavation in a location where it won't be a source of siltation to any wetland areas.
- Provide dust suppression as required.
- Minimize the height of stockpiles which may increase erosion through precipitation and wind.

- Construction should occur in stages to minimize dust erosion from exposed soils.
- Ensure that employees are aware of this ESC Plan and that they are trained on how to prevent erosion and siltation from happening on the project.

## 1.2 General Site Management

Erosion and sedimentation will be controlled, to the degree possible, by implementing the ESC Plan practices described in the BMPs above and by following the best site management practices below:

1. General ESC Plan practices are to be discussed with the Contractor at the start of construction and will be adhered to at all times.
2. As required by the federal *Migratory Birds Convention Act*, vegetation clearing will not be permitted from April 15 to July 31 inclusive.
3. The Contractor must ensure that employees are trained on the implementation, inspection, maintenance and repairs of ESC BMP outlined in the ESC Plan.
4. All manufactured erosion control devices will be installed and maintained in accordance with the manufacturer's recommendations.
5. Erosion and sediment control measures will be inspected at the frequency indicated below during construction and afterwards to ensure that they are functioning properly and are maintained and/or upgraded as required until vegetation has been re-established on the disturbed area.
  - Daily, informal checks during active construction and after storm events by the appointed on-site contractor personnel.
  - Weekly, formal inspections during active construction.
6. Phase construction to limit soil exposure to wind and water erosion. Stabilize exposed soils as soon as practical following construction and before commencing the next stage of construction by using protective barriers or plant materials.
7. Every reasonable effort must be made to minimize disturbance to wetlands and to retain as much of the existing plant cover as possible.
8. Maintenance of erosion control materials and structures is necessary and silt that accumulates in silt fences will be removed and disposed of in a location which is at least 100 m from any known water body, wetland or storm water drainage channel.
9. The installation of permeable sediment barriers or permanent erosion control measures, site clearing, and any earthworks such as ditch or embankment grading will occur before the removal of temporary measures.
10. All equipment on site shall be maintained free of external grease, oil and mud. Measures must be taken to ensure that gasoline, diesel fuel, grease or other deleterious substances do not enter the water body or wetland. Fuel shall be stored and equipment shall be refueled and serviced at least 100 m from any surface water. A fuel spill kit must be available for use on site in case of accidental fuel or oil spill.

11. On a daily basis the construction site must be cleared of scrap wood, excess concrete and other debris, and disturbed soils adequately protected with rip rap, vegetation or geo-fabric to prevent erosion from seasonal precipitation runoff.

The contractor(s) must be made aware of all concerns with regard to erosion and sedimentation and be given a copy of the ESC Plan. Judgment must be used to determine the most viable options for erosion prevention and sediment control considering factors such as site conditions, site access needs, and both seasonal and daily forecasted weather.

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# Vivian Sand Extraction Project

Groundwater Monitoring and Impact Mitigation Plan

EXAMPLE DRAFT

Project number: 60640258

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# Introduction

## Background

- Provide overall summary of Project (location, activities, schedule, etc.).
- Summarize previous studies and data sources.
- Describe silica sand extraction process.

## Objectives

The objectives of the Groundwater Monitoring and Impact Mitigation Plan are to:

- Describe Project activities, with a focus on site preparation, silica sand extraction, processing, stockpiling and the resultant waste streams.
- Summarize hydrogeological characteristics of each aquifer and aquitard, including an overview of groundwater flow based on the Hydrogeology and Geochemical Assessment report (AECOM 2021).
- Establish a framework for survey of existing water supply wells in advance of operations, monitoring of groundwater quantity and quality during and following project operations, and responding to well owner complaints.
- Describe protocols for monitoring surface water and groundwater quality to assess field performance against the design goals and objectives of this Groundwater Monitoring and Impact Mitigation Plan, Waste Characterization and Management Plan and the Water Management Plan.
- Establish the parameters that will be monitored, the frequency of monitoring, monitoring locations and reporting requirements.
- Identify mitigation measures to avoid and/or mitigate any well interference issues. Mitigations may include establishment of a set back distance between extraction activities and wells, modification of extraction operations to avoid impacts, lowering of pumps or provision of alternate water supply.
- Establish a framework for reporting findings to the community and regulatory agencies on a regular basis.

## Regulatory Context

- Describe regulatory setting with respect to the project and the need to monitoring and mitigate any impacts to groundwater quantity and/or quality.
- Present provincial and federal water quality criteria that will be used to assess water quality.

## Site Conditions

### Setting

- Describe natural environment including land use, climate, topography, drainage.
- Identify sensitive environmental features and receiving environments including water supply wells.

