## 6. DESCRIPTION OF PROJECT OPERATION AND PRODUCTION

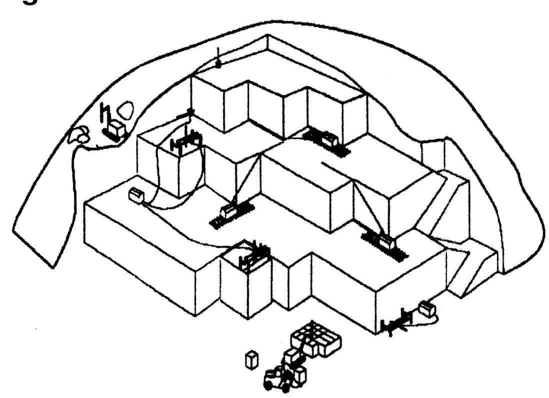
### Background

Once operational, the Kennedys Big Brook quarry will produce approximately 1000 cubic meters per year. Quarry excavation will proceed in a series of three phases, with each new phase expanding into a different area of the deposit over the course of the operational lifespan of the quarry.

1. Phase I - 3,392 square metres in the first year of operation
2. Phase II - 2,658 square metres
3. Phase III - 4,622 square metres
4. Total Quarry Area utilized over 12-15 year operational lifespan - 11,109 square metres.

The production process involves drilling, sawing and removal of marble blocks from the quarry area for shipping or further cutting. A diamond wire saw, a 3 inch down the hole percussion drill unit, and a spherical drill unit, called a quarry bar, will be used to extract marble and create a series of terraced faces in the deposit. An excavator, a rubber tired loader, and mini-excavator will be used for quarry-face preparations, materials stockpiling, and for moving large marble blocks. Trucking activity associated with the undertaking will involve approximately eighty-five tri-axle loads over the quarry season, which translates into two or three truckloads per week.

**Figure 6**



Water management in the quarry involves collecting groundwater in a series of small fire ponds, pumping this water to a storage tank, and then gravity feeding the required 13.5 liters per minute or 3 gallons per minute required to cool the diamond wire as it passes through the stone. [See Appendix VI Water Resources Component and Figure 5] All quarry water will be collected in a settling pond designed to handle a 24-hour intensity for a 1:10 year return [total rainfall=100mm]. In the event of a more significant rainfall event, staff will be available on a 24-hour basis to pump any excess runoff to vegetated areas for filtration and volume reduction .No permanent building structures will be required on the quarry floor. The quarry equipment is portable and can be removed when quarry operations cease. Two proponent-owned diesel generators will supply power for the quarry operation and the plant.

## Project Activities

Development of a new quarry involves: (a) removal of unconsolidated top layers, (b) preparation and/or upgrade of access roads and stone handling areas, and (c) establishing benches. The unconsolidated overburden on the proposed undertaking site averages less than one metre in thickness, and in many places the marble is at the surface. Approximately 1,910 cubic metres of topsoil will be removed, stockpiled and stabilized with hay mulch for the future reclamation of the site. There are three basic quarry layouts: (1) hillside, (2) pit, and (3) underground. The hillside method will be used in the project undertaking because the natural topography of the land lends itself to this type of excavation. This method involves cutting large blocks of marble called benches, in the exposed hillside in order to subdivide them into smaller blocks for processing. In cross-section, this method of quarrying produces a series of steps or terraces. The quarry will be a drive-in type, with a wide, open layout, to facilitate handling and transportation of the cut blocks of marble (Figure 6). Bench sizes vary according to the nature of the marble deposit (primarily the pattern of fractures) in any particular part of the quarry.

Excavating the stone to create the benches will be achieved using the diamond wire-saw method. This technique can be used for all stages of bench extraction, and involves a spinning diamond-encrusted wire that is passed through pre-drilled holes in the quarry face and drawn through the rock by means of a sawing machine that moves along a 15-metre track (Figures 7 and 8). The quarry will use an Italian-made, Marini wire-sawing machine, equipped with a 50 HP electric motor. The dimensions are 2.5 metres by 1.0 metres by 1.5 metres, and weighs 2,140 kilograms. A proponent-owned generator will supply power.

