Best Management Practices for Aggregate Pit and Quarry Rehabilitation in Ontario

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Table of Contents

Acronyms and Initialisms

ARA: Aggregate Resources Act

BMP: best management practice

BRAT: Beneficial Reuse Assessment Tool

CA: Conservation Authority

GHG: greenhouse gas

GW2: Exposure pathway due to inhalation of indoor air containing soil vapour from groundwater at water table

I/C/C: Industrial/Commercial/Community

MassDEP: Massachusetts Department of Environmental Protection

MECP: Ministry of the Environment, Conservation and Parks

MPCA: Minnesota Pollution Control Agency

MNRF: Ministry of Natural Resources and Forestry

QC: Quality control

QP: Qualified person as defined by *O. Reg. 153/04*

R/P/I: Residential/Parkland/Institutional

S-GW: Soil to groundwater exposure pathways

S-GW2: Exposure pathway due to the leaching of a contaminant from soil to groundwater and then moved with groundwater and migrated to indoor air as a vapour.

Executive Summary

This document was developed by the staff and members of the Ontario Society of Professional Engineers (OSPE), with support from the OSPE Excess Soil Project Steering Committee, and was funded by the Ontario Ministry of Environment, Conservation and Parks (MECP), through a Transfer Payment Agreement (TPA), however the MECP or the province of Ontario does not endorse any content, recommendation or opinion found in this document.

This document presents a set of best management practices (BMPs) for the rehabilitation of pits and quarries in Ontario by backfilling with excess soil. The BMPs may be applied to the rehabilitation of licenced and unlicenced aggregate sites. The BMPs are intended to assist Qualified Persons (QPs), municipalities, aggregate licensees, and operators in evaluating options for using excess soils to rehabilitate pits and quarries in a safe, economically viable, and climate positive manner.

The BMPs recommend consideration of a "layer-cake" approach to site rehabilitation, which may allow for placement of soil meeting one or more generic volume independent soil quality standards under certain circumstances. It is recommended that the selection of the generic standards be conducted by QPs who are aware of the underlying assumptions and limitations of the generic model. Table 1 standards (i.e., background condition standards) remain appropriate as a default reference standard and are required in settings described by the regulations (e.g., sites located in an environmentally sensitive area). The Beneficial Reuse Assessment Tool (BRAT) may be an appropriate tool for deriving site-specific standards for pits and quarries. However, QPs should be aware of the limitations of the BRAT, and the circumstances in which the standards derived using the BRAT may not be adequately conservative.

The BMPs include a discussion of potential adverse impacts at pits and quarries that are not specifically addressed by *O. Reg. 406/19* and associated rules such as biological contaminants, invasive species, impacts to the visual appearance of groundwater (e.g., turbidity), soil erosion, noise, and dust. While these adverse impacts are not limited to pit and quarry rehabilitation and may be present in other excess soil reuse projects, they require special attention in the context of pit and quarry rehabilitation given their setting and the relatively large quantities of imported soil that are anticipated.

Depending on site licence status, placement of excess soil at pits and quarries is conditional on compliance with applicable municipal bylaws and/or the *Aggregate Resources Act* (ARA). The BMPs recommend that community engagement and public consultation be undertaken prior to placement of excess soil at unlicenced sites, and best practices for community engagement and public consultation are presented. Finally, the BMPs provide discussion of

climate change mitigation and adaptation considerations as they relate to the placement of excess soil at pits and quarries.

1. Background

The Ontario Ministry of the Environment, Conservation and Parks (MECP) announced *On-Site and Excess Soil Management Regulation (O. Reg. 406/19)* and the accompanying rules in 2019, with several amendments made in 2020. The regulation excludes products leaving a pit or quarry but may be applicable to the import of fill for rehabilitation. Though the regulation, associated rules, and *Rationale Document for Development of Excess Soil Quality Standards* include practices and concepts that could benefit pit and quarry operations and rehabilitation, the aforementioned documents were not developed with specific consideration to a pit and quarry setting. Therefore, applying the regulation to pit or quarry rehabilitation requires consideration of potential deviations from the generic conceptual model.

This document summarizes best management practices (BMPs) for rehabilitating aggregate pits and quarries by backfilling with excess soil. This includes a discussion of MECP generic standard tables that are considered applicable to pits and quarries, as well as the common issues in pit or quarry rehabilitation not specifically addressed by *O. Reg. 406/19* or the associated *Rules for Soil Management and Excess Soil Quality Standards*. This document complements existing regulations and standards, including the *Aggregate Resources Act*, *O. Reg. 406/19*, *O. Reg. 153/04* and *Rules for Soil Management* (*Soil Rules)*, and does not supersede any provincial regulation or municipal bylaw. This document is extracted from the *Scientific Report: Beneficial Reuse of Excess Soil at Aggregate Pits and Quarries (Scientific Report)* also by OSPE and is prepared for guidance purposes only and not intended to be a substitute for the reader reviewing all applicable regulations and rules. The reader can find further details about the literature review, jurisdictional overview, and the theory behind the BMP recommendations in the aforementioned *Scientific Report*.

1.1. Definitions

Some of the more important definitions that apply to this document are presented below for convenience. Readers are encouraged to review the relevant regulations for the official (complete) definitions.

- **Climate change adaptation:** The process of adjustment to actual or expected climate and its effects, to moderate harm or exploit beneficial opportunities (as defined by the Intergovernmental Panel on Climate Change).

- **Climate change mitigation:** All human interventions to reduce emissions or enhance the sinks of greenhouse gases (as defined by the Intergovernmental Panel on Climate Change).
- **Excess soil:** Soil, or soil mixed with rock, that has been excavated as part of a project and removed from the *project area* for the project (as defined by *O. Reg. 406/19*).
- **Licensee:** The person or company (and its successors and assigns) to whom the Aggregate Resources Act licence is issued.
- **Qualified Person (QP):** A Professional Geoscientist, a Professional Engineer or an experienced risk assessment professional as defined in Sections 5 or 6 of *O. Reg. 153/04,* respectively.
- **Reuse site:** For the purposes of this document, an aggregate pit or quarry at which excess soil is used for a beneficial purpose and does not include a waste disposal site.
- **Responsible person:** A person determined by the owner/operator of the reuse site, who controls access to the site and should be trained on screening measures, tracking requirements, and procedures for accepting and rejecting soil.
- **Soil Rules:** Part I of the MECP *Rules for Soil Management and Excess Soil Quality Standards.*
- **Source site** (or *project area*): A single property or adjoining properties on which a project is carried out and from which excess soil is generated.
- **Table 1**: Generic standards set out in "Table 1. Full Depth Background Site Condition Standards" in Part II, Appendix 1 of *Rules for Soil Management and Excess Soil Quality Standards* published by the MECP and dated December 8, 2020.
- **Tables 2.1 to 9.1**: Generic standards set out in Part II, Appendix 1 of *Rules for Soil Management and Excess Soil Quality Standards* also known as the volume-independent standards, published by the MECP and dated December 8, 2020.
- **Topsoil**: Horizons in a soil profile containing organic material, commonly known as the O and the A horizons, and including deposits of partially decomposed organic matter such as peat, as defined by *Municipal Act, 2001*.

1.2. Management of excess soil

Excess soil generation is inevitable during most construction projects. It is estimated that up to 25 million m^3 of excess soil is generated in Ontario annually. Excavated soil should be reused within the *project area* wherever possible. However, this is not always an option, and excess soil often needs to be removed from the *project area*.

The MECP (2016) published a BMP for management of excess soil, and this was followed by *O. Reg. 406/19* and associated rules document to define soil as a resource and provide greater clarity around when soil is a waste.

Management of excess soil has frequently been an afterthought associated with construction projects. A lack of a proactive plan to deal with excess soil often results in an increase in project time and cost. The intention is that with proper planning, excess soil will be beneficially reused at an appropriate reuse site, only going to landfill as a last resort.

Prior to the filing of *O. Reg. 406/19*:

- Municipalities have been reluctant to receive excess soil from outside their boundaries. This is understandable because many municipalities may not have the resources or expertise to develop and implement bylaws to mitigate potential liabilities associated with poorly managed excess soil.
- Many responsible soil generators and/or prospective reuse sites have been cautious about beneficially reusing soil due to a lack of clarity around when soil is a waste, and so the default in many cases was to manage soil exceeding *O. Reg. 153/04* Table 1 background site condition standards as waste.

Disposal of soil at provincially approved landfill sites is expensive and often requires trucking soil relatively long distances – contributing to GHG generation and wear and tear on roads. Landfill space continues to decline and/or require greater hauling distances. Disposal of soil at landfill that could otherwise be reused (i.e., soil of relatively good quality), consumes capacity that our communities require to manage waste. A scarcity of appropriate reuse sites and the evolving standard of care to characterize soil quality prior to movement (e.g., sampling and analyses) are not inexpensive endeavours. However, these costs should be lower than disposal at landfill in the long run, while also managing the risks (and associated costs) of poorly managed (or illegally dumped) excess soil.

1.3. Aggregate operations

Aggregate is an important material to the construction and infrastructure industry. Construction aggregate, commonly referred to as sand/gravel and crushed stone, is extracted from pits and quarries, respectively. The difference between pits and quarries lies in the type of material extracted and, hence the associated extraction methods. A pit is an area from which unconsolidated aggregate, such as sand/gravel, is excavated. The product of a quarry, on the other hand, is crushed stone (or building stone) aggregate derived from bedrock such as limestone and granite. Unlike a pit, it is a common practice to use blasting for material extraction in a quarry. In this document, pits and quarries are differentiated by licenced (active) sites and unlicenced (typically inactive)[1] sites.

1.3.1. Licenced pits and quarries

There are more than 6,000 active pits and quarries in Ontario. Approximately, 3,600 of these sites are operating on private land in designated areas operating under a 'licence', and 2,500 are located on Provincial Crown land operating under a 'permit'. The annual consumption of aggregates in Ontario is estimated to be approximately 170 million tonnes.

Pits and quarries are typically located close to urban areas to reduce transportation costs. If not well sited, designed, and operated, pits and quarries may negatively impact neighbouring ecosystems and communities. Examples of potential negative impacts are contributing to erosion and loss of topsoil, causing noise pollution, contaminating soil, contaminating surface water and groundwater, and introducing invasive species. These issues, especially groundwater protection, require attention, as groundwater is a significant source of potable water for many communities in Ontario. These are all reasons why aggregate operations have been regulated in many jurisdictions around the world.

