



Chapman Bros. Construction Limited

# Westchester Quarry Expansion Project Rose, Cumberland County, Nova Scotia

Addendum to Environmental Assessment Registration Document

December 2022

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# 1 INTRODUCTION

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Chapman Bros. Construction Ltd. (Chapman Brothers) is a construction company which operates an aggregate quarry—Westchester Quarry—located at 2327 Westchester Road, PID 25090887, in the community of Rose, Cumberland County. The quarry is 3.875 ha and operates under a Nova Scotia Industrial Approval (Approval No. 2014-088699) for a quarry less than 4 ha in area. The Quarry has been operated by Chapman Brothers since 2014 and is now reaching its maximum allowable size.

Chapman Brothers has applied for approval from the Province of Nova Scotia to increase the maximum allowed extent of the quarry to 40.36 ha which it proposes to develop gradually in stages, involving both development and reclamation, to allow the company to continue its operations over the next several decades. Environmental Assessment Regulations under the Nova Scotia *Environment Act* require that an environmental assessment following prescribed guidelines be conducted for operation of a quarry 4.0 ha or larger. Chapman Brothers conducted an Environmental Assessment of the proposed expansion and submitted an Environmental Assessment Registration for the proposed expansion in November 2021 as a Class I undertaking under Part IV of the *Environment Act* (<https://novascotia.ca/nse/ea/Chapman-Brothers-Westchester-Quarry-Expansion-Project/>).

After review of the Registration, the Province of Nova Scotia requested additional background information on the project to complete the review, through a letter from the Nova Scotia Minister of Environment and Climate Change (Appendix A) in January 2022. The present document provides additional analysis and results of several environmental studies which were conducted in 2022 to address the Minister’s information request.

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## 2 MINISTER’S REQUEST FOR ADDITIONAL INFORMATION

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### 2.1 REQUIREMENT: SURFACE WATER RESOURCES

#### 2.1.1 Supporting Text

*In consultation with the Sustainability and Applied Science Division of Environment and Climate Change, prepare and provide details for the surface water resources assessment with accompanying discussion and analysis of potential effects to surface water resource quality and quantity, which includes the following:*

- 1) *A detailed water balance analysis for the proposed quarry expansion. This analysis should include the following and be signed off by a qualified Professional Engineer or Geoscientist:*
  - *Analysis of flows and discharges under current and post-development conditions (including reclamation conditions) with considerations for seasonal variation, with an assessment of potential impacts on the water resources identified in the Registration Document resulting from this analysis.*

- *Delineation of watersheds for current and post-development conditions, modelling of flows and discharges using information currently available and justified assumptions where needed, and considerations for validation through monitoring;*
  - *A plan to progressively monitor and update results.*
- 2) *Further details and assessment surrounding surface water management for the various phases of the proposed quarry development (including reclamation case).*

### **2.1.2 Proponent Response**

A Surface Water and Groundwater Resources Management Plan, which includes a development plan for the quarry, was prepared by W.G. Shaw and Associates is presented in Appendix B.

The water balance analysis demonstrated that the change in surface water runoff at the discharge location of the Jersey Road Watershed will be from +0.1% to -1.1 % at a selected location under various development scenarios. These changes to runoff and streamflow are not expected to have significant adverse effects on surface water resources. The conclusion supports the conclusions of the initial Environmental Assessment that after mitigation, there would not be significant effects on groundwater or surface water resources at the site.

## **2.2 REQUIREMENT: COMPREHENSIVE WATER QUALITY MONITORING PROGRAM**

### **2.2.1 Supporting Text**

- 3) *A comprehensive water quality monitoring program in clear flow conditions (not turbid flow caused by a recent precipitation event) and associated assessment in the second unnamed watercourse immediately east to the existing quarry site to understand whether the significant elevations of TSS, conductivity and specific conductivity in this watercourse are associated with existing quarry activities. If so, provide appropriate mitigation measures to be planned and incorporated into the surface water management with the development plan of the proposed expansion. If the elevated turbidity is determined to be unrelated to the existing quarry, provide specific mitigation measures to be included to prevent further impacts to the water quality in this watercourse as a result of the proposed expansion.*

### **2.2.2 Proponent Response**

A Comprehensive Water Quality Monitoring Program (CWQMP), which was carried out from May to September 2022, monitored standard water quality parameters in particular conductivity and Total Suspended Solids in the watercourse immediately adjacent to and east of the Westchester Quarry, as well as in two watercourses of similar size on opposite sides of the watercourse, The CWQMP was carried out by Envirosphere Consultants Limited and the report is presented in Appendix C.

The Comprehensive Water Quality Monitoring Program (CWQMP) found that Total Suspended Solids (TSS) was not elevated in the subject watercourse downstream of the Westchester Quarry, suggesting that activities at the Quarry were not responsible for an elevated level of TSS reported in September 2017. The CWQMP did,

however, show that conductivities in the subject watercourse were slightly elevated over levels typical in the area, which may be due to the influence of the quarry access road. The conclusion supports the conclusions of the initial Environmental Assessment that after mitigation, there would not be significant effects on water quality in watercourses at the site.

## 2.3 REQUIREMENT: FISH AND FISH HABITAT STUDY

### 2.3.1 Supporting Text

- 1) Provide further information regarding the fish habitats along the two unnamed intermittent streams to the north/northeast to determine the risks to fish and fish habitat. Manmade barriers are not considered when assessing fish habitat, as restoration activities may restore access, and/or the habitats may provide contributions to accessible habitat downstream.*

### 2.3.2 Proponent Response

A Fish and Fish Habitat Study, which was conducted in July and September 2022, assessed the presence of fish and suitable fish habitat, as well as relevant water quality measurements at several locations in the two watercourses east of the quarry, including in the upper and lower watersheds. The study was developed in consultation with Fisheries and Oceans Canada. The Fish and Fish Habitat Study was carried out by EnviroSphere Consultants Limited and the report is presented in Appendix D.

The Fish and Fish Habitat Study found no fish in the two watercourses upstream of Westchester Road, including adjacent to the Quarry, and concluded that although there is potential habitat in upstream areas, barriers to fish passage including 'hanging' culverts on Westchester Road, and secondarily on the Quarry access road further downstream may prevent fish from reaching upstream areas. Headwaters of both watercourses are in forested areas which provide inputs of organic matter and nutrients to downstream areas. The conclusions are the same as in the initial Environmental Assessment of the project, namely that with appropriate mitigation, there would not be significant impacts from the Quarry on fish and fish habitat in watercourses adjacent to the site.

## 3 CONCLUSION

In response to a request from the Nova Scotia Minister of Environment and Climate Change for additional information in support of the Environmental Assessment Registration for the expansion of its Westchester Quarry, Chapman Brothers has prepared a surface water and groundwater resources management plan, which includes a development plan; and has conducted both a Comprehensive Water Quality Monitoring Program, and a Fish and Fish Habitat Assessment, focused on watercourses in the immediate vicinity east of the Quarry. The three reports are presented in Appendices to this Addendum report, which is submitted as part of the process to fulfill requirements for an Environmental Assessment Registration for a Quarry expansion beyond 4 ha, as outlined in the Nova Scotia *Environment Act*.