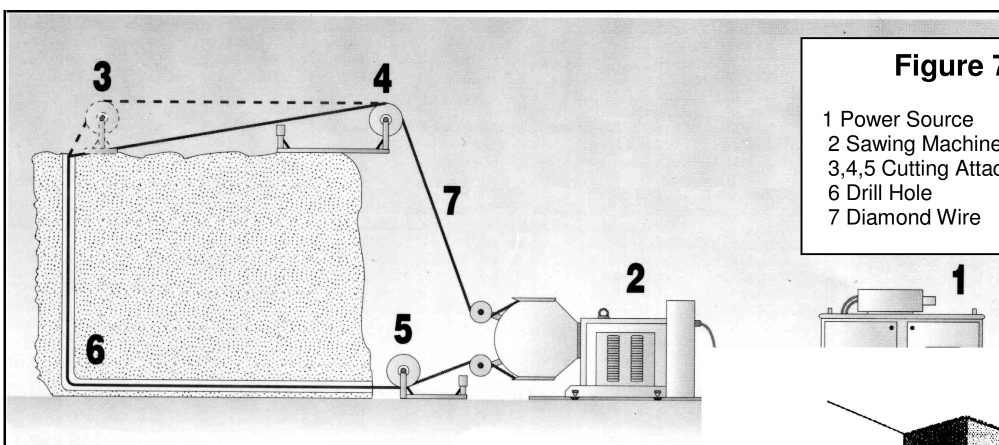



**Figure 7**

1 Power Source
2 Sawing Machine
3,4,5 Cutting Attachments
6 Drill Hole
7 Diamond Wire

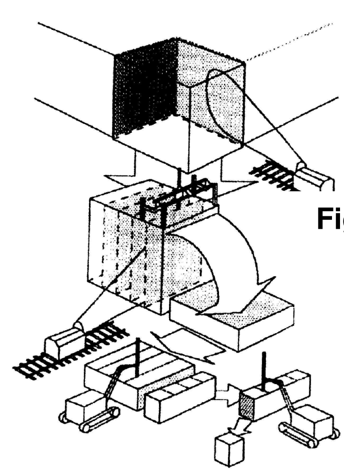


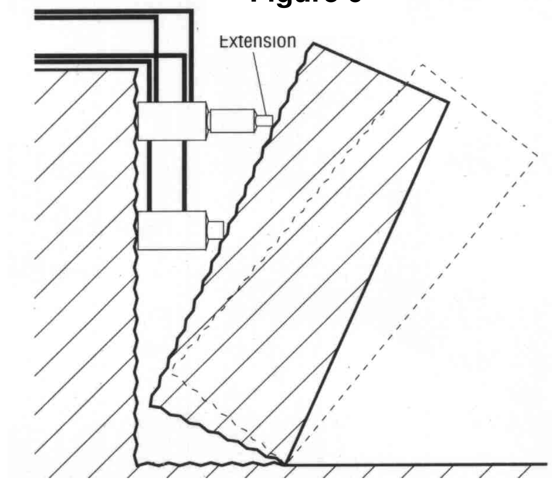
**Figure 8**

Vertical, horizontal and angled cuts can be made with the diamond wire-sawing machine and this method causes no damage to the marble. The cut surface is very smooth, allowing on-site analysis of the quality of the cut rock, so that the type of production method can be assessed prior to processing. There is little or no dust and very low noise levels associated with this method of quarrying. A diamond-bit Marini drilling unit will be used to pre-drill the holes through which the diamond wire is passed (Figure 7, #6). The drilling unit weighs 120 kilograms and operates on compressed air (200 cubic feet per minute at 100 P.S.I).