Regulations in Ontario require aggregate operation owners/operators to minimize potential adverse effects during operation and commit to a closure plan which defines how a pit or quarry operation will be rehabilitated by the end of its useful life. While there are many rehabilitation options, the focus of this BMP document is aggregate operation closure plans that commit to, or allow for, backfill using imported soil. Given the volumes of soil imported, the rehabilitation process can pose short- and long-term impacts to humans, animals, and plants without appropriate planning and management.

Most short-term impacts are associated with trucking backfill material and are typically limited to the time of operation or rehabilitation of the aggregate site. Among the most common operational concerns are noise, dust, ground vibration, tracking of soil onto roadways, and road congestion. However, these concerns are also associated with the production and trucking of aggregate.

Potential long-term impacts may extend beyond the final aggregate site closure. These impacts arise from the potential for contamination of soil, groundwater, and/or nearby surface water. Among the more significant potential long-term impacts are:

[1] Unlicenced sites can also be fully active where they are not regulated under the ARA (see Table A for a more detailed categorization).

- Surface water quality interference
- Groundwater water quality interference
- Air emissions and/or vapour intrusion
- Contamination of soil
- Contamination of flora and fauna (i.e., bioaccumulation and/or biotransformation)
- Introduction of invasive species

Efforts have been made by different government levels and the aggregate industry to limit these impacts as much as possible. Since the introduction of the *Aggregate Resources Act* (*ARA*), both the solutions provided by the aggregate industry to address these issues as well as the regulatory frameworks have evolved considerably.

1.3.2. Rehabilitation of licenced pits and quarries

Provincially regulated pits and quarries are under the jurisdiction of the Ministry of Natural Resources and Forestry (MNRF*)*. These sites are regulated by the *ARA*, which applies to private land in geographically designated parts of Ontario. A site plan is prepared as a component of an *ARA* licence application, and, when the licence is approved, the site plan becomes a legally binding requirement on the licensee and the site operator(s). A site plan prescribes how an aggregate site will be developed, operated, and monitored to ensure that adverse impacts to humans and the environment are limited. The site plan also prescribes how the aggregate extraction site will be rehabilitated during, and at the end of, its aggregate production period.

The *ARA* definition of rehabilitation indicates that the land must be treated in such a way that it is either restored to its original condition or its condition is changed but compatible with neighbouring lands. Rehabilitation does not begin at the end of an aggregate operation's useful life. The *ARA* emphasizes the need for progressive rehabilitation and states that "*every licensee and every permittee shall perform progressive rehabilitation and final rehabilitation on the site.*" The excess soil regulation is interpreted to apply in circumstances where excess soil is brought to a site for rehabilitation. Elements of the excess soil regulation may not apply in circumstances where an instrument (e.g., site plan) defines alternate soil quality and/or quantity limits for imported material.

While rehabilitation strategies are diverse, there are general conventions. Generally, pits and quarries excavated below the water table will be predominantly converted to ponds and lakes, whereas those above the water table will have more opportunities for commercial, residential, recreational, or agricultural use, or naturalized upland habitats (e.g., reforestation). According to the MNRF (2020) statistics, there are 967 active pits and quarries that extract material from below the water table, which constitutes approximately 19% of all active sites in Ontario.

Between 1990 and 2008, more than 450 hectares of *ARA*-licenced pits and quarries were rehabilitated to different final uses in Ontario. The most common final covers include agricultural land and natural areas (e.g., forests, wetlands or alvars). The post-rehabilitation land use and final cover are indicated in the site plan and developed in accordance with the *ARA*, public and agency review processes; and finally, consultation with, and approval by, the MNRF. Pits and quarries to be rehabilitated by backfill will typically identify the quantity and/or quality of the backfill material to be used in the site plan[2] where such information is available at the time.

1.3.3. Unlicenced pits and quarries

Unlicenced pits and quarries are sites not regulated under the *ARA* or by the MNRF. These types of sites fall into two categories: formerly licenced sites for which the licence has been 'surrendered' (i.e., cancelled); and abandoned or legacy sites (See Table A). Since the *ARA* is not applicable to unlicenced pits and quarries, the land use activity that occurs on them is governed by the local municipality, usually through its zoning bylaw[3]. For example, if an owner wants to change the land use of a formerly licenced (now surrendered) pit or quarry, they would typically work through the municipality for a (re-)zoning review. The rehabilitation of these 'surrendered' pits and quarries will have been approved by MNRF and undertaken in accordance with the site plan.

Abandoned pits and quarries, also called legacy pits and quarries, are pits and quarries for which an *ARA* (or predecessor legislation) licence was never in force at any time. In other words, they have never been licenced under the *ARA*. There are approximately 8,000 abandoned pits and quarries in Ontario.

The Ontario Aggregate Resources Corporation (TOARC), which derives its authority from the *ARA*, is responsible for the selective rehabilitation of abandoned pits and quarries through the *Management of Abandoned Aggregate Properties (MAAP)* program, and their rehabilitation costs are paid via the *Abandoned Pits & Quarries Rehabilitation Fund*. Rehabilitation of this class of pits and quarries can be challenging given that information about them is limited

[2] This is only the case for more recent (post-1997) site plans, and there will be more emphasis on soil importation considerations in the future.

[3] In the absence of a municipal instrument e.g., a municipal bylaw or a municipal permit (under the jurisdiction of the *Ministry of Municipal Affairs and Housing*), *O.Reg. 406/19* should apply to these sites, though technical guidance provided in the *Scientific Report* and MECP *Rationale Documents* may be used to support municipal applications.

and/or unreliable. Some of these abandoned sites, which are left unrehabilitated, may present a liability to the owner due to the presence of steep embankments or deep holes or present a danger to neighbouring land uses and users. Moreover, some of these sites could become a location for illegal aggregate extraction or waste dumping. Proper communication and public engagement are important for the rehabilitation of unlicenced pits and quarries, especially abandoned sites. This is because residents may have come to accept them in their current state (i.e., after many years of dormancy/abandonment). Table A summarizes different types of pits and quarries and under which instrument they are operating.

Table A. Summary of different types of pits and quarries in Ontario

<table>
<tr><th>Land Tenure</th><th>Legal Authority</th><th>Status of Pit/Quarry Site</th><th>Regulation Instrument Type or Status</th><th>Regulation Instrument Sub-Type</th></tr>
<tr><td rowspan="6">Private Land</td><td rowspan="3">ARA
- designated parts of Ontario</td><td>Current</td><td>Licence</td><td>Site Plan (Operations and Rehabilitation Plan)</td></tr>
<tr><td>Surrendered (former)</td><td>Surrendered Licence</td><td>Municipal Bylaw
• rezoned from ‘extractive’ zoning at discretion of landowner or municipality</td></tr>
<tr><td>Abandoned</td><td>N/A –never under Licence</td><td>Municipal Bylaw
• rezoned from ‘extractive’ zoning at discretion of landowner or municipality OR never under ‘extractive’ zoning</td></tr>
<tr><td rowspan="3">Planning Act
- non-ARA designated parts of Ontario</td><td>Current</td><td colspan="2">Municipal Bylaw
• ‘extractive’ zoning</td></tr>
<tr><td>Former</td><td colspan="2">Municipal Bylaw
• re-zoned from ‘extractive’ zoning at discretion of landowner or municipality</td></tr>
<tr><td>Abandoned</td><td colspan="2">Municipal Bylaw
• never under ‘extractive’ zoning</td></tr>
<tr><td>Crown Land</td><td>ARA</td><td>Current, Surrendered or Abandoned</td><td>Permit except N/A for Abandoned</td><td>Site plan except N/A for Abandoned</td></tr>
</table>

1.4. Jurisdictional overview

Many jurisdictions have regulated the transport and reuse of excess soil, but not many have detailed recommendations with respect to the quality of soil appropriate for reuse in pits and quarries. Little work has been done about creating conceptual site models for aggregate pits and quarries. For this document, the regulations and best practices of five jurisdictions were studied:

- Massachusetts
- Alberta
- British Columbia (BC)
- Minnesota
- New Jersey

Further details of the jurisdictional overview findings are provided in the *Scientific Report*. The following general commonalities were identified:

- No jurisdiction presented an independent conceptual site model for pits and quarries. A more commonly encountered approach was that excess soil reuse site and aggregate pit or quarry setting were typically differentiated by the volume of imported soil, with pit and quarry sites typically receiving larger volumes.
- Some jurisdictions require large sites (i.e., pits and quarries) to register and submit information, including a detailed soil management plan and a stormwater management plan, to officials prior to soil importation.
- Most jurisdictions have a flexible framework for the assessment of soil quality rather than one table or one set of values. This framework includes a baseline (more conservative) standard and one or more standards with site-specific inputs or considerations.
- All jurisdictions recognize the issue of regional variability in background concentrations.
- In most jurisdictions, the excess soil regulations and standards were more current than existing BMPs for pit and quarry rehabilitation.

2. Purpose and Application of this Document

The intent of this BMP is to address more commonly encountered settings in which pits and quarries are beneficially reusing excess soil for site rehabilitation. This BMP document was developed with consideration to licenced and unlicenced sites, and small and large pits and quarries in Ontario. However, the authors recognize that aggregate pits and quarries are diverse and complex, and addressing all issues related to all site-specific conditions is beyond the scope of this document. Therefore, use of this BMP document should be under the supervision and guidance of a QP that is knowledgeable about assumptions and limitations inherent to the models used in developing *O. Reg. 406/19*, the associated rules, and with consideration to interjurisdictional authorities.

This BMP document discusses application of *O. Reg. 406/19* and the accompanying rules through the lens of a pit or quarry setting, such as soil quality, sampling and auditing, groundwater quality, and record keeping. Next, the BMPs delve into issues of administrative and technical nature specific to pit or quarry rehabilitation by backfilling, which are not explicitly considered by *O. Reg. 406/19* and *Soil Rules*. Examples of these issues are legislative and regulatory considerations to importing of backfill material and addressing biological contaminants and invasive species that may be present in the backfill material. The best practices for approving received loads are discussed with recommendations about site control. Public engagement and best practices for engaging neighbouring communities and Indigenous groups are discussed. Finally, best practices to reduce the impact of pit and quarry rehabilitation on the humans and the natural environmental are presented. This is followed by a discussion about potential impacts of climate change on pits and quarries and thus climate change adaptation plans.