## APPENDICES

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## **APPENDIX A – MINISTER’S DECISION LETTER AND REQUEST FOR INFORMATION**

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**Environment and Climate Change  
Office of the Minister**

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PO Box 442, Halifax, Nova Scotia, Canada B3J 2P8 • Telephone 902-424-3736 • [novascotia.ca](http://novascotia.ca)

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File number: 10700-40-57981  
40100-30-311

January 18, 2022

James C. Chapman, P.Eng.  
Chapman Bros. Construction Ltd.  
32 Maplewood Drive  
New Glasgow, Nova Scotia  
B2H 5Y2  
Email: [cbcl.jamie@bellaliant.com](mailto:cbcl.jamie@bellaliant.com)

Dear James C. Chapman:

**Re: Environmental Assessment – Westchester Quarry Expansion – Rose, Cumberland County, NS**

The environmental assessment of the proposed Westchester Quarry Expansion has been completed.

This is to advise that, pursuant to section 13 (1)(a) of the Environmental Assessment Regulations, I have determined that the Registration Document provided is insufficient to allow a decision, and that I require additional information. Specifically, the review determined that the following additional information is required to evaluate the potential environmental effects that may be caused by the undertaking:

**Surface Water Resources:**

In consultation with the Sustainability and Applied Science Division of Environment and Climate Change, prepare and provide details for the surface water resources assessment with accompanying discussion and analysis of potential effects to surface water resource quality and quantity, which includes the following:

- 1) A detailed water balance analysis for the proposed quarry expansion. This analysis should include the following and be signed off by a qualified Professional Engineer or Geoscientist:
  - Analysis of flows and discharges under current and post-development conditions (including reclamation conditions) with considerations for seasonal variation, with an assessment of potential impacts on the water resources identified in the Registration Document resulting from this analysis.
  - Delineation of watersheds for current and post-development conditions, modelling of flows and discharges using information currently available and justified assumptions where needed, and considerations for validation through monitoring;
  - A plan to progressively monitor and update results.

.../2



- 2) Further details and assessment surrounding surface water management for the various phases of the proposed quarry development (including reclamation case).
- 3) A comprehensive water quality monitoring program in clear flow conditions (not turbid flow caused by a recent precipitation event) and associated assessment in the second unnamed watercourse immediately east to the existing quarry site to understand whether the significant elevations of TSS, conductivity and specific conductivity in this watercourse are associated with existing quarry activities. If so, provide appropriate mitigation measures to be planned and incorporated into the surface water management with the development plan of the proposed expansion. If the elevated turbidity is determined to be unrelated to the existing quarry, provide specific mitigation measures to be included to prevent further impacts to the water quality in this watercourse as a result of the proposed expansion.

**Fish and Fish Habitat:**

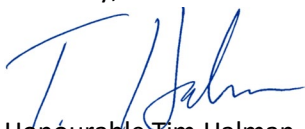
- 1) Provide further information regarding the fish habitats along the two unnamed intermittent streams to the north/northeast to determine the risks to fish and fish habitat. Manmade barriers are not considered when assessing fish habitat, as restoration activities may restore access, and/or the habitats may provide contributions to accessible habitat downstream.

This information must be submitted by the Proponent within one year, as an addendum to the original Registration Document. Upon submission of the information, I will have 50 days to make my decision.

The Proponent shall publish a notice in the same manner as the original notice under Section 10 of the Environmental Assessment Regulations announcing the release of the additional information to the public and stating that the written comments may be submitted about the additional information to the Department.

If you have any questions regarding the approval of this project, please contact Helen MacPhail, Supervisor, Environmental Assessment Branch, (902) 483-2696 or [helen.macphail@novascotia.ca](mailto:helen.macphail@novascotia.ca).

Sincerely,



Honourable Tim Halman, MLA  
Minister of Environment and Climate Change

c: Helen MacPhail, Supervisor, Environment and Climate Change

## **APPENDIX B – SURFACE WATER AND GROUNDWATER RESOURCES MANAGEMENT PLAN**

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Chapman Brothers Construction Ltd.

Westchester Quarry

Rose, Cumberland County, Nova Scotia

Surface Water and Groundwater Resources Management Plan

presented to:

Chapman Brothers Construction Ltd.

W.G. Shaw & Associates Ltd.  
Consulting Geoscientists  
April 11, 2022

**W.G. Shaw & Associates Ltd.****Consulting Geoscientists**

4546 Highway #7  
Antigonish , Nova Scotia  
Canada B2G 2L3  
phone: (902) 863 - 1903  
E-mail : wgshaw@eastlink.ca

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Mr. Jamie Chapman, P.Eng.  
32 Maplewood Drive  
New Glasgow, Nova Scotia  
Canada, B2H 5Y2

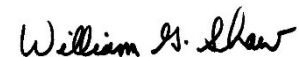
April 11, 2022

Re: Chapman Brothers Construction Ltd. - Westchester Quarry Expansion

Dear Mr. Chapman,

Please find attached a technical report that presents the “Surface Water and Groundwater Resources Management Plan” for the Westchester Quarry Expansion Project.

Sincerely,



William G. Shaw, P.Geo.  
President



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## **1.0 Introduction**

This technical report is supplementary to the report entitled “Westchester Quarry Expansion Project, Rose, Cumberland County, Nova Scotia, Environmental Assessment Registration for a Class 1 Undertaking – Section 9 (1) of the Nova Scotia Environment Assessment Regulations” by Chapman Brothers Construction Ltd, dated November of 2021.

The Westchester Quarry (Quarry) is located at 2327 Westchester Road, near the community of Rose in Cumberland County, Nova Scotia (Figures #1 and #2)(PID# 2509 0887).

Chapman Brothers Construction Ltd. (Chapman Brothers) owns and operates the Westchester Quarry under Nova Scotia Environment and Climate Change Industrial Approval #2014-088699 which provides for the operation of a crushed stone aggregate quarry with an active area of less than four hectares.

The current active area, which covers approximately 4 hectares, includes a rock quarry, quarry roads, an access road, a mobile crushing plant, a weigh scale and scale house, and heavy equipment associated with a crushed stone aggregate quarry. Since 2016, the annual production of rock products at the Westchester Quarry has been an approximately 25,000 tonnes.

Chapman Brothers Construction Limited is proposing to expand the active area of the existing Westchester Quarry from 4 hectares to 40.3 hectares (Figures #2, #3 and #5).