Water is used to lubricate and cool the diamond wire as it is drawn through the marble. Approximately 14.5L/min (3 gpm) is required at the quarry face. Water will be supplied from on-site ponds and pumped to a storage tank and then gravity fed to the saw at the quarry face. The quarry will collect enough water in on-site ponds to supply the requirements of the diamond wire saw. Whenever and wherever possible, water will be collected, recycled and reused. In theory, the water management system is a closed loop and the only loss to the existing groundwater regime will be through evaporation (Baechlar 2002)

Loosening the bench is the most critical and essential step in production. It is important that the bench is as undamaged and free of internal cracks as possible (MacLeod Resources Limited, 2001). The bench is loosened from the quarry face using a hydraulically powered pushing device called a Bull. The Bull uses hydraulic cylinders to pry benches free from the quarry face, so they can be moved (Figure 9). The device is portable and is the used to push and move benches and large block up to 160 Tons. The Bull is powered by a 3 HP electric motor, and is equipped with an air compressor with a maximum working pressure of 700 bar.

**Figure 9**



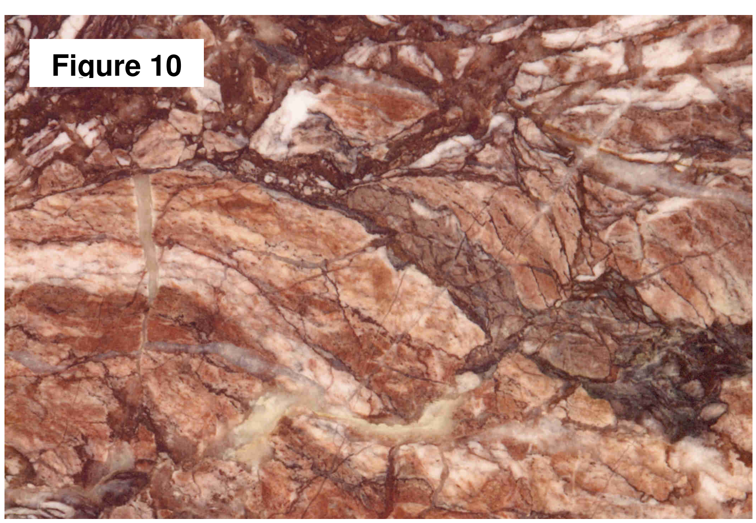

Once the bench is free of the quarry face it is squared-off and/or subdivided into blocks. Blocks are generally random sized, with size determined by the pattern of internal fractures and/or color distribution. Subdivision of the bench is achieved either through additional diamond wire cuts or with a spherical block cutter, called a quarry bar. The quarry bar unit is a drilling device that cuts a series of aligned channels in bench, perforating the stone to form a plane of weakness along which the block is subdivided. The quarry bar is portable and is moved into position in order to achieve the most precise cut. MacLeod Resources will use a pneumatically driven, Marini quarry bar, which can be connected to the same compressor used to power the Bull. The quarry bar use is expected to be minimal with the preferred technique to custom size, dress and shape blocks by additional wire sawing in the proposed plant with a stationary saw.

## Marble Processing and Methods of Production

The processing facility will cover 3000 square feet or 275 square meters and house a stationary diamond wire saw and eventually a small bridge saw and manual, radial arm polisher. This equipment will allow Macleod Resources to square rough-cut blocks from the quarry or to produce 2cm. or 3 cm. slabs for countertops, vanities or furniture. The equipment used to quarry and process the marble is powered by electricity, to be generated on-site by means of two diesel generators. The quarry will use a new 88 KVA Perkins soundproof generator and the plant will use a restored Cat 250 KVA generator housed in a soundproof building.