2.1. This document and the *ARA*

The recommendations put forward in this document do not supersede the *ARA*. The owners of licenced sites who want to apply *O. Reg. 406/19* and the associated rules for importing soil for the purpose of beneficial reuse in a pit or quarry rehabilitation are required to do so by amending the site plan. An added note to the site plan may reference this BMP document and the requirements of the MECP as set out in *O. Reg. 406/19*, however, modification of the site plan is ultimately subject to MNRF approval. For further information on interjurisdictional authority refer to Section 66 of the *ARA*.

2.2. This document and the MECP Excess Soil BMP

The MECP prepared a BMP (2016) for management of excess soil prior to development of *O. Reg. 406/19*. The 2016 BMP indicates that it does not apply to the products of pits and quarries, but pit and quarry owners/operators may still refer to the BMP for management of soil received for the purposes of rehabilitation. The MECP Excess Soil BMP was one of the many sources referenced in the development of this document. However, this BMP document has several important differences:

- The scope is focused on pits and quarries as reuse sites for excess soil reuse.
- MECP generic standards described in *O. Reg. 406/19* and associated rules and/or the Beneficial Reuse Assessment Tool (BRAT) are considered.
- Microbiological contaminants are discussed.
- Groundwater-related concerns, including potential physical and chemical impacts associated with large volumes, are addressed.

2.3. This document and *O. Reg. 406/19*

This document is developed based on the requirements and the assumptions described in *O. Reg. 406/19*, its accompanying rules, and *Rationale Documents* for excess soil (MECP 2020) with emphasis on pits and quarries as reuse sites. The best practices gathered in this document are specifically developed for a pit or quarry setting and are intended to complement the regulation and associated rules. Furthermore, these best practices are intended to provide additional guidance on concerns not specifically addressed by *O. Reg. 406/19* that may be commonly encountered in a pit and quarry setting.

2.4. This document and the Beneficial Reuse Assessment Tool (BRAT)

The BRAT provides an alternative to the generic excess soil quality standards, and in most circumstances is anticipated to be reasonably applied to common pit and quarry settings. Pits and quarries may have conditions that invalidate the assumptions made in the development of the generic standards. For example, hydrogeological conditions may vary from the default range of inputs considered in the development of the generic excess soil standards as described in the *Rationale Document* (MECP 2020) and the *Scientific Report*. In such cases the generic standards may not be appropriate. QPs can use the BRAT to develop site-specific soil quality standards that are more appropriate for settings/conditions that are not well represented by the generic model assumptions.

While the BRAT provides additional flexibility to consider site-specific conditions, assumptions made in the development of the BRAT (e.g., the scope of contaminants, receptors and/or pathways considered, and the range of inputs can vary for different sites). In circumstances where the generic standards and/or BRAT are not appropriate (e.g., due to invalidation of an assumption made in the development of the model), a site-specific risk assessment should be undertaken to derive site specific standards.

3. Soil and Groundwater Quality Considerations

This section presents the main considerations regarding soil, topsoil, and groundwater quality when rehabilitating pits and quarries. The appropriate MECP standard tables for placing fill under different circumstances are discussed following by a discussion on soil quality assurance. Furthermore, best practices for groundwater monitoring are presented. The operational details of site control and record maintenance are presented in Section 4.

3.1. Soil quality requirements

Appropriate application of MECP generic standards is dependent upon a QP evaluating the specific reuse site setting and considering the assumptions and limitations of the models used to develop the generic excess soil quality standards. Applying Table 1, as a conservative standard, does not generally require such supervision. When considering the appropriateness of generic soil standards for placement of excess soil at pits and quarries, QPs must consider:

- Site end use[4] (e.g., agricultural or residential)
- Groundwater potability
- Location with respect to closest surface water body
- Whether soil is placed in a shallow bedrock setting
- If excess soil contains volatile compounds
- Whether groundwater level is in close proximity to buildings of concern.
- Whether the site is in an environmentally sensitive area as defined by *Soil Rules*
- And other regulatory considerations such as whether an RSC is required

For a typical pit or quarry setting, as shown in Figure a.1 (Appendix A) or in Figure a in the *Scientific Report*, this document suggests a 'layer-cake' approach when considering placement of excess soil meeting various generic standards. This implies that consideration may be given to placement of different quality of soil at different depths as long as the following conditions are satisfied:

- Sites located in environmentally sensitive areas and/or highly permeable karst may be rehabilitated using Table 1 standards.

[4] For example, if there is an agreement with pit operator to convey the pit to a Conservation Authority, parkland use standards may be appropriate and should be used in standard derivation.

- This BMP also prescribes Table 1 for fill placed below the water table due to high uncertainty with respect to the leaching behaviour of metals in saturated conditions[5]. Note that the MECP soil quality standards and the BRAT do not include S-GW pathways for metals[6]. If a QP determines that Table 1 remains too conservative after considering site-specific conditions, consideration may be given to the modeling tools presented in Appendix 2 as an option for deriving site-specific quality standards with the support of a risk assessment.
- When a site is less than 30 m from a surface body of water (such as a stream or pond), Tables 8.1 and 9.1 must be used to protect the aquatic life.
- Tables 6.1 and 7.1, also known as shallow soil tables, are anticipated to be the most appropriate options for placing soil in quarries with shallow bedrock (no deeper than 2 m). In addition, these tables are also used in situations where excess soil contains volatile compounds and the groundwater table at the reuse site is in a close proximity to buildings of concerns. These tables are also appropriate for placing fill within 2 m above the water table when backfilling below-water table sites (see Figure a. 1 in Appendix 1). For pits and quarries with a substantial overburden, component values related to vapour intrusion via groundwater (i.e., S-GW2) derived for these situations are anticipated to be conservative.
- Tables 2.1 and 3.1 may be used in a pit or quarry above the water table in potable and non-potable groundwater conditions, respectively.
- Tables 4.1 and 5.1 may be used to place fill above the water table and below 1.5 m of the surface when Stratified Conditions, as prescribed by Section D.2.(4) of *Soil Rules*, are met.

These recommendations are summarized in Figure A and Table B. Note that a QP may use multiple quality standard tables for the rehabilitation of a certain site when using the flowchart in Figure A and the 'layer-cake approach' described in the appendix.

[5] For more information on metal fate and transport in saturated conditions see Section 3.7 and Appendix 6 of the Scientific Report.
[6] Therefore, leachate analysis may be required for some situations to make sure this pathway is appropriately addressed.

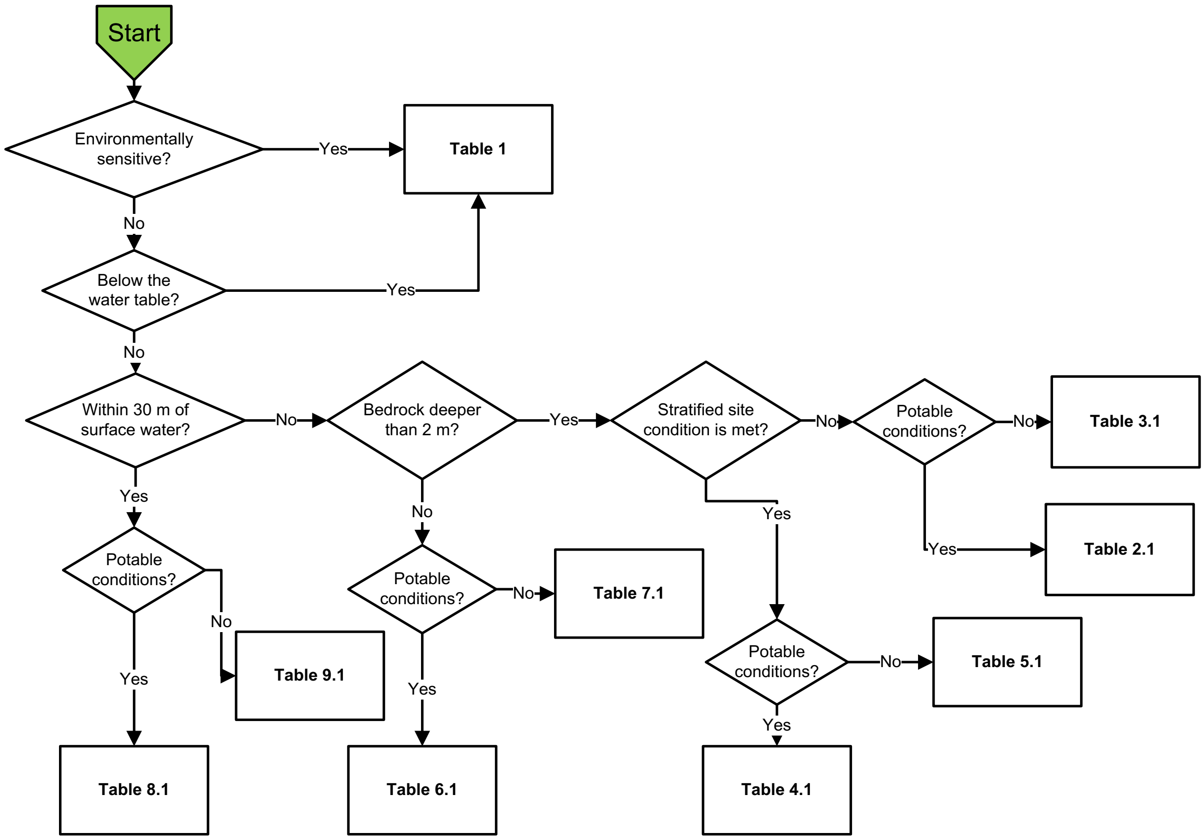

Figure A. Flowchart for considering appropriate standards for placing fill at a pit or quarry[7]

Table B. A decision matrix for considering the appropriate MECP standard table for different depths

Location/depth of soil placement	**Environmentally sensitive site**	**Within 30m of water body**	**Other scenarios**
<1.5 m (top 1.5m)	Table 1	Table 8.1/9.1	Table 2.1/3.1
>1.5m (above the water table and bedrock)	Table 1	Table 8.1/9.1	Table 4.1/5.1
Shallow bedrock	Table 1	Table 8.1/9.1	Table 6.1/7.1[8]
Below water table	Table 1	Table 1	Table 1

Note that for licenced sites the soil quality standards mentioned above do not override the quality/quantity required by an instrument. For licenced sites, the quality and quantity requirements specified in the instrument must be followed. If the quality and quantity is not specified in the instrument or there is no instrument (unlicenced sites) then the flowchart of

[7,8] Also, where excess soil contains volatile compounds and the groundwater table at the reuse site is at close proximity to buildings of concerns Table 6.1 and 7.1 may be used.