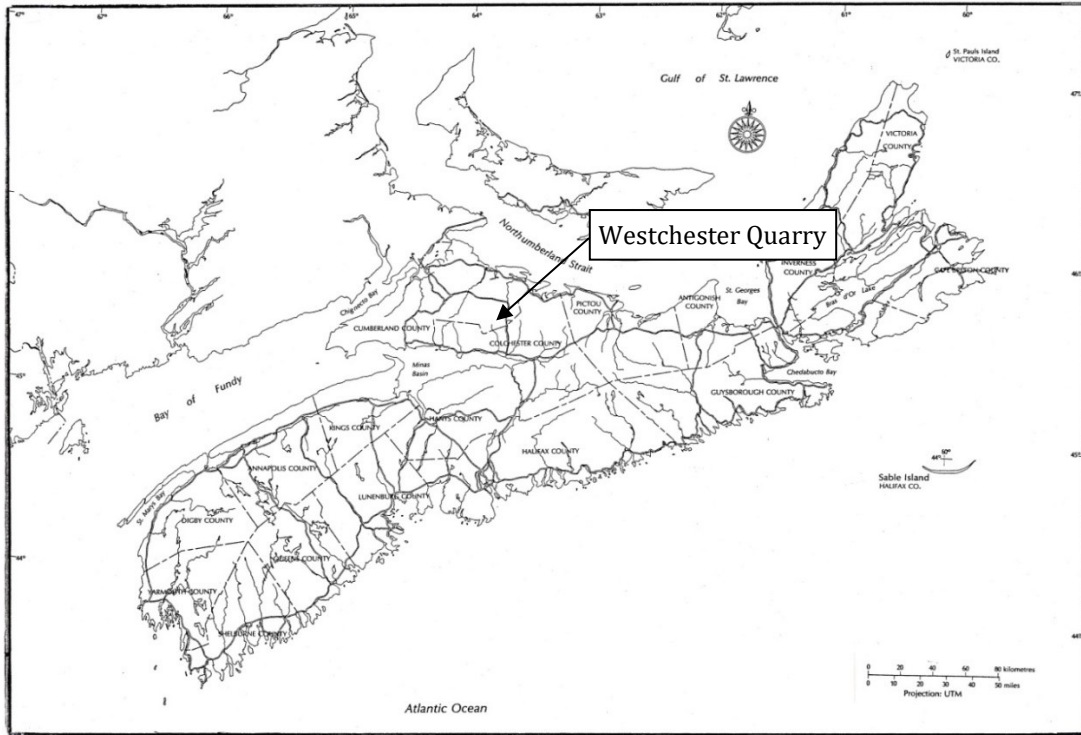


Figure #1 Location of the Westchester Crushed Stone Aggregate Quarry

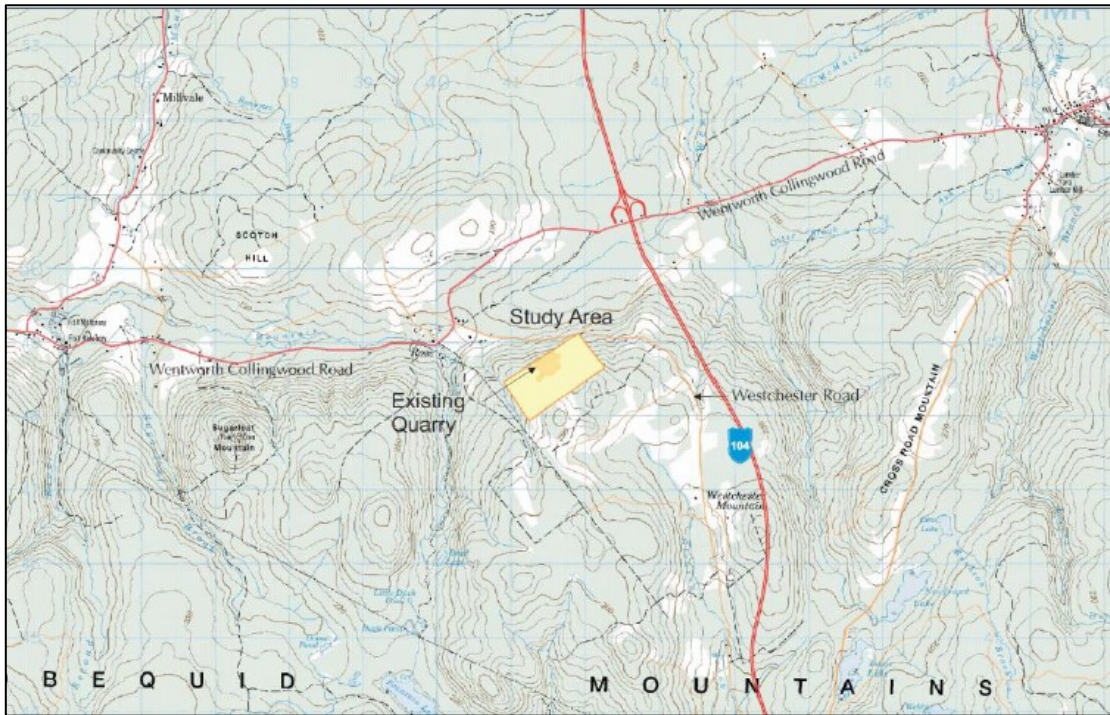


Figure #2 Location of Westchester Quarry on 1:50 K Topo Map (from Chapman Brothers Construction Ltd., 2021)

## **2.0 Future Development Plans**

The production of crushed stone aggregate products at the Westchester Quarry over the next several decades will depend on the demand for aggregate for projects in Prince Edward Island and north-mainland, Nova Scotia.

The future development plan for the Quarry is to operate entirely above the water table at approximately the current quarry floor base level which is 250 metres above sea level. The future plan is to advance the quarry high-wall toward the south and west in order to access successive up-slope and lateral rock material (Figures #3 and #4).

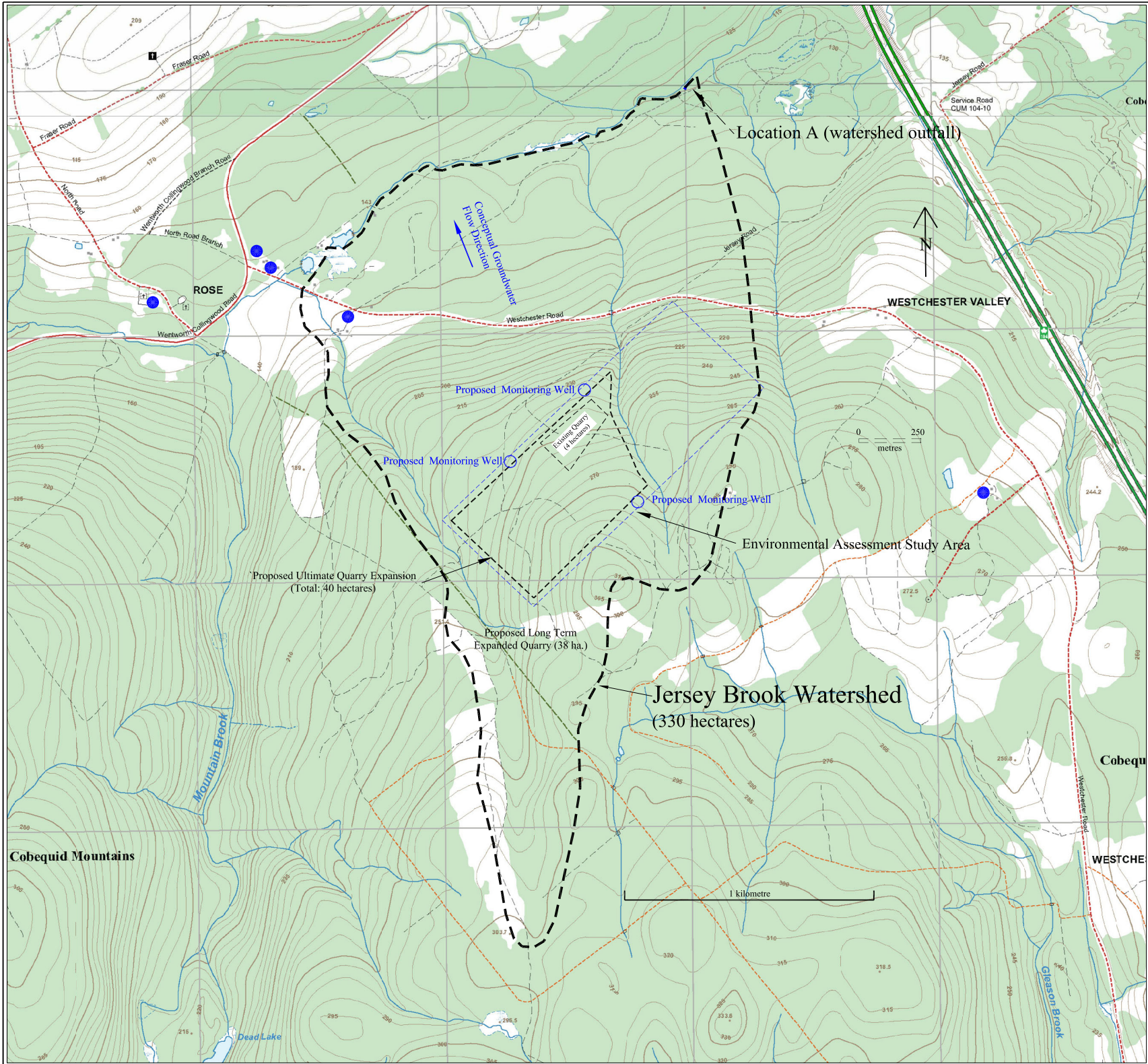
Chapman Brothers intends to continue quarry operations at the Westchester Quarry using existing infrastructure as the quarry expands over the next several decades. It is anticipated that future production will supply 25,000 to 100,000 tonnes of aggregate per year, for 50 years or more, as a result of the quarry expansion. The annual quantity may vary depending on demand and future project requirements. The maximum resource available is estimated to be approximately 25 million tonnes.