Cutting and polishing are wet-processes and approximately 20 litres per minute of water is required for operation of the processing facility. Water for processing only will be supplied through a closed loop from a dug well to the building where it will be collected, piped to a concrete settling tank, then to a series of small settling ponds and back to the dug well. A separate dug well will be installed for potable water. This will not be a public water supply, and the plants water requirements do not exceed 23000 liters per day. The processing plant is planned in accordance with all safety considerations and will include means to protect the environment from potential impacts from the facility. The facility will operate within a single building. Sorting and cataloging marble by: (a) block and slab size, (b) colour, (c) degree of veining, or (d) overall quality and grade, is an important part of the production process, and is necessary to develop an inventory of marble for various applications and product markets. Inside the plant, marble blocks will be squared or cut into slabs, which may then be polished to manufacture finished products. The production facility will use a Viper 500 single-wire overhead bridge saw, capable of cutting blocks into slabs of thicknesses between 2cm and 150cm. The cut slabs are then sold rough sawn or moved to a manual radial-arm polishing machine, housed in the production facility. The radial arm-polisher can polish slabs up to 2 metres by 1 metre in dimension, and from 2cm to 150cm in thickness. Polished marble slabs are used to manufacture indoor and outdoor floor and wall tiles, countertops, furniture, and other applications (Figure 10).

Although the red marble is considered to be rare and therefore highly marketable, the white, grey, blue, and green colored marble quarried on-site will also be processed in the plant so that waste marble generated from the operation is minimized. Uses for byproduct stone materials generated during the quarrying and production stages will be manufactured at the processing facility, in order to enlarge their range of products. The company has a “zero waste” philosophy and has found applications and markets for all the materials generated in the operation of the quarry. Marble aggregate can be collected and sorted by colour to manufacture terrazzo tiles or sold in bulk as bagged aggregate. Aggregate can also be crushed to various sizes and to sand-grade particles, which is used as a colour-additive in agglomerate tiles. The company plans to rent a crusher on a per-day basis when necessary. Fine, mud-grade particles of marble paste (which is essentially limestone) that collect at the base of the wire saws can be collected and dried and used as a soil amendment, or as a color additive to concrete and stone resins (See appendix 7 for a lab analysis of this material).




A Sample of Polished Marble from the Kennedys Big Brook Red Marble Deposit

## Occupations

Once operational the Kennedys Big Brook Red Marble Quarry will have eleven fulltime positions. Employment ranges from quarry equipment operators to administration and marketing positions (Table 1). MacLeod Resources Limited will employ residents from local communities and will provide training for quarry equipment operators and processing plant workers.

**Table 1: Fulltime Positions** **Source: MacLeod Resources Limited, 2001)**

| Position | Number of Employees |
|---|---|
| Quarry Operator | 3 |
| Heavy Equipment Operator | 2 |
| Plant Workers | 4 |
| Administration | 1 |
| Marketing | 1 |
| **TOTAL** | **11** |

## Projected Capital Costs

**YEAR 1 PHASE I**

| **COSTS** | |
|---|---|
| Access Road & Site Preparation | $ 45,000. |
| Water Source | 25,000. |
| Base setup, Storage | 20,000. |
| Permits & Environmental Mitigation | 12,000. |
| Diamond Wire Saw | 64,700. |
| Stationary Wire Saw | 69,565. |
| Drill | 18,400. |
| Quarry Bar | 14,100. |
| Hydraulic Unit | 9,600. |
| Diamond Wire | 18,000. |
| Small Wares | 12,897. |
| Compressor | 14,000. |
| Generator | 19,000. |
| Excavator/backhoe | 80,000. |
| Contingency | 60,000. |
| **TOTAL** | **$ 482,262.** |
| **TOTAL WITH SHIPPING/TAXES** | **$ 554,602.** |

| **SOURCES** | |
|---|---|
| Investors | $ 110,920. |
| Enterprise Cape Breton Corporation | 277,301. |
| Lending Institution | 166,381. |
| **TOTAL** | **$ 554,602.** |

(Source: MacLeod Resources Limited, 2001)