Figure A, Table B, and the layer-cake approach in Appendix 1 may be considered. Some pit/quarries are located on leased lands. Conditions of the leased agreement also then need to be considered with respect to restoration of the lands.

Finally, if a QP determines that the assumptions of MECP (2020) *Rationale Document* for development of the generic standards may be invalidated, using the BRAT or the completion of a full risk assessment are options. For details on conditions that may deviate from the MECP generic model assumptions see Sections 3.2 and 8.5 of the *Scientific Report*. A full risk assessment and additional supporting technical studies are recommended in circumstances when an assumption will be invalidated and may elevate the potential for an adverse impact.

3.1.1. Topsoil

Site owners/licensees are required to follow the standards of the *Aggregate Resources of Ontario: Site Plan Standards*, which requires a description on the site plan of whether soil, topsoil or fill material (to be hereafter referred to as soil) is to be imported for the purpose of rehabilitation. If this is proposed by the owner/licensee, it generally requires some demonstration of the need for soil for rehabilitation purposes, along with identifying on the rehabilitation diagram or rehabilitation notes of the site plan where the soil will be placed. Other necessary information, if and where available, may include the description of the generating site or the type of site in general, the volume of soil anticipated to be imported, anticipated timeframe, and sufficient proof of compliance with the site plan. Topsoil, as a specific form or type of soil importation, is considered high quality and relatively rare soil; thus, its best management practices will differ from subsoil or other types of fill. Licenced sites must meet the requirements of *O. Reg. 466/20* regarding topsoil. The following best practices are recommended as well:

- During operation and preparation for rehabilitation, native topsoil should be salvaged and reused during progressive rehabilitation. Topsoil should not be mixed with subsoil or buried under stockpiles of subsoil.
- Imported topsoil should be used as quickly as possible for final cover. Stockpiling topsoil for long periods of time degrades its quality.
- Additional testing may be required for topsoil as deemed by the QP or the MNRF to confirm environmental quality and/or that the nutrient properties are suitable for the intended final use.

3.1.2. Quality assurance

Section B of *Soil Rules* identifies a minimum number of samples by volume that must be collected when conducting in situ or stockpile sampling at a source site and submitted for laboratory analyses (e.g., bulk and leachate analyses) prior to transfer of excess soil to a reuse site. Section B of the *Soil Rules* also specifies a minimum set of chemical parameters that must be evaluated and discusses the process for evaluating potential sources of contamination (Assessment of Past Uses) within the *project area* that may identify the need to evaluate additional chemical parameters.
O*. Reg. 406/19* and the *Soil Rules* require the source site to provide the reuse site with documentation identifying the source and quality of the material and supporting information summarizing the source site setting and assessment of past uses prior to transfer of the soil. Furthermore, the source and reuse site must coordinate on a tracking system to ensure that only trucks from pre-approved source sites are allowed to access the reuse site. The minimum requirements of a tracking system are defined in the *Soil Rules*. Further discussion of soil tracking and site control best practices (e.g., screening loads) is provided in Section 4.

Given the large quantity of imported soil that is anticipated to be received at a typical site undergoing rehabilitation, potentially from multiple source sites, with the possibility for contaminants to be introduced during loading and transport of the soil (e.g., load release agents), and potential for misrepresentation, development, and implementation of a quality assurance program is recommended to build confidence that soil accepted at the receiving site for use in rehabilitation meets the required soil quality prior to final placement. The MECP *(2016) Excess Soil BMP* recommends that the QP at the reuse site design monitoring and sampling protocols, and a contingency plan for subsequent actions when non-conformant soil is identified.

As a best practice, the quality assurance procedure should validate that soil is consistent with the supporting documentation provided by the source site. The quality assurance procedure should include:

- Retaining the service of a knowledgeable individual (e.g., a QP) to develop the quality assurance plan and to train individuals responsible for monitoring loads received, and to confirm tracking and record maintenance requirements.
- Identification of the person(s) responsible for accepting/rejecting material.
- Review of supporting documents used to track the material (e.g., the hauling record) and validate that it is of the appropriate quality and from a pre-approved source site. If

a truck presents at the receiving site and is not from an approved source site it should not be allowed to enter the site.

- Identification of amendments used (if any) for soil solidification during dewater and/or load release agents.
- Screening of the material (e.g., visual, olfactory) for discrepancies from the source site documentation such as the type of material, presence of debris or other contaminants, and a protocol for rejection or segregation of the material for additional inspection and/or testing if it fails the screening protocol. Soil should be screened before it is unloaded from the truck and following unloading.
- Random sampling of a minimum quantity of material to confirm that the results are consistent with those previously reported by the source site.

O. Reg. 406/19 and the *Soil Rules* do not prescribe minimum quality assurance sampling requirements for soil received at a beneficial reuse site (i.e., to validate the results of sampling completed at the project area prior to transfer). The MNRF *Aurora District Off-Site Fill Acceptance Protocol,* includes the best practices identified in the foregoing bullets and requires a minimum of one quality assurance audit sample be collected at the receiving site for every 10,000 m^3 of fill received (or as approved by MNRF), noting that additional sampling should be undertaken if inconsistencies are observed (e.g., qualitative evidence of impact). This should be considered a minimum audit frequency given that this protocol pre-dates *O. Reg. 406/19* and assumes Table 1 soil is being transferred.

Records should be developed and maintained to document the soil audit sampling procedure and the rationale behind it. A QP should consider the source of the material and required end use when developing the QA sampling frequency. Other factors such as control over source and receiving site (e.g., managed by same parties or different parties), the quantity of material to be managed, and outcomes of community consultation may influence audit sampling program development and design.

Samples collected for audit purposes should be submitted to an accredited laboratory for analysis and may be analyzed for the following parameters based on consideration of sampling undertaken at the source site prior to transfer, and consideration of the receiving site needs:[9]

[9] Sampling and inspection for soil imported from stormwater management ponds must satisfy the requirements set out by *Soil Rules* including those in Sections B.2(3)17 and B.2(5)3.

- Petroleum hydrocarbon fractions 1 through 4 (PHCs F1 to F4) including benzene, toluene, ethylbenzene, and xylene (BTEX)
- Metals and hydride-forming metals (such as barium, arsenic and lead)
- Sodium adsorption ratio (SAR) and electrical conductivity (EC)
- Leachate analysis, if required
- Any potential contaminant of concern identified in the assessment of past uses of the source site

3.2. Groundwater monitoring

Three lines of evidence should be considered to alert the QP to potential risk of groundwater chemical or physical contamination:

- Soil quality standard values
- Leachate analysis
- An on-site groundwater monitoring program (e.g., when required by a site instrument)

The first two methods are proactive, and groundwater monitoring is reactive. If there are existing groundwater monitoring wells, consideration should be given to utilizing them for the purposes of groundwater monitoring. The resulting data may be used to establish baseline data and empirically measure any changes associated with excess soil placement over time.

The excess soil quality standards and leachate screening levels were developed to be protective of groundwater resources[10] in the absence of groundwater monitoring. Therefore, the expectation is that excess soil will not adversely impact groundwater providing that the reuse site is only accepting soil meeting the appropriate generic soil standard(s) and leachate screening levels (where required). Soil containing chemical contaminants not considered by the excess soil standards should not be placed at a reuse site unless the QP can demonstrate that the placement of the soil in question is protective of site occupants and the environment (e.g., through the completion of risk assessment[11]).

Below the water table, pits and quarries may already have an existing monitoring well network and monitoring program. This is particularly likely for Class ‘A’ licenced pits and quarries (with an annual production more than 20,000 tonnes), that have been approved since 1997 given the enhanced study, monitoring, and reporting requirements that were instituted at that time.

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[10] As long as the standards are appropriate to use (see Appendix I of the *Rules for Soil Management and Excess Soil Quality Standards* for limitations where use of these standards may not be appropriate).

[11] *“For contaminants for which generic excess soil quality standards are not derived, if they are present in excess soil and known to have the potential to adversely impact human health or the environment, the reuse site owner or operator must retain a QP to develop site-specific excess soil quality standards for those contaminants using a separate risk assessment, as outlined in Section 4 of Section D of Part I of this document,” Soil Rules*, Appendix I

Groundwater monitoring may be necessary for other *ARA*-licenced pits and quarries when they are in highly permeable soil or in a significant potable groundwater setting (e.g., in a critical location within a well-head protection area or intake protection zone). In the event of impactful changes to groundwater level or quality, it is a common *ARA* licence requirement that the MNRF and/or MECP be notified.[12] A typical groundwater monitoring program may include the following information:

- Establishing objective(s) of the groundwater sampling program which may be different from the objective(s) during the extraction phase
- Documentation of the number and type of samples
- The timing of sampling and other important considerations
- The parameters of interest
- The standards to be used[13] (this will depend on the program objectives)
- The reporting requirements

Samples should be collected by or on behalf of the owner/licensee under the supervision of the QP and delivered to an accredited laboratory for testing. Results should be presented to the governing municipality or the MNRF (depending on licence status) upon request.

If the reuse site has an existing monitoring well network, as a best practice, baseline groundwater data should be collected, prior to placement of excess soil. This may allow a reuse site owner to better differentiate between background conditions and conditions arising from soil placement.

[12] When the impacts arise from excess soil, the MECP must be notified as well. For the municipally regulated sites the governing municipality must be notified.

[13] For example, Ontario Drinking Water Quality Standards (ODWQS) for sites in potable groundwater conditions or site condition standard tables (i.e., Tables 1 to 9).