Surface water drainage control will be maintained by constructing a series of low-gradient drainage ditches that will direct surface runoff toward the northeast corner of the future quarry and into two sedimentation ponds located in the northeast corner. From the sedimentation ponds, the surface water will be directed into a rock-lined drainage ditch which will direct the water toward the north to a mixed forest area which will accommodate the overland flow. Effective erosion and sedimentation control mechanisms will be installed where needed.

Water for dust suppression will be obtained either from sedimentation ponds on site or brought in from off-site sources, at an expected rate of use of less than 23,000 L / day.

At present , aggregate produced at the Westchester Quarry is not washed on site. If a requirement for washed aggregate arises, water used will be from on site sources such as sedimentation ponds or brought in from off-site sources and recycled in ponds constructed for that purpose.





Explanation

● Private Water Well (house well)

Chapman Brothers Construction Ltd.

Westchester Quarry

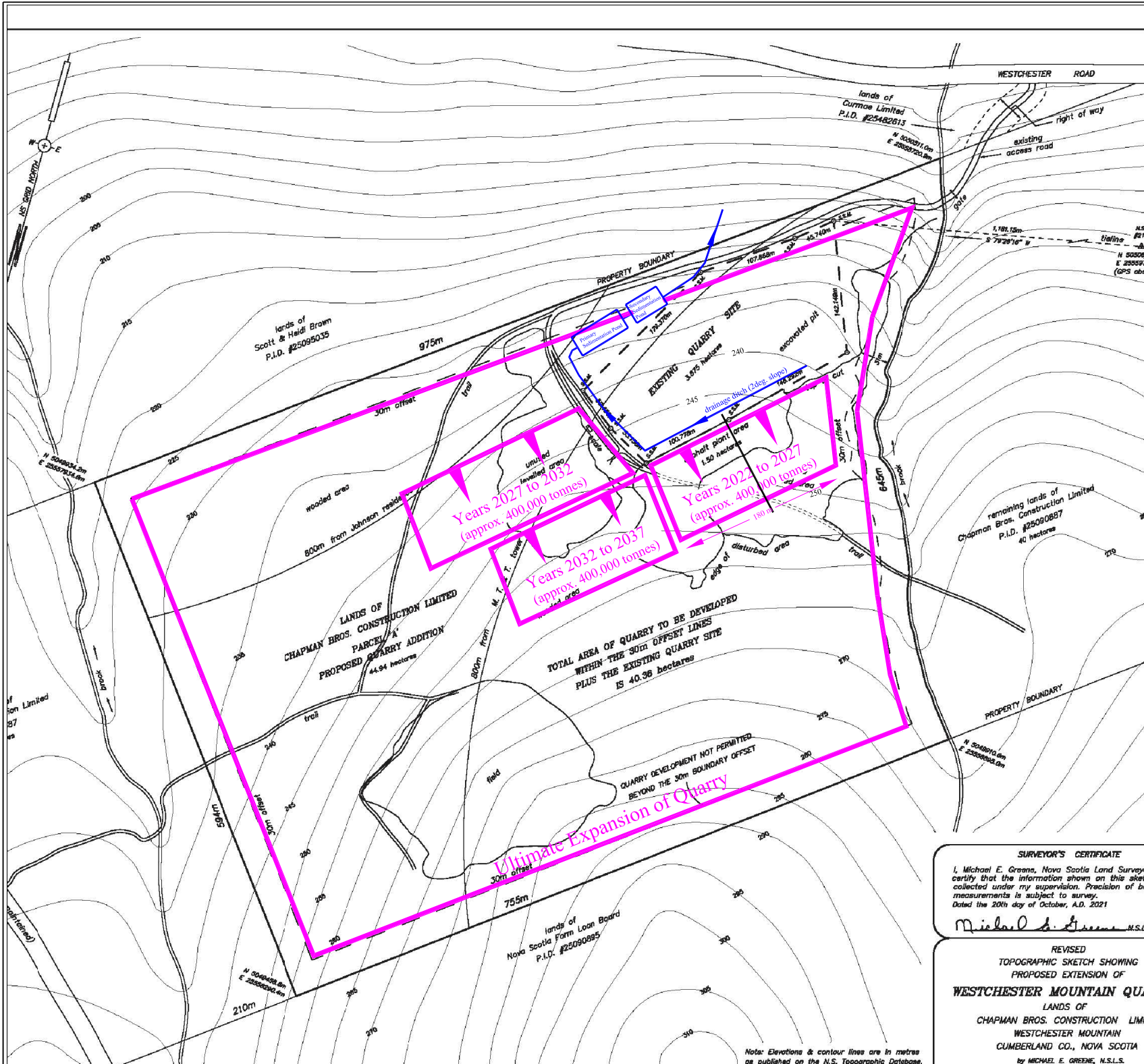
Cumberland County, Nova Scotia

Figure #3

March, 2022

# Explanation

Direction of Bench Face Advancement



TOTAL AREA OF QUARRY TO BE DEVELOPED WITHIN THE 30m OFFSET LINES PLUS THE EXISTING QUARRY SITE IS 40.36 hectares

QUARRY DEVELOPMENT NOT PERMITTED BEYOND THE 30m BOUNDARY OFFSET

**SURVEYOR'S CERTIFICATE**  
 I, Michael E. Greene, Nova Scotia Land Surveyor, certify that the information shown on this sketch was collected under my supervision. Precision of measurements is subject to survey.  
 Dated the 20th day of October, A.D. 2021  
*Michael E. Greene, M.S.L.S.*

REVISED  
 TOPOGRAPHIC SKETCH SHOWING  
 PROPOSED EXTENSION OF  
**WESTCHESTER MOUNTAIN QUARRY**  
 LANDS OF  
 CHAPMAN BROS. CONSTRUCTION LIMITED  
 WESTCHESTER MOUNTAIN  
 CUMBERLAND CO., NOVA SCOTIA  
 by MICHAEL E. GREENE, M.S.L.S.