## 7. ENVIRONMENTAL SETTING

### General Background

The proposed marble quarry undertaking is located within the Bras d'Or North Mountain Ridge Natural Landscape (N.S. Department of Environment & Labour Natural Landscape # 49). The Bras d'Or uplands are a series of elongated northeast-southwest oriented fault blocks located on the north side of Bras d'Or Lake. The uplands occupy a prominent position in the landscape and generally reach elevations between 245 metres and 310 metres. They are predominantly Precambrian in age, and include the Malagawatch Formation of rock strata. Drainage is radial off the upland via high gradient streams and few lakes (NSDE&L, 2000). Streams in the surrounding landscape are straight and fast-flowing and shelter brook trout, golden shiner, white perch, sticklebacks, and banded killifish. Deer winter on the relatively protected mountain slopes, which are forested with sugar maple, yellow birch, beech, and shade-intolerant hardwoods. Surficial materials are thin, and in many places glacially scoured bedrock outcrops at the surface. Soil cover is also thin, and is soils are generally stony loam tills that are coarse textured and well drained (NS Museum, 1989). The proposed undertaking is located along North Mountain, a prominent, northeast-trending upland region that parallels West Bay Bras d'Or Lake.

### Physiographic Setting

North Mountain lies on the west side of Bras d'Or Lake between River Denys Basin and West Bay. North Mountain is about 260 metres in elevation and is underlain by a mixture of Precambrian carbonate and clastic metasedimentary rocks and late-Cambrian to Ordovician age intrusions of varied composition. The elevations of the North Bras d'Or Uplands are greatest along the southeast side where movement was faults and tilt toward the northwest, declining in elevation. The relief along the boundaries of the uplands depends on the nature of the adjacent Carboniferous deposits. Some parts of the margins are set against resistant rock types, whereas others are against much softer, more erodible rock types.

North Mountain is crosscut by a fault, which has formed a narrow steep-sided valley that contains Kennedys Big Brook. North and east of the valley, the Marble Mountain Pluton underlies the bulk of the upland block. Clastic and carbonate sedimentary rocks of the Malagawatch Formation, and south and west of the valley underlie the valley itself; the upland block is underlain by clastic and carbonate metasedimentary rocks of the Lime Hill Gneissic Complex and Big Brook and West Bay Plutons. North Mountain is almost entirely surrounded by Carboniferous-aged, Windsor Group deposits, which are deeply eroded and give maximum relief on both the north and south sides, although its crest is relatively flat. The scarp is steepest on the south side and forms cliffs along West Bay.

## Property Geology

Milligan performed the first comprehensive interpretation of the geology of the bedrock in the River Denys area in 1970. Milligan placed the rock units found in this area within the George River Group of Precambrian-aged strata. More recent interpretation of the geology has resulted in the re-designation of some strata to the Malagawatch Formation.

Early geological mapping results of the MacLeod Resources property and proposed quarry site were substantially augmented by later work conducted by Aurion Minerals Limited in 1992, which resulted in the delineation of outcropping pink to red marble over a substantial area (Mercator, 2002). Additional research by Garth Demont, NSDNR, found that the marbles located on the property occur within the carbonate units of the Malagawatch Formation, a stratigraphic unit which consists of interbedded slate, calcitic and dolomitic marble, quartzite, and lesser amounts of mafic to intermediate meta-volcanics. On a regional scale these rocks were metamorphosed to chlorite grade greenschist facies, but locally the rocks exhibit higher-grade contact metamorphism near pluton margins. All lithologies in the Malagawatch Formation are affected by greenschist grade regional metamorphism and bear evidence of deformation (Mercator, 2002).