## Hydrogeology

- Describe geology and hydrogeology of Project Area.
- Describe groundwater and/or surface water quality in each aquifer/location in the Project Area.

## Groundwater Monitoring Plan

The groundwater monitoring component of this plan relies on the following components:

- Establishment of a regional and local groundwater monitoring well network consisting of monitoring wells completed in the Glacial Sediments, Red River Carbonate and Winnipeg Sandstone to facilitate monitoring of groundwater levels (groundwater quantity), and groundwater quality before, during and after operations. Proposed project activities will be evaluated in advance of each operational year to determine the zone of influence and water supply wells that may be impacted by project operations. A local groundwater monitoring well network may be installed to supplement the regional network based on proximity to project operations each year and access to existing water supply wells for monitoring.
- Conducting a water well survey within the zone of influence to determine the precise location of existing water supply wells, well construction, well condition, well performance history and water quality. Some of these wells may be utilized to expand upon the regional groundwater monitoring well network before, during and immediately following nearby project operations.
- A rigorous monitoring plan to confirm the findings of the Hydrogeology and Geochemistry Assessment (AECOM 2021) with respect to the zone of influence around project operations and any impacts on groundwater quantity and groundwater quality. Results will be evaluated by a qualified professional with experience in hydrogeology and geochemistry, with findings documented.
- Primary mitigation measures that aim to avoid impacts and secondary mitigation measures that aim to significantly reduce any impacts.

## Groundwater Monitoring Well Network

- A regional groundwater monitoring network will be established that allows monitoring of groundwater levels and water quality in the project operational area and surrounding lands.
- A local groundwater monitoring network will include existing and newly installed regional observation water wells and water wells located within the simulated zone of influence of operation subject to permission of well owners.
- Under direction from professional hydrogeologists, additional observation monitoring wells will be installed to satisfy any data gaps in the regional and local groundwater monitoring well network. The goal will be to establish a network of monitoring wells between operating extraction wells and private water supply wells to allow for early detection of impacts to groundwater quantity or quality for each year of operations and adjustment of operational procedures to avoid water supply well impacts.
- Regional observation wells will be inspected for damage during routine monitoring works (discussed below) and the need for any repairs will be identified. Regional monitoring wells will be monitored for a period of no less than five years after project completion and then decommissioned in accordance with well abandonment protocols in Manitoba.

## Water Well Survey

- Property owners within the forecast zone of influence of operations each year will be asked to participate in a Water Well Survey prior to project operations. This survey will include all property owners, including those registered in the provincial/federal water well database within a two-kilometre radius of the operational area. Results will be documented and provided to well owners for their own review and records.

- Well owners who agree to participate in the water well survey will undergo an in-person interview to discuss the history and demand of the well. They will be canvassed for input on the exact location, age, depth, pump configuration, condition, number of users, type of use and yield of water supply well(s) on their property. They will also be queried to obtain current water quality information and historical taste/odour issues. The information collected will be similar to the information collected during the fall 2020 hydrogeologic investigation domestic water well surveys.
- During the water well survey, static / pumping groundwater level measurements will be collected. Select wells will be outfitted with a pressure transducer to facilitate collection of continuous groundwater level measurements during operations if permitted by the well owner.
- A well water sample will be collected to assess the quality of the water in accordance with the monitoring plan presented below. If a sample can not be collected directly from the well due to existing pump infrastructure, a sample will be collected from a hose bib or indoor tap. The presence of water treatment (e.g. water softener, etc.) and type of plumbing (i.e. copper, PVC, etc.) will be documented to aid in interpretation of water quality results.
- Surveys will be completed starting in advance of project operations until five years after project operations within a two-kilometer radius have ended in accordance with the monitoring plan presented below. Information collected during each survey, including water level and quality results, will be provided to the well owner annually through establishment of a data sharing portal or other method.

## Groundwater Quantity and Quality Monitoring

- At minimum, monitoring of the regional monitoring wells and local water supply/monitoring wells will be completed starting prior to project development and ending five years after project completion in accordance with the monitoring plan.
- Groundwater levels and groundwater/well water samples will be collected from the regional groundwater monitoring network wells in accordance with **Table X**. Manual water level measurements will be collected quarterly to supplement continuous water level measurements using pressure transducers installed in wells that will collect data hourly. Groundwater and well water samples will be submitted to an accredited laboratory for analysis of routine drinking water parameters, as well as any project specific contaminants of concern identified in the Hydrogeological and Geochemical Assessment (AECOM 2021).