Notes: Elevations & contour lines are in metres as published on the N.S. Topographic Database.

Chapman Brothers Construction Ltd.

Westchester Quarry

Cumberland County, Nova Scotia

Figure #4

March, 2022

### **3.0 Regional Landscape, Topography and Climate**

The Westchester Quarry is located in the north-central part of the Cobequid Mountain Natural Landscape. This natural landscape is a 90 kilometres long, rectangular shaped, east-trending upland area that reaches maximum elevations of approximately 320 metres. The top of this natural landscape is characterized by a broad, fairly smooth to undulating terrain that is dissected by numerous sub-linear and dendritic watercourses, most of which flow northward and southward from the high elevations.



Photograph #1 View of the Crushed Stone Stockpile Area (facing northeast)



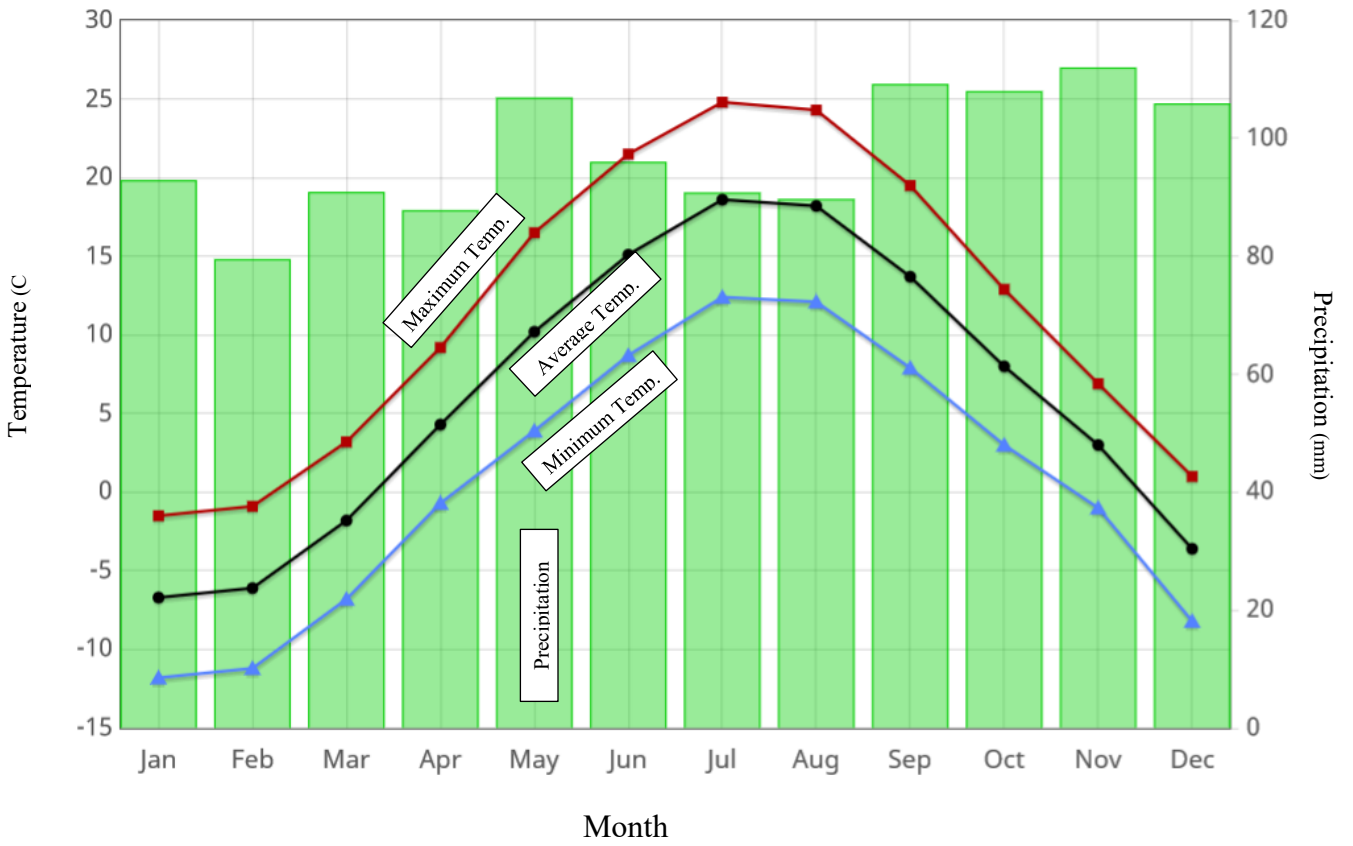
Photograph #2 View of the High Wall at the South End of the Quarry (facing south)

### Climate

The Westchester Quarry area has a humid, temperate, continental climate that is modified by the proximity to the Northumberland Strait. The mean annual temperature is 6.8°C. The warmest temperatures are generally in July, with a mean of 18°C, and the coldest temperatures are in February with a mean of -6°C.

### Precipitation

The Westchester Quarry area receives total annual precipitation of 1,000 to 1,300 millimetres with a mean annual figure of 1,165 millimetres. Much of the precipitation and moisture surplus occurs within one distinct wet season from mid-November to mid-March. Snowfall events occur between late November to early April with typical total yearly snowfall accumulations in the order of 3.1 metres. A warming trend from March through April releases the snow pack, and eliminates the frost cover to generate a major surface water runoff and groundwater recharge event from March to May. There is generally a significant dry season that lasts from June to mid-September. The summer season is generally relatively dry with rainfall accumulations of less than 10 centimetres common for the months of June, July and August.



Graphic Illustration #1: Temperature and Precipitation Graph for 1981 to 2010 Canadian Climate Normals, Debert, Nova Scotia (Environment Canada)

#### 4.0 Surface Water Resources and Local Drainage

The Westchester Quarry is located within the Wallace River Secondary Watershed (Figure #5).