Calcic marbles make up the bulk of the carbonate units exposed on the site of the proposed undertaking. These rocks are generally dark to pale grey, but red and pink zones also occur locally, particularly near fault zones. Units are generally pure and massive, but some beds contain thin argillaceous laminae. The argillaceous (slate) laminae are assumed to represent primary bedding layers. Secondary white fracture-filling carbonate veins are common in this unit. Many of these veins contain red, earthy hematite or disseminated specular hematite. Weathered surfaces of this unit are generally very smooth and rounded. Dolomitic marbles also outcrop on the MacLeod property and occur as narrow lenticular layers that are parallel to primary bedding laminae. Mapping of the dolomitic marbles on the property has shown that they appear to coincide with the two most extensive zones of red and pink calcitic marble. MacLeod Resources current interest is focused on a zone of consisting of pale pink to red, grey and white calcitic, and dolomitic marble that can be traced with certainty within 400 metres along the strike of the bedrock deposit.

Marble outcrops are exposed in a series of northwest trending, discontinuous, ridges or domes. These ridges, which roughly parallel the strike of the primary sedimentary bedding, are produced as a result of folding of the marble beds. Regionally the Malagawatch Formation marbles trend in a northeast direction, however, along the brook valley, bedding is oriented in a northwest orientation. The change in bedding orientation is thought to reflect post depositional faulting, folding or a combination of the two. Lithologic bedding is not apparent in the marble units exposed at the quarry site, except in areas where argillaceous laminae occur. In general bedding appears to strike northwest, with the exception of two small areas located near northeast trending faults (Demont, 2002).

Faulting has played a key role in both the location and dimensional size of the red marble deposit. Movement along two different fault system orientations provided the ground conditions required for fluid flow. In the Kennedys Big Brook area, movement along the two fault systems created breccia zones and zones of intense fracturing which significantly increased the permeability, thus allowing easy passage of the fluid that deposited the hematite in the marbles. Three zones of red, hemitized marble occur on the MacLeod property. These areas may be connected at depth, but surface evidence suggests they are distinct from one another (Demont, 2002).

## Climate

The dominant influence on the climate of this region is elevation, modified by proximity to different water masses. The North Bras d'Or Lakes Uplands region experiences more severe winters with greater amounts of precipitation and shorter growing seasons than the surrounding lowlands, although conditions are not as harsh as the Cape Breton Highlands. The uplands south and east of the Bras d'Or Lake are slightly warmer than the rest of the region, because of the modifying effect of the lake (NS Museum, 1989). Canadian Climate Normals data for Port Hastings, located near Port Hawkesbury, indicate that the area receives approximately 1,448 mm of precipitation annually. Measurable amounts of precipitation are recorded for 159 days per year with an extreme daily precipitation event of 132 mm. Extreme daily precipitation of 178 mm has been recorded in River Denys (Young, 2001).

## Hydrology [See Appendix VII]

The MacLeod property lies within the Kennedy Big Brook watershed, a twelfth order stream draining into River Denys. River Denys is one of the five major rivers flowing into the Bras d'Or Lakes. Land use in the watershed is generally rural, being mainly commercial forestry activities, areas under agricultural cultivation or managed woodlots. Most homeowners in the River Denys area rely on dug wells for potable water, as drilled wells typically yield poor quality water (hard, sulfates). The abandoned farm is used only seasonally and is located within 1.6 km of the quarry site relies on a dug well for water. On-site sewage disposal systems (mainly septic tanks) service both residential and commercial developments (Baechlar, 2002). The vast majority of the watershed (lowland) is underlain by rocks of the Windsor Group, which consist of soft shales and siltstones, gypsum, anhydrite and salt deposits. River Denys Basin has had a long history of gypsum quarrying. These rocks and the overlying surficial materials are highly erodible and contribute relatively high sediment load to River Denys Basin when compared to the rivers flowing off the highlands of Cape Breton.