**Table X. Regional Groundwater Monitoring Frequency**

Well Type	Groundwater Monitoring and Sampling Frequency Prior to Operations	Groundwater Monitoring and Sampling Frequency During Operations	Groundwater Monitoring and Sampling Frequency for Years 1-3 Post-Operations	Groundwater Monitoring and Sampling Frequency for Years 4-5 Post-Operations
Regional Observation Well Network	Quarterly	Quarterly	Quarterly	Semi-annually
Water Supply Wells Within Simulated Zone of Influence	Semi-annually	Quarterly	Semi-annually	Semi-annually

- During operations, a more detailed local-scale monitoring program will be completed at select monitoring locations in conjunction with the regional program. Detailed monitoring locations will be selected in conjunction with a professional hydrogeologist to allow for early detection of potential issues and implementation of

mitigative actions. This program will include an increased monitoring frequency (e.g. monthly) and groundwater samples will be analyzed for a larger suite of analytical parameters.

# Impact Mitigation Plans

- **Table X** below presents the mitigation measures that will be put in place during site development, operation and five years post-operation. Mitigation measures will be assessed and proactively be applied following review of routinely collected groundwater monitoring data and/or receipt of any complaints from the public.

**Table X. Mitigation Measures and Triggers**

Impact	Trigger for Application of Mitigation Measure	Mitigation Measure
Low Groundwater Levels in Regional Observation Well Network	Measured water levels in Regional Observation Well Network decrease to levels below established thresholds that have the potential to exceed well-specific Safe Available Drawdown in nearby private water wells.	<p>Water level information evaluated quarterly by qualified hydrogeologist, with results shared publicly.</p> <p>Proactively adjust location and number of extraction wells, or rate of sand extraction to reduce impact of operations on water levels in nearby private water wells so they do not exceed Safe Available Drawdown.</p> <p>Private Well Owners notified in the event there are deemed to be risks to water quantity in private wells.</p> <p>In extreme cases, provide potable water to any affected parties via certified water purveyor until the situation is assessed and rectified if impacts deemed related to Project operations.</p>
Low Groundwater Levels / Inadequate Yield in Private Water Wells	<p>Measured water levels in private water wells decrease to levels that exceed well-specific Safe Available Drawdown in nearby private water wells.</p> <p>Public complaints specific to changes in water supply well performance.</p>	<p>Water level information from monitored private wells evaluated by qualified hydrogeologist, with results shared directly with well owner.</p> <p>Reduce number of sand extraction wells that are operating concurrently, and/or the rate of extraction to reduce impact of operations on water levels in nearby private water wells so they do not exceed Safe Available Drawdown.</p> <p>In extreme cases, provide potable water to any affected parties via certified water purveyor until the situation is assessed and rectified if impacts deemed related to Project operations.</p>
Degraded Groundwater Quality in Regional Observation Well Network	Water quality in Regional Observation Well Network significantly degraded relative to measured water quality prior to operations. Newly identified exceedances of applicable regulatory criteria based on water use.	Water quality evaluated quarterly by qualified hydrogeologist and/or geochemist, with results shared publicly.

Private Well Owners notified in the event there are deemed to be risks to water quality in private wells.

Potable water will be provided to the affected party via certified water purveyor while the situation is assessed and rectified if impacts deemed related to Project operations.

Degraded Groundwater Quality in Private Water Wells

Water quality in Regional Observation Well Network significantly degraded relative to measured water quality prior to operations. Newly identified exceedances of applicable regulatory criteria based on water use.

Public complaints specific to changes in water quality, taste or odour of well water.

Water quality information from monitored private wells evaluated quarterly by qualified hydrogeologist and/or geochemist, with results shared directly with well owner.

Potable water will be provided to the affected party via certified water purveyor while the situation is assessed and rectified if impacts deemed related to Project operations.

## Well Interference Response Plan

- A well interference response plan will be developed and presented in flowchart format to guide mitigation and management of well owner complaints related to well interference and water quality changes. The plan will be developed and with the province for input prior to finalization of the plan. A website, email address and/or telephone number will be maintained for registration of any complaints.

## Annual Reporting

- Annual monitoring reports that interpret impacts from operations on water quantity and quality will be prepared.
- Water quality results will be compared to applicable criteria, with any exceedances flagged.
- Time series plots of water levels in the Regional Observation Well Network will be summarized.
- Private well owner complaints will be summarized and any corrective actions will be documented.

# Appendix A Document copies

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# Vivian Sand Extraction Project

Waste Characterization and Management Plan

EXAMPLE DRAFT

Project number: 60640258

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# Introduction

## Background

- Provide overall summary of Project (location, activities, schedule, etc.).
- Summarize previous studies and data sources.
- Describe silica sand extraction process.