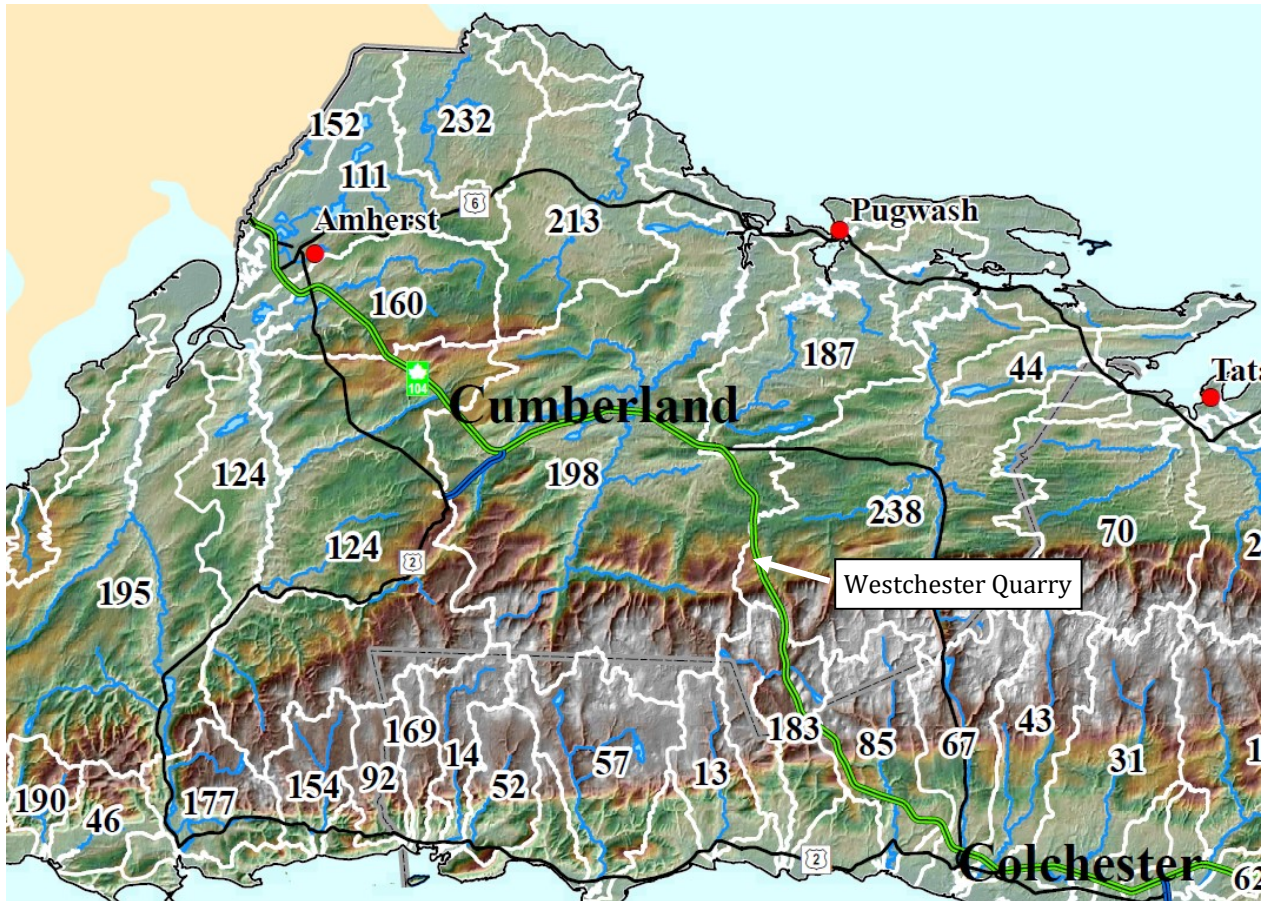


Figure #5 Wallace River Secondary Watershed (#238) on Secondary Watershed Maps of Nova Scotia

Local surface water drainage and runoff from the Quarry is by overland flow toward the northeast, north and northwest ultimately flowing into one of two, unnamed watercourses labeled East Branch and West Branch within a tertiary watershed we have named the Jersey Brook Watershed<sup>1</sup> (Figure #3).

<sup>1</sup> The name "Jersey Brook Watershed" has been chosen by the author after the name of a local, gravel road.

Expansion of the quarry will result in some changes in local surface water runoff patterns which may affect the Jersey Brook Watershed. Exposed surfaces on the quarry floor and on access roads can result in flashy runoff patterns during heavy rainfall and snow melt events. The planned drainage ditches, erosion control berms and the sedimentation ponds will be designed to mitigate these effects.

Chapter 6.0 addresses anticipated changes in surface water runoff and groundwater recharge.

## 5.0 Hydrogeology of the Quarry Area

### 5.1 Surficial Sediments (Soils)

Soils and Surficial sediments, in the vicinity of the Westchester Quarry consist of gravely, sandy silt (glacial till) which has been derived from local bedrock sources. In the immediate vicinity of the Westchester Quarry, the surficial sediments are from 0.5 to 2 metres thick.

### 5.2 Bedrock

Bedrock within the Westchester Quarry is dominated by dark grey coloured, fine grained diorite and gabbro (black granite) with subordinate amounts of orange coloured, medium grained granite. These rock-types are crystalline in character and are extensively fractured with several fracture pattern orientations; therefore, groundwater flow is by “fracture flow” throughout the bedrock unit (Figure #6).

Approximately 500 metres north of the Westchester Quarry, the crystalline rocks are overlain by a thick, sandstone unit which is part of the regionally extensive Boss Point Formation (Figure #3).

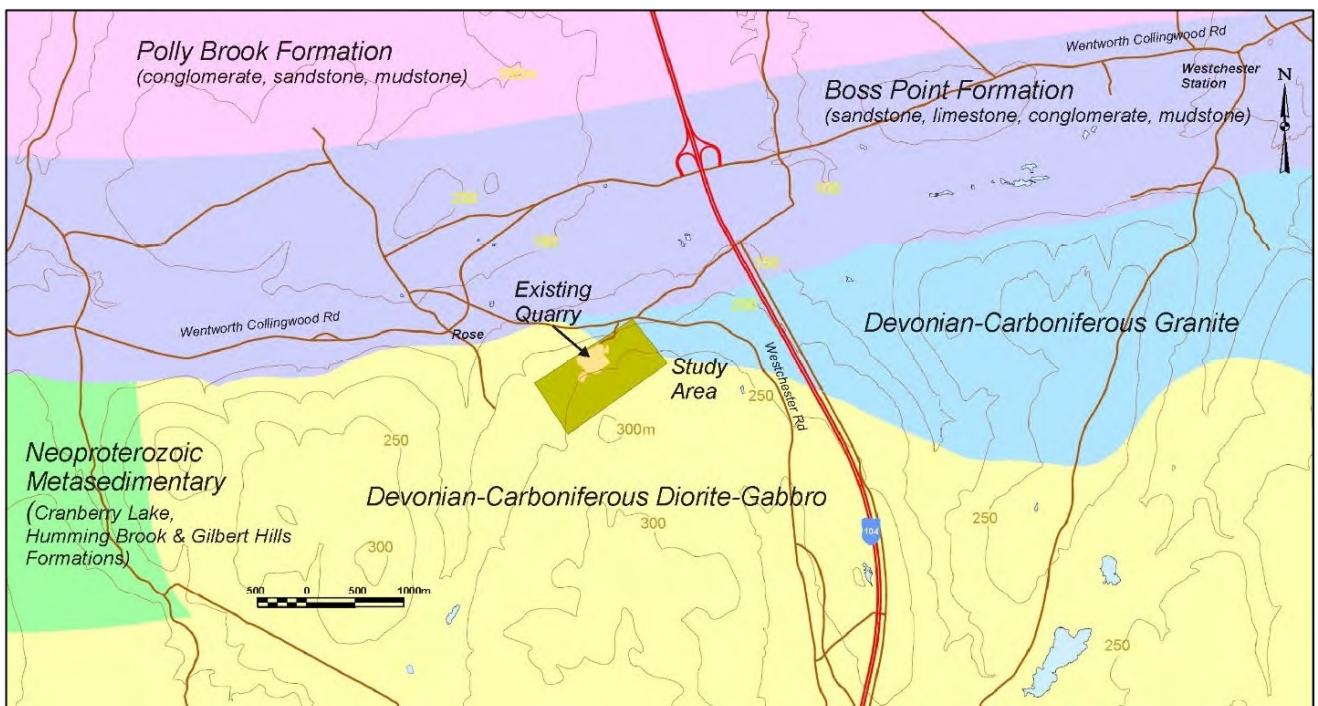


Figure #6 Bedrock Geology Map of the Westchester Quarry Area





Photograph #3 View of the Active Face of the Quarry in 2017 (facing southeast)



Photograph #4 View of the Active Face of the Quarry in 2017 (facing southwest)

### **5.3 Hydrogeology**

In the vicinity of the Westchester Quarry, groundwater flow direction would be expected to be a subdued replica of the topographic gradient which is toward the north, northeast and northwest.