The proposed quarry site is located on a marble ridge that generally trends northwest parallel to Kennedy Big Brook. Drainage over the property occurs to the south toward the largest tributary brook recently named MacLean Brook, and toward the west in two small tributaries draining directly into Kennedy Big Brook. These are Homestead Brook and Camp Brook. Surface drainage is shown on Figure 11. Kennedy Big Brook flows into River Denys and is part of the River Denys Watershed. The River Denys watershed (215. 20 sq km) covers approximately 8.7 % of the Bras d'Or Lakes watershed (2480 sq km). The Kennedy Big Brook watershed covers 1,594 hectares and drains the North Mountain upland. Most of the watershed of Kennedy Big Brook is upland topography. A relatively small percentage of flow is over lowland terrain, through sand and gravel deposits that flank North Mountain; and it is reported that the lower reaches of Kennedy Big Brook intermittently disappears into the sands and gravels before reaching River Denys. The water chemistries of tributaries flowing into Kennedy Big Brook reflect the presence of the underlying marbles. There is no quantitative flow data available for Kennedy Big Brook or for similar watercourses draining North Mountain. The nearest long term weather station is located at Sydney airport, approximately 90 km to the northeast. There are no defined watercourses in the direct vicinity of the proposed quarry operations; however two springs located in the vicinity are headwaters to tributary brooks. The source spring for Red Brook, discharges approximately 65 meters down gradient and south of the proposed extraction site, at an elevation between 158.8 metres (high flow) and 153.9 metres (low flow). MacLean Spring, which is a headwater for MacLean Brook, discharges approximately 400 metres east of the proposed quarry site at an elevation of 135.7 metres. Red Brook meets MacLean Brook approximately 150 m north of the MacLeod Road. Both Homestead Brook and Camp Brook begin in swales close to the top of the ridge. Both headwaters appear to be in the meta-sediments; however, Camp Brook flows over a dolomite band before it continues on its course west to meet Kennedy Big Brook near the first bridge on the road.

Surface water quality was examined through three sampling events. The first sampling event occurred on February 20, 2002, and represented relatively low stream flow, winter conditions. Sampling was carried out during a period of no precipitation and was timed before the snow melt. Figure 11 shows the location of the monitoring stations. The second sampling event on April 2, 2002 represented high flow conditions. Samples were collected approximately 24 hours after a heavy rainfall event and a prolonged period of snowmelt. Very little snow was left in the woods except in hollows and northward facing slopes. The third sampling event occurred July 25, 2002 and represented low flow summer conditions In addition to surface water samples; field conductivity measurements were collected from small seepage areas to determine sites impacted by carbonate dissolution. Surface flow discharges for the tributary brooks of Kennedys Big Brook were calculated using the cross-sectional area and velocity measured in each watercourse. Based on the calculated flows it was determined that at high flow, MacLean Brook contributes approximately 5% of the total flow in Kennedy Big Brook (Baechlar, 2002). Surface flow, field conductivities, temperatures, bacteria, and the results of chemical analysis of surface water have been documented to provide baseline data for monitoring.

There are no drilled wells to provide data on the groundwater resources in the vicinity of the proposed quarry. However, the two springs discharging to the south and east of the proposed quarry site are likely connected to the underlying carbonate aquifer (Baechlar, 2002). In the area of initial marble extraction, two resistant marble knolls are separated by a depression or swale, possibly a solution collapse feature, typical of karst terrain. At the present time there is no information on the depth to the underlying water table. Based on the elevation of Red Spring, where the water table intersects the ground surface, it is thought to be near an elevation of approximately 165 metres or 3 - 5 metres (10 - 15 feet) below ground surface in the low area (swale) between the two marble knolls (Baechlar, 2002). The water table typically parallels the topography, at some distance below the surface. Groundwater is expected to flow from the topographic highs around the central swale, toward the central swale, and then continue south toward Red Spring. This appears to be a relatively small, seasonal flow system as expressed by the sometimes-intermittent discharge at Red Spring. For a more detailed discussion of the water resources component please see Appendix VI, which contains the entire report submitted to the proponent by Lynn Baechla