## Objectives

The objectives of this Waste Characterization and Management Plan are to:

- Describe Project activities, with a focus on site preparation, silica sand extraction, processing, stockpiling and the resultant waste streams.
- Summarize characteristics of each type of waste material that will be extracted based on the Hydrogeology and Geochemical Assessment report (AECOM 2021), literature and laboratory testing.
- Describe protocols for identifying, sampling, characterizing and managing waste materials to minimize the risk of ML/ARD and incremental impacts to the environment by following protocols consistent with industry standards.
- Define appropriate end uses for each type of waste material based on the volume of waste material generated, degree of characterization, geochemical classification (PAG, Uncertain, Non-PAG, ML, etc.), understanding of its geochemical behaviour and the intended end use.
- Describe measures that can be implemented to mitigate ML/ARD and incremental impacts to the environment.
- Describe protocols for monitoring surface water and groundwater quality to assess field performance against the design goals and objectives of the management plan.

## Regulatory Context

- Describe regulatory setting with respect to management of waste materials and protection of groundwater and surface water quality.

## Site Conditions

### Setting

- Describe natural environment including climate, topography, drainage.
- Identify sensitive environmental features and receiving environments.

### Geology and Mineralogy

- Describe surficial geology, bedrock geology and mineralogy.

## Groundwater and Surface Water

- Describe existing groundwater quantity or refer to EAP / Hydrogeology and Geochemistry Assessment documents.
- Describe existing groundwater quality and surface water quality or refer to EAP / Hydrogeology and Geochemistry Assessment documents.

## Waste Materials

The following waste materials will be generated during the operation:

- Quaternary Sediments
- Red River Carbonate
- Winnipeg Shale

The estimated volume of each type of waste material generated over the first five years of operation are summarized in **Table A**.

**Table A. Estimated Waste Material Production by Waste Type**

Lithology <sup>1</sup>	Assumed Thickness		Borehole Diameter		Extraction Wells (total number)	Estimated Volume of Waste <sup>2</sup>	
	(ft)	(m)	(inches)	(m)		(m <sup>3</sup> /well)	(m <sup>3</sup> )
Quaternary Sediments	118	36	16	0.406	1,680	4.66	7,830
Red River Carbonate	43	13	10	0.254	1,680	0.66	1,107
Winnipeg Shale	10	3	10	0.254	1,680	0.15	255

Notes:

1. Winnipeg Sandstone will not be a waste stream.
2. No bulking factor applied to volumes.

Based on the results of the Hydrogeology and Geochemistry Assessment (AECOM 2021), the materials were classified as follows:

- Red River Carbonate: Non-PAG (3 samples)
- Winnipeg Shale: Uncertain (2 samples) or Non-PAG (1 sample)
- Winnipeg Sandstone: Non-PAG (3 samples)

Shake Flask Extraction (SFE) results indicated the potential for elevated concentrations of aluminum, selenium, arsenic and uranium in one or more samples.

AECOM recommended additional characterization and monitoring during Project operations to confirm the geochemical findings and direct management of waste materials during operations. Until those findings have been confirmed, AECOM recommended that waste comprised of the Red River Carbonate and Winnipeg Shale be managed conservatively in accordance with this Waste Characterization and Management Plan. This approach is routinely employed during mining of metals, coal and industrial minerals, including several mines in Manitoba.

# Waste Characterization Plan

Determine ML/ARD potential and if applicable, the timing for each type of waste materials and the deposition conditions which they will be exposed.

## Sampling Methodology

- Describe sampling methodology for waste materials during project activities with focus on drilling of extraction wells, which will produce the largest volume of waste material.
- Describe visual observations and borehole logging protocols for inspection of drill cuttings during operations.
- Describe sample selection procedures to ensure collection of representative samples for geochemical testing in the laboratory, or field testing to evaluate the geochemical behaviour of each rock type under field conditions.

## Sampling Frequency

- Establish sampling frequency for each waste material based on understanding of geochemistry of each waste type and spatial distribution of extraction wells across the Project Area.
- Provide minimum number of samples that should be collected and analyzed to adhere to industry standard of one sample per 1,000 m<sup>3</sup> (or 3 samples per 10,000 tonnes) of each type of waste material until geochemistry is well understood and has been characterized across the Project Area.
- Establish criteria for reduction in sampling frequency for waste materials classified as PAG, Non-PAG or prone to metal leaching. Any reduction in the sampling frequency will require evaluation of data by a qualified hydrogeologist or geochemist with expertise in ML/ARD.
- Sampling frequency for each waste type should be further reduced once geochemical condition and spatial variations are evaluated.

## Laboratory Testing

- Establish laboratory testing program for each waste material based on understanding of geochemistry of each waste type that considers needs for static testing and kinetic testing. Draft static testing program below.
- Provide rationale for laboratory testing program. Draft kinetic testing program below.