4. Best Practices for Site Control and Approving Soil at the Reuse Sites

This section explains the best practices for site control and approving material at the reuse site. The QP at the reuse site should be familiar with the requirements of the *Soil Rules* and the level of detail that should be provided by the source site. The reuse site must ensure that the following information is provided and reviewed prior to acceptance of soil, as described in the *Soil Rules*:

- Assessment of past uses
- Sampling and analysis plan
- Soil characterization report
- Excess soil destination assessment report

4.1. Application for shipment of fill material

Shipment of excess soil should only be permitted upon receipt of a written approval from the reuse site owner stating that the material proposed to be shipped has been accepted in accordance with the applicable reuse site standards. An application to ship material must contain the information required in Section B.4 of the *Soil Rules* and Section 13 of *O. Reg. 406/19* (Excess Soil Destination Assessment Report), which include the following:

- Name of the owner of the source site and the representative of the source site authorized to sign any hauling record or other documents.
- One or more reports, prepared by a QP from the source site, to include the following information:
  - A description of the source site and its history, including the location, past and present uses, and current activities.
  - A description of the material to be shipped to the reuse site and the processes involved in its generation.
  - A record of the results of a comprehensive soil testing program for the source site as prescribed by the *Soil Rules*, including a description of the sampling locations, sample collection procedures and parameters analyzed. An explanation or rationale for the selection of the sampling locations and the parameters for testing should be included.
  - A statement from a QP stating that in their opinion the material satisfies the requirements set out by this BMP and *O. Reg. 406/19* and its accompanying rules.
  - The anticipated volume of material to be shipped to the reuse site.
  - An estimated timeline in which the material will be shipped.

The responsible person for the reuse site will review the application to determine whether the material proposed for shipment is acceptable. This individual may be a QP or a person trained to evaluate applications. The responsible individual will consider the results of the sampling program, including, but not limited to, whether the sampling locations and number of samples are representative of the material proposed to be shipped, whether the test results include the full range of parameters of potential concern relating to the source site, and whether a suitable QA/QC program was implemented. The responsible individual will communicate the approval or rejection, in writing, along with any terms or conditions of approval to the applicant and confirm the approximate times of shipment.

It is recommended that a master list of hauling records (and/or bills of lading) be produced for each source site by the reuse site owner/licensee. The master list will enable the hauling records to be linked by number to the specific source site, transportation company, and site assessment report[14]. The site owner or licensee must keep a copy at the site of the documentation referred to in this paragraph and provide a copy thereof promptly upon request to the MNRF or governing municipality (depending on the status of the site licence). Further discussion of record retention is provided in Section 4.3.

4.2. Tracking and operational controls at the reuse site

A locational tracking grid should be developed for the reuse site to record final placement of fill material. The locational tracking grid may identify the required soil quality standards and/or required geotechnical properties for specific areas of the reuse site (when they are varied) and should be developed to align with site rehabilitation requirements (e.g., phased restoration). The locational tracking grid may be used to revisit or evaluate soil following final placement (if required).

Actions required to prevent unauthorized access to a site may vary depending on its size and location. The following best practices to manage site access are presented for consideration:

- Unauthorized access or entry locations to the reuse site by trucks should be prevented through signage, fencing, and gates to prevent illegal dumping or any type of unauthorized activity. The receiving site should have a responsible person that controls authorized access to the site. The responsible person should be appropriately trained on required screening measures, tracking requirements, and procedures for accepting and rejecting soil.

[14] Relational databases can be very appropriate for this purpose

- The locations on the reuse site where filling activities will occur should be identified by the responsible person daily. One of the main criteria should be the history of the source site for each incoming load. Loads received from different sources should be placed in separate locations. This will mitigate risks associated with mixing material in the event soil from a specific source needs to be identified and recovered. Placement of soil should be tracked through a locational tracking grid system. Such records should be retained and made available to the governing municipality and/or the MNRF upon request.
- All trucks are required to present their hauling record before they can enter the site. A completed hauling record must include the information required by Section 18. (1) of *O. Reg. 406/19*.
- The responsible person should check the information on the hauling record against the list of approved source sites.
- Unmanifested (i.e., undocumented or untested) loads with no hauling record should be rejected immediately.
- The responsible person should screen each load for consistency with the document and/or visual, olfactory, or other evidence of impact before granting permission to unload. Loads containing unacceptable material or exhibiting evidence of possible chemical impact (such as unusual odour or staining) should not be permitted access.
- If the material received from an approved source site is rejected, the source site must be notified. Before accepting any further material from the source site, the source site should reevaluate the conceptual understanding of site conditions, the QC system, remedial actions taken to address the issues and provide a written summary to the reuse site. The reuse site should determine if the source site material remains acceptable and/or consider whether additional QA measures are required[15].
- After the responsible person approves the load for acceptance, they should approve or sign the hauling record and direct the driver to a specific unloading location. The assigned soil placement location (i.e., corresponding to the location tracking grid) should be noted on the hauling record.

4.3. Maintaining records

A daily record should be maintained for cumulative record of import, loads shipped to the reuse site, including rejected loads. Every entry of this record should include at a minimum:

[15] As a best practice, the reuse and source site can use the contractual forms presented in OPSS 180 from Ontario Provincial Standards Specifications (Ministry of Transportation 2016) to manage excess soil. Consideration should be given to incorporating necessary changes, as these specifications and forms predate O. Reg. 406/19.

- Date
- Daily total number of trucks entering the site
- Daily total number of trucks accepted
- Daily total number of trucks rejected and the reason(s) for rejection
- For each source site the following information should be recorded:
    - ID number for each hauling record received on that date
    - Cumulative volume of fill received
    - Location fill was placed on the locational tracking grid

All recorded information including daily logs of material accepted at the reuse site, hauling records and records of material approved for acceptance should be retained by the project leader for a period of at least seven years after the date that the document or record is created or acquired as prescribed under Section 28 of *O. Reg. 406/19.*

4.4. Discovery of non-conformant material

Should any unacceptable materials (e.g., imported fill containing contaminants exceeding the concentrations discussed in Section 3.1) be discovered through the audit program or during or after placement of the fill, the site proponent/owner should take the following course of action.

- The MNRF[16] or the governing municipality (depending on the type of licence or permit) should be notified promptly in writing by the owner/licensee.
- All non-conformant material should be located using the site log and locational tracking grid, recovered, and stockpiled for removal and/or further assessment.
- A record of the actions taken as well as any applicable documentation (e.g., sampling results) with respect to the non-conformant material should be kept in the site log.
- A copy of supporting documentation should be provided immediately upon request to the governing municipality or the MNRF.

[16] Or MECP (depending on what the prevailing site instrument is and whether there is an off-site adverse impact).

5. Non-Chemical Contaminants and Other Issues

O. Reg. 406/19 and accompanying rules address issues related to chemical contaminants. However, issues related to physical and microbiological contaminants and invasive species are not addressed by the excess soil standards. These issues are not specific to pits and quarries and may be present in other excess soil reuse settings as well. This section summarizes best practices to evaluate these concerns during pit and quarry rehabilitation.

5.1. Biological contaminants

Microbiological contaminants can travel through groundwater; therefore, these types of contaminants should not be overlooked when rehabilitating pits and quarries. Biological contaminants of concern may include E. coli and other forms of coliform bacteria. Given that below water table pits and quarries may include a large area of exposed groundwater, there is a risk of accidental or intentional releases of such contaminants to the water. The presence of such bacteria in the water could be the result of fecal waste from birds and other wild or domestic animals. These contaminants may pose a health risk if the groundwater is used for potable purposes (e.g., if there is a connection to a local aquifer). Some of the best practices for protecting the site against such contaminants are:

- Proper site control measures (such as installing fence and gate), which can reduce the risk of introducing contamination by animals.
- Some ancillary land-use activities on aggregate sites could be a potential source (for example, having a septic wastewater system on-site for the use of the workers, which is considered a potential source of biological contaminants such as E. coli.
- Knowing the history of the source site is important. The source sites that have an increased risk of bacterial contaminants are farms, feedlots, rural areas with a history of livestock farming, sewage sludge (biosolids), and areas in the vicinity of sewer systems such as sewer pipes or septic tanks.
- Farms can sanitize the manure by composting it. However, precautions must be taken when dealing with the above-mentioned sites because the speed and extent of attenuating the bacteria varies with temperature and quality of composting practices.
- In areas with potable groundwater conditions, the soil should be screened for biological contaminants (e.g., soils containing biosolids[17]) during the visual inspection.

[17] Manure, sludge, etc.

5.2. Groundwater flow

The natural flow of groundwater may be disrupted by lowering of the water table by dewatering during extraction or rehabilitation and/or by altering conductivity if backfilling with material of a different permeability than the surroundings. In some rare situations, this may have positive outcomes for the neighbouring communities. For instance, in an area with agricultural land use where the soil is water-logged, continuous pumping may lower the water table and make the soil conditions more favourable. However, because of the serious potential impacts on groundwater and surface water, it is recommended that rehabilitation of pits and quarries be undertaken in a way that limits adverse impacts to groundwater flow.

If it is necessary to extract or place material below the water table, the following approaches should be considered to minimize potential physical impacts on groundwater flow:

- Excavating or backfilling the portion of the site below the water table during seasonal low elevations.
- Backfilling with free draining granular material prior to the peak water table season. This approach may not be attractive to owners/operators because granular material is the product of pits and quarries that are commercially valuable. However, owners/operators can always use salvaged native material, which do not satisfy the specifications for use as construction aggregate material but have suitable permeability. Furthermore, the materials may be relatively consistent with the permeability of the surrounding, unexcavated areas.
- Building impoundment berms across the pit or quarry at multiple locations. The space between these berms will be filled with water and they will act as small dams and regulate the water table level.
- Lowering the final depth of the pit or quarry to less than 1m below the high winter water table level.

Generally, quarries within impermeable rocks are less likely to change the water table elevation or affect neighbouring wells. However, in situations where the rock is permeable (e.g., due to karst conditions, fractures/faults, or porous rocks) or when the pit/quarry exposes a bedrock groundwater unit that is also used for potable purposes within the vicinity of the area of backfill, consideration should be given to potential adverse impacts arising from the backfill of soil material.

5.3. Groundwater turbidity

When a pit or quarry operates below the water table, it may increase the turbidity of the surrounding groundwater, which may manifest as elevated total suspended solids (TSS) and total dissolved solids (TDS). The same issue may occur when backfilling a pit or quarry using excess soil. Generally, there is a buffer between the extraction zone and the boundary of the site that allows turbidity to mitigate before groundwater crosses the property boundary. However, receiving sites should be vigilant of issues related to groundwater turbidity in potable groundwater conditions if:

- There have been previous turbidity issues during the extraction phase.
- The pit or quarry is located in a highly permeable material that cannot attenuate the turbidity (e.g., karst, fractured rock, gravel with high permeability, or other preferential pathways).
- The pit or quarry is a legacy pit or quarry, and the hydrogeology of the site and surroundings is poorly characterized.