As part of our field research, we conducted field mapping within several kilometres of the Westchester Quarry with emphasis on the location of occupied dwellings which would have private water supply wells. There are three private water supply wells from 900 to 1,500 metres northwest and one private water supply well located 1,600 metres east of the existing quarry (Figure #3). Some permanent homes and seasonal residences in the vicinity of the Westchester Quarry have dug wells or transport water to their properties.

We researched the Nova Scotia Groundwater Atlas to match drilled well records with occupied dwellings in the area and found only two of the four wells Normal are included in this NSE database. Both of these wells are in the vicinity of the community of Rose and have total depths of 31.4 and 56.9 meters and estimated yields of 10 to 15 litres per minute.

## **6.0 Water Balance**

### **6.1 Introduction and Methodology**

A water balance calculation employs the principle of conservation of mass in a closed system, whereby all water entering a system, from rainfall or snow melt, will be transferred into either evaporation, transpiration, surface water runoff, and changes in underground storage (soil water and groundwater). This equation requires the system to be closed; where it is not closed, such as when surface runoff contributes to a different watershed, this must be taken into account.

The general water balance equation is as follows:

$$P = R + ET + \Delta S \quad \text{where}$$

P is precipitation

R is streamflow or surface water runoff

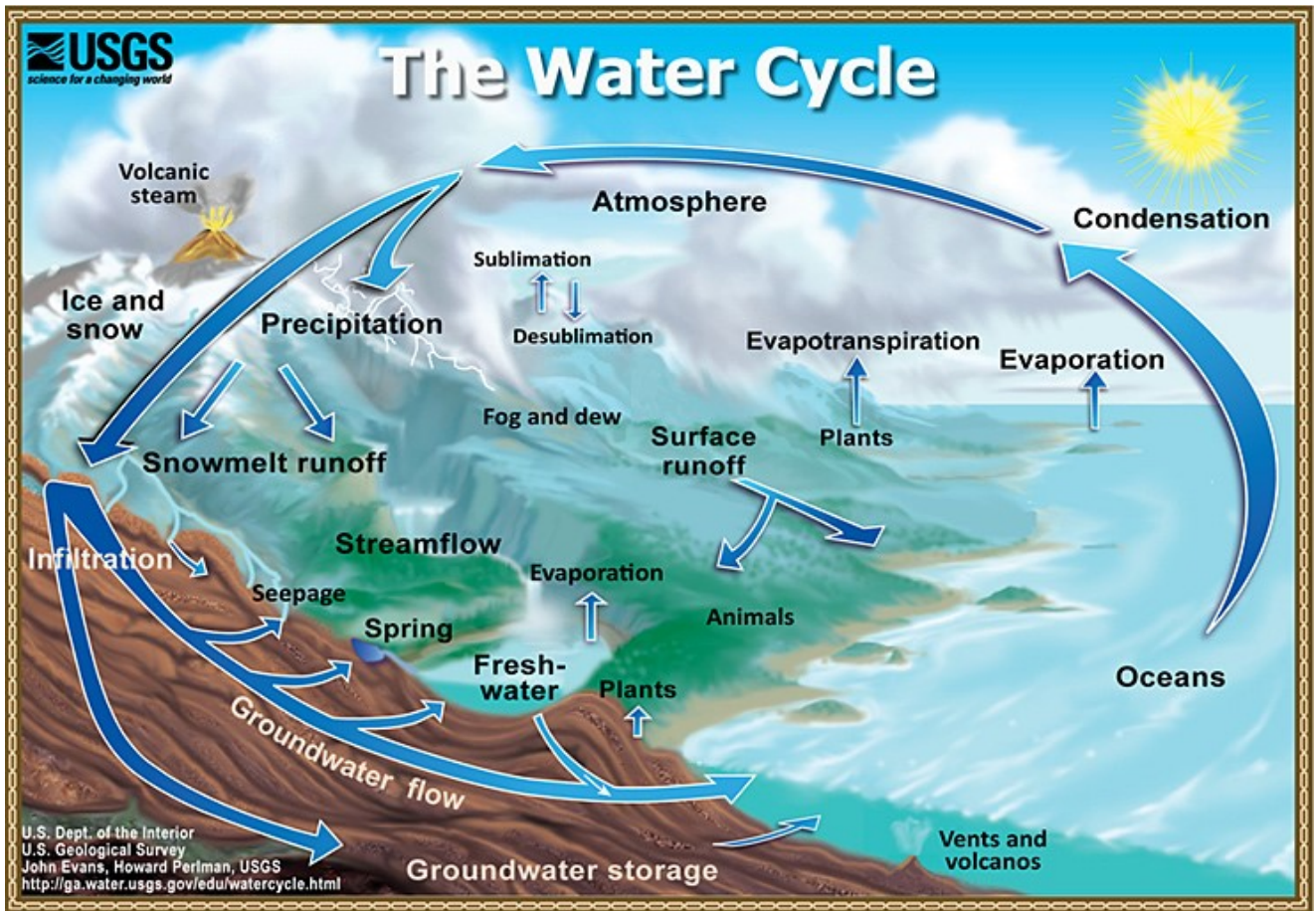
ET is evapotranspiration (evaporation and transpiration)

$\Delta S$  is the change in storage of water (soil water and groundwater)

The water balance can be utilized to assess the quantitative effects on surface water and groundwater resources resulting from a change in land use such as residential, industrial or quarry development.

In this report, the focus of the water balance assessment is to estimate changes in surface water flow patterns as a result of changes in land uses related to the proposed expansion of the Westchester Quarry.

The methodology used in this report is similar to methodologies employed in other technical reports that have been recently submitted for quarry expansion projects in Nova Scotia. We have used the changes in water balance covering the expansion period of 2022 to 2037 as a conceptual indication of the changes that can be anticipated as the development proceeds to the full 40.3 hectares.



Graphic Illustration #2

Schematic Diagram of the Hydrologic Cycle and Water Balance Principle  
(United States Geological Survey, 2009)

For this Water Balance Assessment the following property conditions were analyzed:

- 1) existing conditions at the Westchester Quarry (4 hectares area);
- 2) conditions at 10 hectares of active area;
- 3) conditions at 20 hectare of active area;
- 3) conditions at 40 hectares of active area; and
- 4) conditions after quarry rehabilitation.

Existing conditions include a flat, gravelled quarry area of approximately 4 hectares, nearly flat quarry floor, quarry highwalls, stockpile areas, haulage roads and a site access road.

The water balance was completed using the following inputs:

Total Annual Precipitation	=	1,165	mm
Lake Evaporation (no lakes)	=	0	mm
Potential Evapotranspiration	=	524	mm
Infiltration Factor for Watershed	=	0.28	
Infiltration Factor for Quarry	=	0.30	

As in most quarries in Nova Scotia, the Westchester Quarry will be progressively rehabilitated to simulate pre-quarrying conditions including the following:

- removal of heavy equipment, weigh scale and associated buildings
- reduction of steep slopes
- overall site grading
- re-vegetation efforts

Surface water runoff volumes for this water balance were assumed to equal the total precipitation less the potential evapotranspiration, lake evaporation and infiltration. Infiltration includes groundwater recharge and groundwater that contributes to surface water resources as baseflow.