The recommended static geochemical testing for each waste material is summarized in **Table B**. After enough samples have been collected to satisfy the recommended sampling frequency, the laboratory testing requirements may be adjusted according to recommendations of a qualified hydrogeologist or geochemist with expertise in ML/ARD.

**Table B. Recommended Geochemical Testing for Each Waste Type**

Waste Type	Total Metals	ARD/ML Potential	Mineralogy	Whole Rock Analysis	Acid-Base Accounting (ABA) Test	Shake Flask Extraction (SFE) Test
Quaternary Sediments	Yes	Low	No	No	Yes	Yes
Red River Carbonate	No	Low	No	No	Yes	Yes
Winnipeg Shale	No	High	Yes	Yes	Yes	Yes

If static tests indicate waste material has strong potential to generate acid and/or leach metals, kinetic tests will be recommended to support refinement of previous assessments, reaction rates and drainage chemistry. The goal of the kinetic tests is to develop site-specific operational parameters and threshold values for waste classification (i.e., PAG/Non-PAG), so that waste material can be characterized using simple field and laboratory methods to guide proactive management of waste. At a minimum, the following kinetic tests will be conducted:

- **Laboratory Column Tests:** Column tests are designed to allow contaminants released from primary minerals to precipitate at their natural rates as secondary minerals. Column tests provide a more accurate measure of drainage chemistry and can be conducted over an extended period, if required. Column tests may be modified to simulate the effects of site-specific climate conditions and mitigation measures such as covers and amended waste materials.
- **In-Situ Field Tests (i.e. Field Bins):** Field bins allow for field-based kinetic tests and are used to monitor ML/ARD behaviour under site-specific field and weathering conditions. Field bins may contain a single parent material or be constructed to evaluate composite materials. After the field leach bins are setup, natural precipitation is allowed to pass through the bins and accumulate in the leachate collector. Water samples are periodically collected and submitted for laboratory analysis.

# Waste Management

## Waste Classification and Management

- This section will describe appropriate end uses for each waste material based on their level of characterization, geochemical classification (PAG, Uncertain, Non-PAG, High-ML, Low-ML, etc.), understanding of geochemical behaviour based on laboratory and field testing, desktop evaluation and volume. Draft description below.

Waste materials will be visually classified at the time of extraction by a qualified geologist, hydrogeologist or geochemist with expertise in geology, mineralogy and ML/ARD. Field classification of waste materials will follow criteria established based on a combination of laboratory static testing (ABA, SFE, whole rock and mineralogy) and kinetic testing (laboratory column testing and in-situ field tests). The consistency of materials with previously characterized bedrock, and the results of any additional geochemical testing will be considered.

Based on the results of ABA testing, waste materials will be classified as either PAG, Uncertain or non-PAG. PAG is defined as having  $NPR < 1$ . Non-PAG is defined as having  $NPR > 2$ . Uncertain is defined as having  $1 < NPR < 2$ . Site-specific screening criteria may be developed if kinetic tests are conducted.

Based on the results of SFE testing and water quality sampling, waste materials will be classified based on their potential for metal leaching (i.e. either Low-ML or High-ML). High-ML materials include those for which SFE results and/or water quality monitoring results from kinetic tests exceed applicable toxicity-based water quality criteria for one or more constituents. Low-ML waste materials include those that do not exceed applicable criteria.

All waste materials will be conservatively managed as PAG until they have been adequately characterized and classified as Non-PAG and Low-ML.

The development, implementation, and assessment of the ARD management plan should follow the sequence of steps illustrated in the flowchart in **Figure A**.