Placing fill below the water table should be undertaken gradually. Where monitoring wells are available, they should be inspected for signs of turbidity. The operation must stop immediately if turbidity is observed in peripheral monitoring wells. When placing soil below the water table upgradient and downgradient monitoring wells should be evaluated against *Ontario Drinking Water Quality Standards (ODWQS)* to confirm that there is no adverse impact (note that this is a reactive line of evidence and should be in addition to screening of soil as described in Section 3). In settings where risk of adverse impact due to elevated turbidity is high (such as fractured rock connections to wells, groundwater discharge to surface water receptors), consideration should be given to implementing mitigative measures such as use of a geotextile or an attenuating gravel pack.

5.4. Invasive species

The *Invasive Species Act* (Government of Ontario 2015) in Ontario defines invasive species as *“a species that is not native to Ontario, or to a part of Ontario”*.

Some invasive species of particular interest in Ontario are:

- European fire ants
- Russian olive
- Japanese knotweed
- Phragmites
- Giant hogweed
- Garlic mustard

- Dog-strangling vine
- Certain species of nematodes

Parasitic or invasive species of nematodes in Ontario include:

- Soybean cyst nematode (*Heterodera glycines*)
- Oat cyst nematode (*Heterodera avenae*)
- The sugar beet cyst nematode (*Heterodera schachtii*)
- The northern rootknot nematode (*Meloidogyne hapla*)
- Bulb and stem nematode (*Ditylenchus dipsaci*)
- Dagger nematode (*Xyphinema sp*.)
- The root lesion nematode (*Pratylenchus penetrans*)
- Certain *Falcaustra* species such as *F. inglisi, F. chelydrae, F. wardi, F. affinis and F. catesbeianae*

The following best practices are recommended through different stages of rehabilitation to mitigate adverse impacts arising from invasive species:

- Soils with a history of a nematode problem, or other invasive species, should be either avoided or sampled when imported to reuse sites for agricultural or parkland purposes.
- Sampling for nematodes in sites near or located on agricultural land should be performed according to *Ontario Ministry of Agriculture, Food and Rural Affairs* guidelines.
- Identify any occurrences of invasive species plants before beginning any expansion of the operations, such as tree removal or movement of brushes or soil.
- Discuss the management implications with the operational staff.
- Report the identified invasive species to the MNRF[18].
- An annual invasive species assessment should be conducted, and invasive plants should be removed.

5.5. Dust

Dust may represent an adverse effect or impact under the *Environmental Protection Act (EPA)*, and importation of soil may be limited until the adverse effect or impact is sufficiently

[18] You can report invasive species to MNRF via a toll-free phone number, an online map, or a mobile application. More information is available here: https://www.ontario.ca/page/invasive-species-ontario#section-1

mitigated. The development and implementation of dust control management plan and measures is recommended during placement of excess soil, including but not limited to:

- Every effort should be made to keep the roadways inside and near the site free of loose material.
- Water should be regularly applied to unpaved roads as a dust suppressant.
- There are various approved dust suppressant products on the market that may be effective in controlling dust. However, these products may have an adverse environmental effect on the quality of air, surface water, and groundwater and should be used with caution.
- Outgoing trucks should pass through mud mats or a tire wash to limit tracking of dirt onto road surfaces near residential areas.
- Paved roads should be washed or swept regularly to remove material tracked from the reuse site.
- Operational measures, such as limiting the height from which material is dropped, can reduce the generation of dust. Additionally, placement/movement of material may be limited when conditions are unfavourable (e.g., high winds).
- Planting vegetation or placing mulch on topsoil stockpiles or slopes that are exposed will significantly reduce erosion and windblown dust.
- In windy areas, stockpiles of production material should be kept small to reduce the risk of wind erosion and dust emission.

5.6. Noise

During rehabilitation by backfilling most noise is anticipated to be generated by heavy equipment (e.g., engines and truck tailgate slamming). However, since in active pits and quarries, rehabilitation and extraction are often conducted simultaneously, existing efforts to manage noise may already be in place and can be adapted to backfill operations.

The following best practices for noise reduction should be considered:

- For unlicenced sites operations must comply with local noise bylaws. As a best practice consideration should be given to potential receptors and where possible, operations should be scheduled to limit noise to pre-determined days and time periods with consideration to the receptors (e.g., limiting work on weekends and evenings in an area with residential receptors).
- Choose the quietest set of equipment.

- Stationary equipment noise is the easiest to reduce because the noise source is in the same location. Providing physical barriers can reduce noise for both mobile and stationary equipment. However, barriers are only effective if they are long and high enough to cover all possible equipment locations.
- For trucks and other material transfer equipment, barriers, enclosures, and impact absorbing linings are effective noise control approaches.
    - Barriers should be built out of relatively heavy, non-porous materials (e.g., earth, rock, sand, 18-gauge steel, and wood). Stockpiles of sand or gravel could be placed in a way that they act as barriers.
    - A barrier should be tall enough to interrupt the line of sight between the top of the noise source and the neighbours. It also should be long enough to preclude the noise from leaking from the ends.
- Modification of equipment: for example, standard engine exhaust mufflers can be replaced with more powerful models that offer additional silencing. Some equipment manufacturers produce engine enclosure kits.
- Skilled and well-trained drivers and operators who operate equipment to limit the generation of noise (e.g., by reducing tailgate slamming) are an important contributor to noise reduction.

5.7. Vibration

Although vibration during the rehabilitation phase is considerably lower than the vibration caused by extraction, the vibration generated by hauling trucks and other heavy equipment may be of concern to neighbours. These vibrations are not expected to damage neighbouring structures, but rather prompt nuisance complaints. The following best practices should be considered to alleviate vibration impacts:

- To reduce truck vibration, roads leading to the site should be paved, regularly monitored, and maintained in a good state of repair.
- Truck speed should be minimized when approaching the site.
- Reuse sites should consider local traffic bylaws and prepare a traffic and transportation management plan in consultation with upper and lower tier municipalities to identify appropriate transportation routes.

5.8. Geotechnical stability

Placement of large quantities of soil in a pit or quarry will require consideration of geotechnical stability. Geotechnical stability considerations will be particularly relevant if the future use of the site will include development of above or below grade structures. This may require consideration of compaction during placement, sequencing of material based on its physical properties, and/or engineered solutions (e.g., placement of geotextile).

Groundwater has a significant impact on geotechnical stability. The presence of groundwater reduces the effective stress and frictional strength in soil (especially fine-grained material). For example, a cohesive soil (clay) with a frictional strength of 2H:1V will stand at a 2 to 1 slope in dry conditions, but its angle drops to 3H:1V under groundwater seepage conditions. Therefore, consideration of geotechnical stability will be of particular importance for larger sites that have portions below the water table.

Consultation with a geotechnical engineer or a geoscientist is required to evaluate site-specific geotechnical stability requirements. The following general best practices should be considered:

- Placing soil in groundwater should be avoided where possible. Where placing soil under the water table is unavoidable, using native granular material for backfilling is preferred over imported material. Placement of granular material beneath the water table (and perched water table) reduces slope instability or undesired settlement. These issues may be caused by placing saturated fine-grained soil below the water table or in the lower layers.
- Frozen soil may become unstable after melting in spring. Therefore, consideration should be given to how wet material[19] is placed in winter.
- For sites with commercial or residential land use consolidation and settlement should be considered, especially for poorly graded soil. Placing more fill onto unconsolidated slurries will compound instability because entrapped water may up-filter and migrate through the emplaced fill, and delay consolidation.
- In addition to geotechnical issues, placing fine-grained soil may also impede the natural flow of groundwater, adversely impacting human and/or ecological uses of groundwater.

[19] Wet but not liquid soil. Importation and storage of liquid soil is only allowed upon meeting the requirements of Section C.1.(2) and Section C.5 of *Soil Rules*.

5.9. Soil erosion

Soil erosion concerns during rehabilitation are not anticipated to be as significant as the extraction stage. Most activities resulting in soil erosion occur during the extraction phase. However, since extraction and progressive rehabilitation are undertaken simultaneously, considerations for reducing erosion during this phase are presented here. Furthermore, unlicenced sites that have been dormant for many years may require site preparation prior to rehabilitation, and the preparatory activities may contribute to soil erosion. As a best practice, consideration of the following is recommended to mitigate adverse impacts arising from soil erosion:

- Erosion may be caused by wind, water, and destruction of permafrost. Silt and fine sand with small quantities of organic content or clay, are the most susceptible to wind and water erosion. Erosion arising from wind is largely addressed by dust control and mitigation measures (Section 5.5).
- Water erosion should be considered during the placement of excess soils to limit adverse impact to surface water receptors and/or groundwater via preferential pathways.
- To minimize the potential for water erosion and impact on neighbouring surface water, the site proponent/licensee should minimize the period during which uncontrolled runoff from the site can cause an impact on neighbouring water bodies or adjacent properties. Therefore, perimeter interception ditches, creek diversions, and treatment facilities should be constructed prior to, during, or immediately after the stripping of the site.
- Overburden removal and grubbing should be undertaken in the warm and dry season (early summer to early fall). If the initial site work is to be completed during the wet season, there is a higher risk that uncontrolled runoff will affect adjacent water bodies. Furthermore, handling and stockpiling wet soil materials is challenging.
- Reuse sites should consider local municipal and conservation authority (CA) fill bylaws regarding soil erosion and impact on surface water.
- Development and implementation of sediment and soil erosion control plans and measures is highly recommended. This should result in materials remaining where placed and preventing discharge from the site to sensitive receptors by using engineered controls (e.g., silt fencing and hay bales). If overburden removal or surface finishing is likely to occur during periods of intensive rainfall, care should be given to implementing temporary or permanent measures to contain and treat surface runoff from the disturbed areas or recently backfilled areas.

6. Consultation and Engagement

O. Reg. 406/19 does not include a minimum requirement regarding public consultation but ensures that the public can access the information they need via a registry. But the MECP (2016) Excess Soil BMP includes best practices for public consultation.