## **6.2 Watershed Mapping**

The Provincial 1:10,000 scale maps with a contour interval of 5 metres were used to delineate the watershed catchment area for the Jersey Brook Watershed. The existing quarry and proposed quarry expansion area are located in the south part of the Watershed that is approximately 330 hectares in size.

## **6.3 Climate Data**

Precipitation and temperature data were collected from the Debert Climate Station (1981- 2010) which is located approximately 40 kilometers southeast of the Westchester Quarry.

Monthly lake evaporation normals were obtained from the Environment Canada Truro Station (1981-2010). The Truro station is the closest climate station to the Westchester Quarry that collects lake evaporation data and is located approximately 60 kilometres from the Quarry. Monthly potential evapotranspiration normals were calculated using the Hamon equation (1961) (Lu, et al., 2005).

Table #1

Westchester Quarry

Canadian Climate Normals 1981-2010 Station Data

Debert Climate Station, Nova Scotia

Month of Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Temperature (°C)	-6.7	-6.1	-1.8	4.3	10.2	15.1	18.6	18.2	13.7	8.0	3.0	-3.6	6.1
Precipitation (mm)	92.8	79.4	90.8	87.7	106.8	95.9	90.7	89.6	109.1	107.9	111.9	105.8	1,168.3
Lake Evaporation (mm)	0.0	0.0	0.0	0.0	89.9	102.0	117.8	96.1	69.0	40.3	0.0	0.0	515.0
Pot. Evap. Transpiration (mm)	0.0	0.0	0.0	39.3	60.9	87.0	103.5	94.6	66.7	40.9	26.6	0.0	520.0

Notes

1) Lake Evaporation were iobtained from the Truro, Nova Scotia Climate Station

2) Potential Evapotranspiration was calculated using the Hamon equation (1961), Lu, et al., 2005)

**6.4 Infiltration Factors**

The infiltration factor employed in the water balance is the most difficult to quantify due to the lack of hydrologic data specific to the Jersey Brook Watershed. As a result, this report utilizes infiltration factor estimates that are published in the Ontario Ministry of Environment, Conservation and Parks (OMECPP) Stormwater Management Planning and Design Manual (2003).

From this process, Table #2 provides estimates of infiltration factors for the unaffected part of the Jersey Brook Watershed and the Active Area that have been used in the water balance estimates.

It should be noted the expanded quarry floor and the rehabilitated active area will have an average slope of approximately 1% which will be much less than the current topographic slope of 10%. This change in slope is expected to enhance the infiltration of the Active Area (Table #2).

Table #2Westchester Quarry

Jersey Brook Watershed

Infiltration Factor Estimates

Undisturbed Part of Watershed			
Topography	Hilly Land	IF =	0.08
Sediment - Soil Type	Sandy, Gravelly, Silt (glacial till)	IF =	0.10
Vegetation Cover	Partial Woodland	IF =	0.10
Total Infiltration Factor			0.28

Quarry Active Area			
Topography	Flat	IF =	0.20
Sediment - Soil Type	Quarry Floor	IF =	0.10
Vegetation Cover	None	IF =	0.00
Total Infiltration Factor			0.30

IF = Infiltration Factor

**6.6 Results of Water Balance Calculations**

The Westchester Quarry water balance calculations have been generated for four (4) levels of quarry development as listed in Section 6.0 and Table #3.

This water balance assessment provides an estimate of the effects on the entire Jersey Brook Watershed as expressed as total annual runoff at the furthest down-gradient discharge location of the watershed (Location A on Figure #3).

Table #3

Westchester Quarry

## Water Balance Estimates

Conditions	Watershed	Active Area	Unaffected	Available	Potential ET	Infiltration		Surface Water	Change in
	Area	of Quarry	Watershed	Water	(520 mm)	Non-Quarry	Quarry Area	Runoff	
	hectares	hectares		cubic metres	cubic metres	cubic metres	cubic metres	Entire	Surface Runoff
								Watershed	%
								cubic metres	
Existing Conditions	330	4	326	3,854,400	2,004,288	1,066,150	14,016	769,946	0.0
Early Quarry Development	330	10	320	3,854,400	2,004,288	1,046,528	35,040	768,544	-0.2
Mid-Quarry Development	330	20	310	3,854,400	2,004,288	1,013,824	70,080	766,208	-0.5
Full Quarry Development	330	40	290	3,854,400	2,004,288	948,416	140,160	761,536	-1.1
Reclaimed Quarry	330	0	330	3,854,400	2,004,288	1,079,232	0	770,880	0.1

Notes

1) Total annual precipitation = 1,168 mm (1.168 metres)

2) Potential ET = Potential Evapotranspiration

The results of the water balance illustrates the change in surface water runoff at the discharge location of the Jersey Road Watershed will be from +0.1% to -1.1 % at Location A. These changes to runoff and streamflow in East Branch and West Branch are not expected to have significant adverse effects on surface water resources.



## **7.0 Summary and Recommendations**

### **7.1 Surface Water Resources**

#### Summary

The existing quarry and proposed quarry expansion area are located in the south part of the Jersey Brook Watershed that is approximately 330 hectares in size.

The results of the water balance illustrates the change in surface water runoff at the discharge location of the Jersey Road Watershed will be from +0.1% to -1.1 % at Location A. These changes to runoff and streamflow in East Branch and West Branch are not expected to have significant adverse effects on surface water resources.

#### Recommendations

A plan for monitoring and documenting site conditions in relation to surface waters will be developed in collaboration with NSECC. These plans will include augmenting existing monitoring to fulfill requirements in the industrial Approval for the Westchester Quarry. Such a plan might include periodic site visits by a qualified professional, surface water quality monitoring and documenting and mitigating effects of high streamflow events.

### **7.2 Groundwater Resources**

#### Summary

Bedrock within the Westchester Quarry is dominated by dark grey coloured, fine grained diorite and gabbro (black granite) with minor amounts of orange coloured, medium grained granite. These rock-types are crystalline in character and are extensively fractured with several fracture pattern orientations; therefore, groundwater flow is by “fracture flow” throughout the bedrock unit.

In the vicinity of the Westchester Quarry, groundwater flow direction would be expected to be a subdued replica of the topographic gradient which is toward the north, northeast and northwest.

There are three private water supply wells from 900 to 1,500 metres northwest of the quarry and one private water supply well located 1,600 metres east of the quarry (Figure #3). Some permanent homes and seasonal residences in the vicinity of the Westchester Quarry have dug wells or transport water to their properties. Only two of the four wells are included in this NSE database, both of which are in the vicinity of the community of Rose and have total

depths of 31.4 and 56.9 meters and estimated yields of 10 to 15 litres per minute.

#### Recommendations

Considering the Westchester Quarry is to operate above the watertable, we recommend three (3) groundwater monitoring wells be constructed at the locations shown on Figure #3. These wells will be utilized to determine the seasonal elevation of the watertable, direction of groundwater flow, assist with quarry planning and facilitate groundwater quality monitoring to ensure there are no adverse effects on water quality due to the operation of the Westchester Quarry.