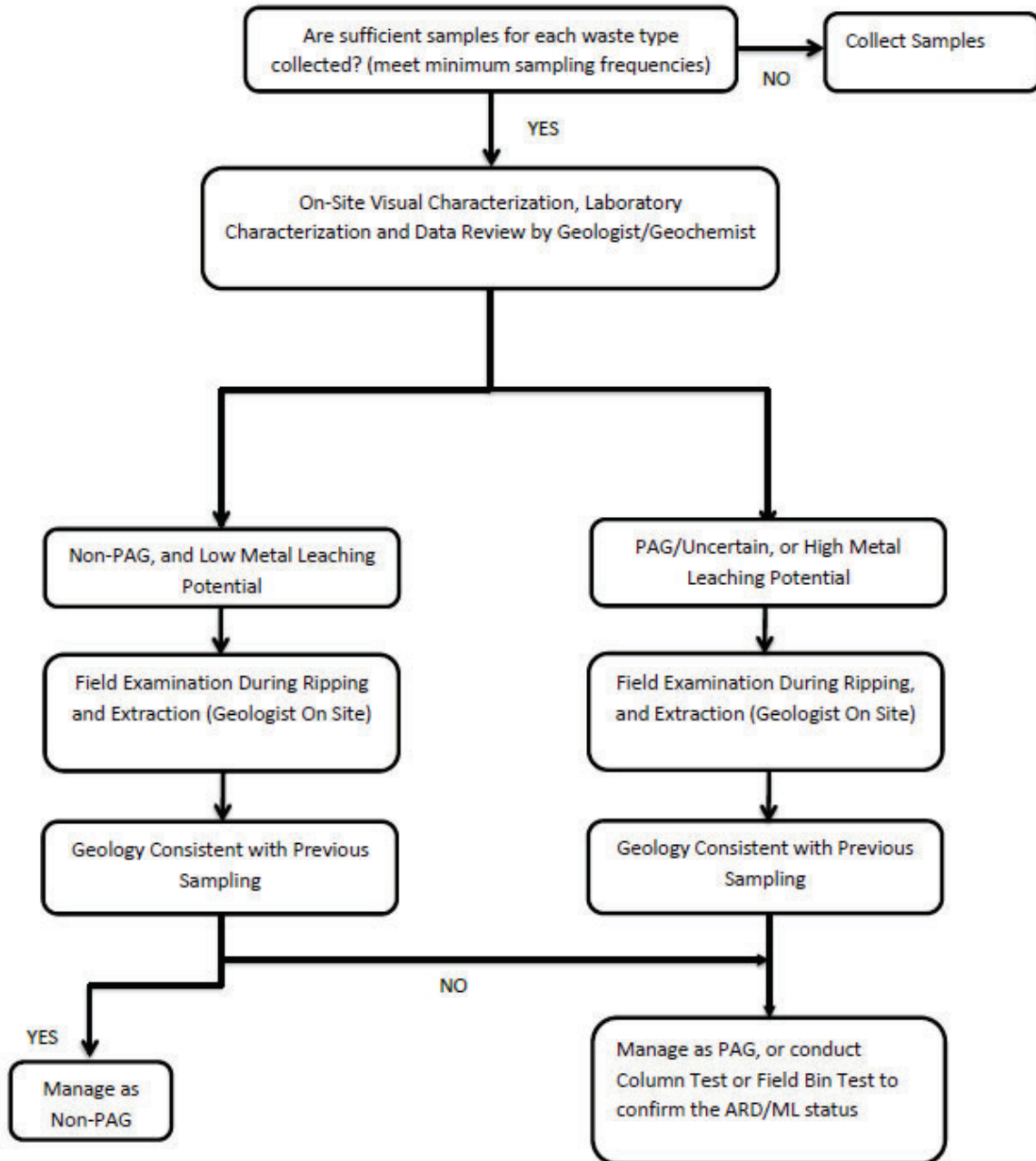


Figure A. Decision Matrix for Management of Waste Material

\* PAG is not to be crushed, or placed outside the footprint of perimeter drainage ditches. It must remain within the footprint of the turbine laydown area from which it originated. It is not to be used for erosion protection of drainage ditches unless it has been confirmed to be non-PAG. It should be buried with non-PAG soil or rock wherever possible.

## Mitigation Measures

All material classified as PAG, Uncertain or High-ML will be conservatively managed in a lined repository or by application of other mitigation measures as described below.

All waste materials that are classified as PAG or have high potential for metal leaching (High-ML) will be segregated from non-PAG, flagged, and labelled as PAG. The following mitigation measures may also be applied to preserve water quality:

- Avoid spreading the potential PAG materials.
- Divert surface water around waste stockpiles.
- Restrict infiltration into PAG waste piles to reduce leachate generation using tarps, liners or covered storage areas.
- Restrict ingress of oxygen and/or moisture to restrict ML/ARD processes.
- Offset acid potential through the addition of neutralization potential in the form of amendments or suitable geologic materials.
- Treat effluent using passive or active treatment methods.

Mitigation measures will be developed and prescribed by a qualified hydrogeologist or geochemist with expertise in characterization and management of ML/ARD.

All waste materials classified as Non-PAG or Low-ML will be:

- Segregated from PAG, flagged and labelled as Non-PAG if stockpiled.
- Permitted for unrestricted use within the Project area.

## Monitoring

The effectiveness of mitigation measures should be verified through monitoring of soil quality, surface water and groundwater quality in proximity to any waste deposits or stockpiles. Sampling should be conducted at regular intervals during the open water season (i.e. spring, summer, fall months) during Project operations. The need for ongoing monitoring of field-based kinetic tests (i.e. field bins) will be evaluated and incorporated into the geochemical monitoring program. Further, the need for any monitoring following closure will be evaluated after additional geochemical testing has been completed and based on the results of operational monitoring. Water quality should meet applicable drainage discharge criteria and permit/approval requirements. This Waste Characterization and Management Plan should be updated regularly based on geochemical testing and geochemical monitoring results.