6.1. Neighbouring communities

Recommendations presented in this section are for unlicenced sites, particularly legacy pits and quarries. Licenced sites undergo a public consultation process to secure their existing site-specific regulatory instrument. Additional consultation by licenced pits and quarries is typically required as a component of a major site plan amendment.

Public engagement should be a priority throughout the lifecycle of the project. This means that members of the public or their representatives should be informed and consulted from the beginning to the end of the project. Host community concerns with neighbouring pits and quarries are generally categorized as concerns of potential long-term adverse effects to soil and groundwater, and concerns related to daily operations such as noise and dust.

Rehabilitation of large pits and quarries may take many years, and the public will expect an estimate of the time required to complete rehabilitation work. Therefore, the magnitude of the project, the estimated time and required resources should be communicated to the public. The public should be educated about the potential restrictions or disruptions caused by the project. At the same time, the positive influences of the project on the neighbourhood should be considered and communicated.

The host community may have concerns arising from experience during the extraction phase of the pit or quarry. Communications about the rehabilitation phase should consider the past experience/concerns of the community. For example, rehabilitation is not anticipated to be as noisy as the extraction phase. Sources of noise or vibration during production are often absent during rehabilitation because rehabilitation does not include activities such as rock drilling, blasting, and dumping rock into steel hoppers.

Consideration should be given to diverse channels of public communication, including:

- Door-to-door notices
- Community consultation meetings
- Engaging local Business Improvement Areas (BIAs)
- Municipal council
- Social media
- Websites
- Hotlines

- Meetings at physical offices

When engaging neighbouring communities, the licensee/owner should:

- Notify the communities of open houses and public meetings.
- Provide the communities with project documentation and other information (e.g., a high-level schedule, milestones, traffic management plans and sketches of the site).
- Respond clearly to questions or concerns from the community about project impacts including any disruptions to businesses and possible mitigation strategies or compensations.
- Update the community about any upcoming change to the schedule or project scope.
- Document consultation processes and meeting dates and contents.
- Consider maintaining a log of reported adverse impacts and efforts made to investigate and mitigate them.

6.2. Indigenous communities

Ontario is home to many Indigenous communities. Consultation with Indigenous communities is a requirement for environmental assessment of projects in Ontario and a best practice when not otherwise mandated. Therefore, pit and quarry owners/licensees should discuss with each identified and potentially affected First Nation and Métis community, the ways to mitigate or eliminate potential adverse effects a project may have on their Aboriginal or treaty rights (established or asserted).

As a best practice, a list of all neighbouring Indigenous communities should be prepared based on:[20][21]

- Potential adverse impacts from the proposed project to the environment where Aboriginal or treaty rights may be exercised
- Information related to historic Aboriginal occupation found on the *Ministry of Indigenous Relations and Reconciliation (MIRR)* and *Indigenous and Northern Affairs Canada (INAC)* websites
- Current land claims and land-related negotiations listed on provincial and federal government websites

[20] This list is adopted from Ontario Ministry of Indigenous Affairs

[21] For *ARA* applications for new pit/quarry sites, MNRF will provide the Applicant with a list of aboriginal communities to be notified.

- Reserves that are near the *project area* (information can be found through sources such as the Aboriginal Communities and Friendship Centres in Google Earth and the Aboriginal and Treaty Rights Information System[22] (ATRIS))
- Chiefs of Ontario website[23] which provides a directory of contact information for all First Nations and Chiefs, as well as a map of the location of Ontario First Nations communities in Ontario
- Results of any information in any known archaeological assessments
- Review of Historic Treaties, Treaty Guides and map of Historical Indian Treaties
- Information about Métis communities available on the Métis Nation of Ontario website[24] or through the Ministry of Indigenous Relations and Reconciliation

In addition to the best practices mentioned above for community engagement, the following points should be considered when consulting with Indigenous communities:

- First Nation communities should be contacted through the Chief and Band Council
- Métis communities should be contacted through their elected leadership
- Follow any other requirements for Aboriginal (and the public) consultation in MECP consultation guidelines and codes of practice.[25]

QPs or other professionals may be delegated by the owner/licensee to communicate with Indigenous communities. Reuse sites should consider whether additional considerations under the Ontario *Environmental Assessment Act* and *Heritage Act* apply. Rehabilitation of pits and quarries by backfilling usually does not trigger an environmental assessment and does not include land ownership conflicts. However, it is the responsibility of the owner/licensee to ensure that all legal requirements, including necessary communications with the Crown, are met.

6.3. Conservation Authorities (CA)

There are 36 CAs in Ontario, which are local watershed management agencies. Prior to receiving fill material, the local CA should be contacted if:

- CA regulated area is within pit or quarry boundaries
- The site is adjacent to area regulated by a CA

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[22] ATRIS is an online platform to map the location of indigenous communities. Available at: https://sidait-atris.aadnc-aandc.gc.ca/atris_online/home-accueil.aspx
[23] Available at: http://chiefs-of-ontario.org/
[24] Available at: http://www.metisnation.org/
[25] Available at: https://www.ontario.ca/page/consultation-ontarios-environmental-assessment-process

- Governing municipality requires their consultation in support of Site Alteration Permit application for fill importation to unlicenced pit/quarry.

Contacting CAs is to determine if the reuse site is within an area regulated by the CA and/or subject to any specific limitations and/or permit requirements. As a best practice, CAs should be consulted on the following:

- Soil and sediment erosion
- Endangered species
- Invasive species
- Appropriateness of the final land use
- Stormwater management and flood control
- Protecting water courses
- Hazardous lands and wetlands

7. Climate Change

Both mitigation and adaptation sides of climate change require attention in the aggregate industry. Although *O. Reg. 406/19* mostly emphasizes mitigation considerations, the impact of climate change on pit and quarry operation and rehabilitation may be considerable over time. Therefore, considerations related to climate change adaptation are presented as well.

7.1. Climate change mitigation

An objective of *O. Reg. 406/19* is the reduction of greenhouse gas (GHG) emission levels by promoting local reuse of excess soil, rather than trucking the soil long distances to landfill. This is possible through opportunities for better synergy between pit/quarry site that produces material destined for a construction site and the production of excess soil that may be beneficially reused in the rehabilitation of a pit/quarry site. Even if this type of direct site to site matching is not practical in a large scale, the close-to-market and dispersed pit/quarry sites that provide the benefit of reduced haul distance as an aggregate supplier and excess soil receiver can contribute to GHG reduction.

Source and reuse site proponents should consider climate change mitigation and GHG reduction measures wherever possible. Best practices for reducing GHG emissions include:

- Minimize the generation of excess soils from the source site through project design and planning
- The most climate-positive reuse is reusing the soil on the source site
- Consider the establishment and use of local temporary sites, where applicable
- Identify reuse sites that reduce the distance the soil travels
- Choose routes and transport times of day that includes not only the shortest distance, but also takes traffic and idling times into consideration
- Control operational efficiency of the equipment on-site to reduce idle time
- Revisit supply chain, and promote the use of local material, equipment, and firms.

7.2. Climate change adaptation

Climate change adaptation considerations may be more relevant to long-term planning or policymaking rather than day to day site operations. The impact of climate change on different parts of Ontario is anticipated to be varied given its large geographical area. However, the following general patterns are anticipated over the coming decades:

- An increase in annual precipitation level, the number of days of precipitation, as well as an anticipated increase in the frequency of high intensity precipitation events, which may increase surface runoff and soil erosion across the province.
- An increase in groundwater recharge because of the overall increase in precipitation and increased water infiltration due to an earlier spring melt.
- An increase in annual average temperature, which may result in a shift from continuous permafrost to discontinuous or sporadic permafrost in Northern Ontario (The destruction of permafrost is a factor contributing to soil erosion in these areas).
- An anticipated increase in frequencies of future wind gust events by the end of the century, which can contribute to soil erosion.
- An impact on the balance of invasive and native species (including aquatic and terrestrial wildlife and plants) across the province as a result of aforementioned stressors.
- Local increase in groundwater elevation which may saturate material that was otherwise anticipated to remain in the vadose zone (see Sections 4.5 and 3.7 of the *Scientific Report* for discussion of soil quality and geotechnical stability considerations in saturated conditions, respectively).

8. Acknowledgements

The preparation of this best management practice document was not possible without the inputs of the OSPE Excess Soil Project Steering Committee members. The efforts of all committee members listed below are acknowledged.

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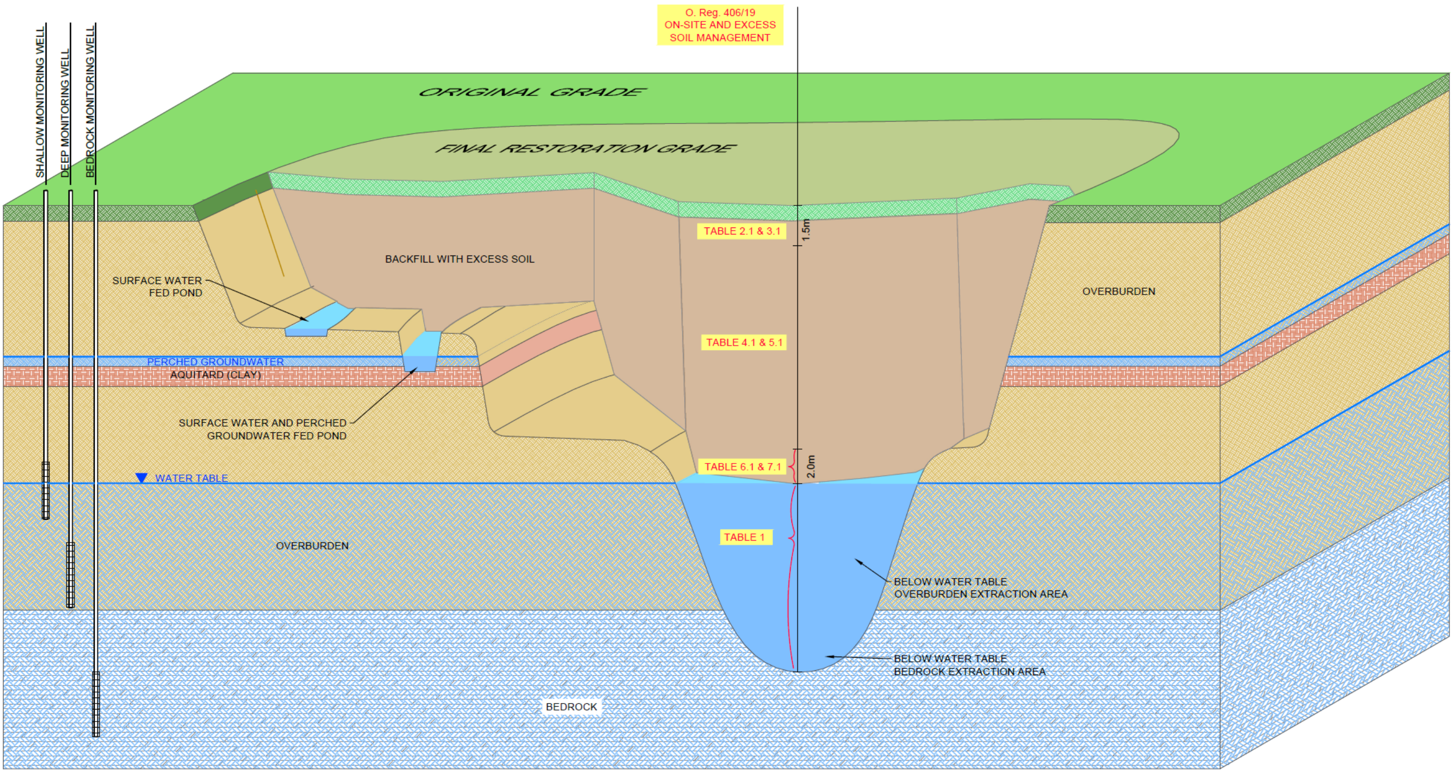
10. Appendix

10.1. Appendix 1: Layer-Cake Approach for Pit and Quarry Rehabilitation

Figure a.1 shows the conceptual site model of a typical pit or quarry that reaches below the water table. This figure shows how a pit or quarry can be rehabilitated using a 'layer-cake approach'. Therefore, the quality of the soil appropriate for each layer is shown on the figure. Figure a. 2 shows a less common setting in which the pit or quarry is located in a highly permeable karst geological structure. To see examples of applying the proposed methodology to case studies see Appendix 7 of the *Scientific Report*.

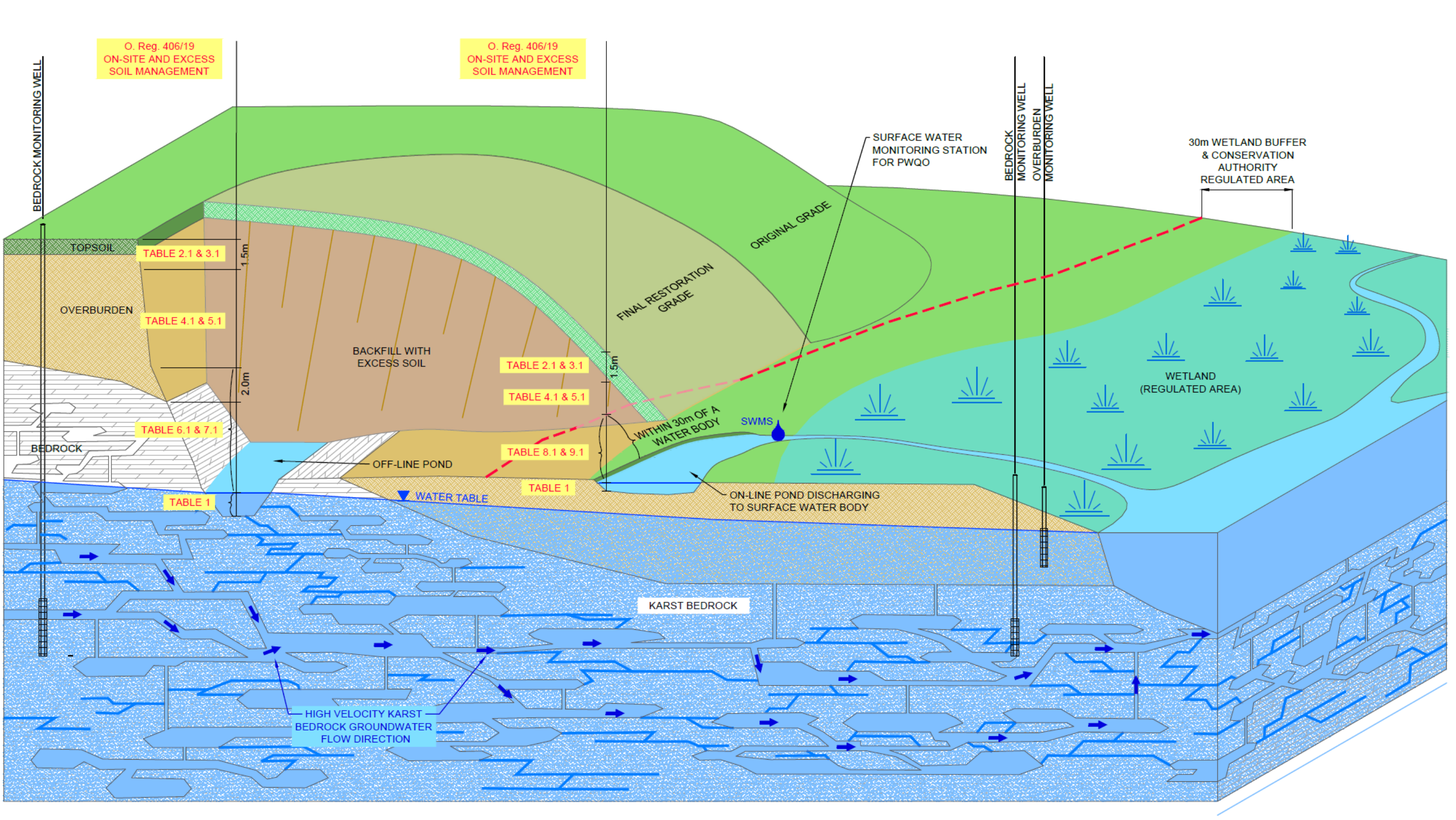


NOTES:
Tables 2.1, 4.1, and 6.1 are for potable groundwater conditions.
Tables 3.1, 5.1, and 7.1 are for non-potable groundwater conditions.

Site specific studies can also be used to determine appropriate soil quality standards including:
- Beneficial Reuse Assessment Tool (BRAT)
- Site Specific Risk Assessment (SSRA)

	Figure Title: **BACKFILLING PITS AND QUARRIES WITH EXCESS SOIL** CONCEPTUAL SITE PLAN TYPICAL CONDITIONS		
Client: **ONTARIO SOCIETY OF PROFESSIONAL ENGINEERS (OSPE)**	Drawn: C.S. Checked: J.W. Scale: N.T.S.	Date: NOVEMBER 2020 Project No.: OPSE	Figure No.: **1**

Figure a. 1. Conceptual site model of a typical pit or quarry below the water table. The application of the layer-cake approach for rehabilitating this site is shown.



NOTES:
Tables 2.1, 4.1, and 6.1 are for potable groundwater conditions.
Tables 3.1, 5.1, and 7.1 are for non-potable groundwater conditions.

Site specific studies can also be used to determine appropriate soil quality standards including:
- Beneficial Reuse Assessment Tool (BRAT)
- Site Specific Risk Assessment (SSRA)

Figure Title	**BACKFILLING PITS AND QUARRIES WITH EXCESS SOIL** CONCEPTUAL SITE PLAN - UNUSUAL CONDITIONS
Client: **ONTARIO SOCIETY OF PROFESSIONAL ENGINEERS (OSPE)**	Drawn: C.S. / Checked: J.W. / Date: NOVEMBER 2020 / Scale: N.T.S. / Project No.: OPSE / Figure No.: **2**

Figure a. 2. Conceptual site model of a pit or quarry below the water table located in karst in the presence of a surface water body.The application of the layer-cake approach is demonstrated.

10.2. Appendix 2: Geochemical Models for Metal Fate and Transport

Placing soil below the water table requires modeling metal fate and transport in saturated conditions, something that is not incorporated into *O. Reg. 406/19* and associated rules. Geochemical models for assessing the risk of chemicals in saturated conditions are categorized into three classes: static, reaction path and coupled reactive transport models. Table a.1 shows several examples of the available geochemical models that are used by practitioners and academics. It also mentions their modeling approach and whether they are in public domain (i.e., available for free). These models are an option for QPs who decide to evaluate alternatives to Table 1 for placement of fill below the water table.

Table a.1. Examples of geochemical models for assessing the risk of metal fate and transport

Model	Category	Public domain
2DFATMIC	Coupled reactive transport	Yes
3DFATMIC	Coupled reactive transport	Yes
BIOMOC	Coupled reactive transport	Yes
BIOPLUME III	Coupled reactive transport	Yes
BIOSCREEN	Coupled reactive transport	Yes
CHEMFLO	Coupled reactive transport	Yes
FEHM	Coupled reactive transport	Yes
FLOTRAN	Coupled reactive transport	No
HST3D	Coupled reactive transport	Yes
HYDROBIOGEOCHEM	Coupled reactive transport	Yes
MOC	Coupled reactive transport	Yes
MOC3D	Coupled reactive transport	Yes
MOFAT	Coupled reactive transport	Yes
MPATH	Coupled reactive transport	Yes
MIN3P	Coupled reactive transport	No
MT3D	Coupled reactive transport	Yes

PHAST	Coupled reactive transport	Yes
PHREEQC	Coupled reactive transport	Yes
RITZ	Coupled reactive transport	Yes
RT3D	Coupled reactive transport	Yes
SUTRA	Coupled reactive transport	Yes
UNSATCHEM	Coupled reactive transport	Yes
VLEACH	Coupled reactive transport	Yes
VS2DT	Coupled reactive transport	Yes
AquaChem	Static models	No
CHESS	Static models	Yes
EQ3/6	Static models	No
Geochemist's Workbench	Static models	No
MinEQL+	Static models	No
MINTEQA2	Static models	Yes
NETPATH	Reaction path or static	Yes
PHREEQC2	Static or reactive transport	Yes
PHRQPITZ	Static models	Yes
SteadyQL	Static models	No
WATEQ4F	Static models	Yes
WHAM	Static models	No