## Annual Reporting

- Annual monitoring reports will be prepared that compare soil quality, surface water quality and groundwater quality in proximity to any waste piles to applicable criteria, with any exceedances flagged. Reports will also summarize the results of any geochemical testing (static or kinetic), the volume of waste generated each year by waste material type. Any recommended changes to the monitoring program will be summarized.

# References

Key references will include:

- Global Acid Rock Drainage Guide (GARD Guide). 2018. International Network for Acid Prevention (INAP), ([www.gardguide.com](http://www.gardguide.com)). 473 pp.
- Price, W.A. 2009. Prediction manual for drainage chemistry from sulphidic geologic materials. MEND Report 1.20.1. Mine Environment Neutral Drainage Program (MEND), CANMET-Mining and Mineral Sciences Laboratories, British Columbia, Canada. 579 pp.

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# Vivian Sand Extraction Project

Water Management Plan

EXAMPLE DRAFT

Project number: 60640258

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# Introduction

## Background

- Provide overall summary of Project (location, activities, schedule, etc.).
- Summarize previous studies and data sources.
- Describe silica sand extraction process.
- Describe how water will be managed during operations and closure phases of Project.

## Objectives

The objectives of the Water Management Plan are to:

- Establish objectives for management of water during operations and closure pertaining to management of surface water, groundwater, slurry and process water contained in the plant and slurry lines. It will include separation of contact/non-contact water and management of sediment-laden water related to Project operations.
- Describe Project activities, with a focus on site preparation, silica sand extraction, processing, stockpiling, the resultant flow of water, solids and/or slurry, the volume of storage vessels and the expected volume of water reinjected into the aquifer. The volume of water required to commission the slurry system each year will be provided.
- Describe the operational management strategy for water and solids during operations and closure phases of the Project. Inputs to the water balance, storage volumes and outputs will be identified for Extraction Mobile Equipment and Permanent Equipment systems.
- Establish a framework for monitoring of water, solids, and slurry flow during and following project operations to assess field performance against the design goals and objectives of this Water Management Plan.
- Establish the parameters that will be monitored, the frequency of monitoring, monitoring locations (e.g. pumping rates, groundwater use, reinjection rates).
- Identify best management practices for the management of water, solids, slurry and sediment during Project operations and closure to ensure groundwater and surface water resources are preserved.
- Establish a framework for reporting findings to the community and regulatory agencies on a regular basis.

## Regulatory Context

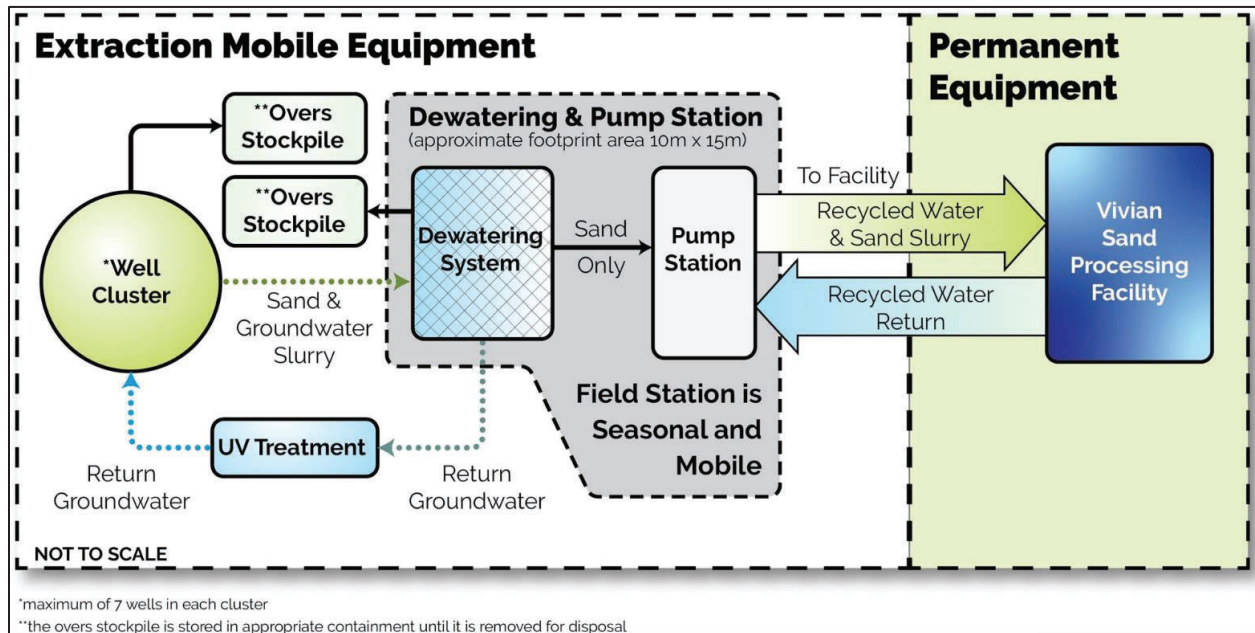
- Describe regulatory setting with respect to the project and the need to monitor water flows and mitigate any impacts to surface and groundwater quantity and/or quality.

## Setting

- Describe natural environment including land use, climate, topography, drainage.
- Identify sensitive environmental features and receiving environments including surface water features, ditches, ponds, wetlands and water supply wells including any delineated capture zones.

# Water Balance

- Project flow during seasonal operations and closure.
- Provide process flow diagram annotated with storage quantities for Extraction Mobile Equipment and Permanent Equipment.
- Classify water as either Contact Water, Non-Contact Water or fines management.



## Extraction Well System

Approximately 54 m<sup>3</sup>/day (10 U.S. gpm) of water from the extraction activities per cluster remains with the sand as it enters the slurry loop system because the dewatering system at the extraction site will not remove 100% of the water from the extracted sand. The sand will remain wet as it enters the slurry loop system.

## Slurry Loop System

The slurry loop system needs approximately 1,325 m<sup>3</sup> (350,500 U.S. gallons) of water to operate. This is a gradual one-time groundwater draw volume to fill the system the first time the system is started up. During the winter months, the water in the system will be drained into storage tanks located at the Processing Facility site for re-use the following year.

## Sand Processing Facility

- Describe water and solids balance for processing facility.
- Provide process flow diagram for water and solids.

## Water Treatment and Reinjection System

The groundwater separated from the sand at the dewatering station then passes through a UV treatment system before being immediately returned to the extraction well and to the Winnipeg Sandstone aquifer that the groundwater was originally extracted from.

# Water Management

## Infrastructure

- Present figures depicting movement of water, solids and slurry around the Project Area.
- Describe infrastructure components including estimated inputs (precipitation, snowmelt, water supply wells, slurry, etc.), conveyance lines, storage vessels and outputs (evaporation, residual moisture in sand, reinjected water, etc.).
- Describe monitoring locations for verification of water levels, flows, volumes, etc. to inform regular updates to water balance.

## Water and Sediment Controls

A variety of controls will be employed to ensure water and sediment are managed in a way that is protective of groundwater and surface water resources including the following:

- **Drainage Controls:** These will aim to convey non-contact surface runoff away from impacted or working areas and collect and manage high sediment and contact water separately.
- **Erosion Controls:** These will aim to control erosion and sediment transport at the source.
- **Sediment Controls:** These will aim to capture and retain sediment being transported by water by promoting ponding and associated sedimentation processes downstream of areas where erosion may occur.
- **Contact Water Storage:** These will aim to store water from the slurry loop system and within the processing facility, including any sediment control ponds prior to treatment and/or direct release. This will also minimize the consumptive use of water as part of the Project.
- **Water treatment:** These will aim to treat all contact water that will be reinjected to the groundwater aquifer.

Specific application of controls to be discussed in future plans and shown on key plan maps.

# Water Monitoring Plan

The water monitoring component of this plan relies on the following components:

- Establishment of a groundwater and surface water monitoring network consisting of flow meters, and water level monitoring devices to facilitate monitoring of water levels, pressures, stored quantity and flows during and after seasonal extraction operations.
- Routine monitoring of the volume of sand extracted to allow for an assessment of groundwater reinjection efficiency.
- Routine inspections of water management infrastructure including extraction facilities, mitigation measures, conveyance piping, storage volumes, etc.
- A rigorous water monitoring plan to confirm the findings of the Hydrogeology and Geochemistry Assessment (AECOM 2021) with respect to the effective pumping rate from each extraction well and the resultant zone of influence around project operations to confirm the magnitude and extent of any impacts on groundwater quantity. Results will be evaluated by a qualified professional with experience in hydrogeology and geochemistry, with findings reported to the community on a regular basis.
- Primary mitigation measures (Best Management Practices) that aim to avoid impacts and secondary mitigation measures that aim to significantly reduce any impacts.

# Annual Reporting

- Annual monitoring reports that present the monthly water and solids balance from operations will be prepared.
- Performance of Best Management Practices and other mitigation measures will be assessed.
- Any proposed changes to the sand extraction well footprint and water management procedures will be evaluated and adjustments to the monitoring plan will be recommended.
- Community complaints will be summarized and any corrective actions will be documented.

# Appendix A Document copies

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