Results of a Suspended Solids Survey at the Whites Point Quarry, Little River, Digby County, Nova Scotia

Prepared for

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1.0 Background

On 30 April 2003, Global Quarry Products initiated development of a gravel quarry at Whites Point, Little River, Digby County, Nova Scotia. The first stage of development involves site preparation, mainly land clearing and grubbing, and construction of a sediment retention pond and associated structures to minimize sediment run off into the nearby coastal zone.

On 27 May 2003, a Department of Fisheries and Ocean inspector examined the quarry site and issued a directive to carry out a number of remedial actions to ensure minimum sediment input into the coastal area during the construction and operational stages of the quarry. The inspector's report also stated *"Evidence of sediment entering the BAY from the disturbed area was found in two distinct areas along the shore and intertidal zone"*.

The main objectives of this survey were (1) to determine if significant amounts of sediments have been exported from the quarry site into the intertidal zone as a result of the construction activities carried out up to the date of the survey, and (2) to obtain baseline background information on sediment characteristics at tide pool sites far removed from current quarry construction and operation activities.

2.0 Approach

On 5 June 2003, samples for sediment analyses were collected at a number of sites located within the Whites Point Quarry area (Figure 2.1). The selection of sample sites was made based on the degree to which they would be expected to be impacted by quarry operations, especially during the early stages of land clearing and grubbing and construction of the sediment retention pond. Water samples for analysis of Total Suspended Solids (TSS) were collected from the sediment retention pond, the outflow of the sediment pond at a point below the check dams, and from six upper shoreline intertidal pools located various distances from the sediment pond. Three of the intertidal pools were located in areas considered likely to be impacted by the construction activities previously carried out (Tide Pools 1, 2 and 5), and the remaining three in areas unlikely to have been impacted (Tide Pools 3, 4 and 6). Sediment contained within the tide pools was also sampled, mainly to determine the degree to which they may have accumulated inorganic sediments, the assumption being that inorganic, as opposed to organic, sediment is the type most harmful to aquatic organisms and most likely to be the dominant type mobilized by the quarry activities.

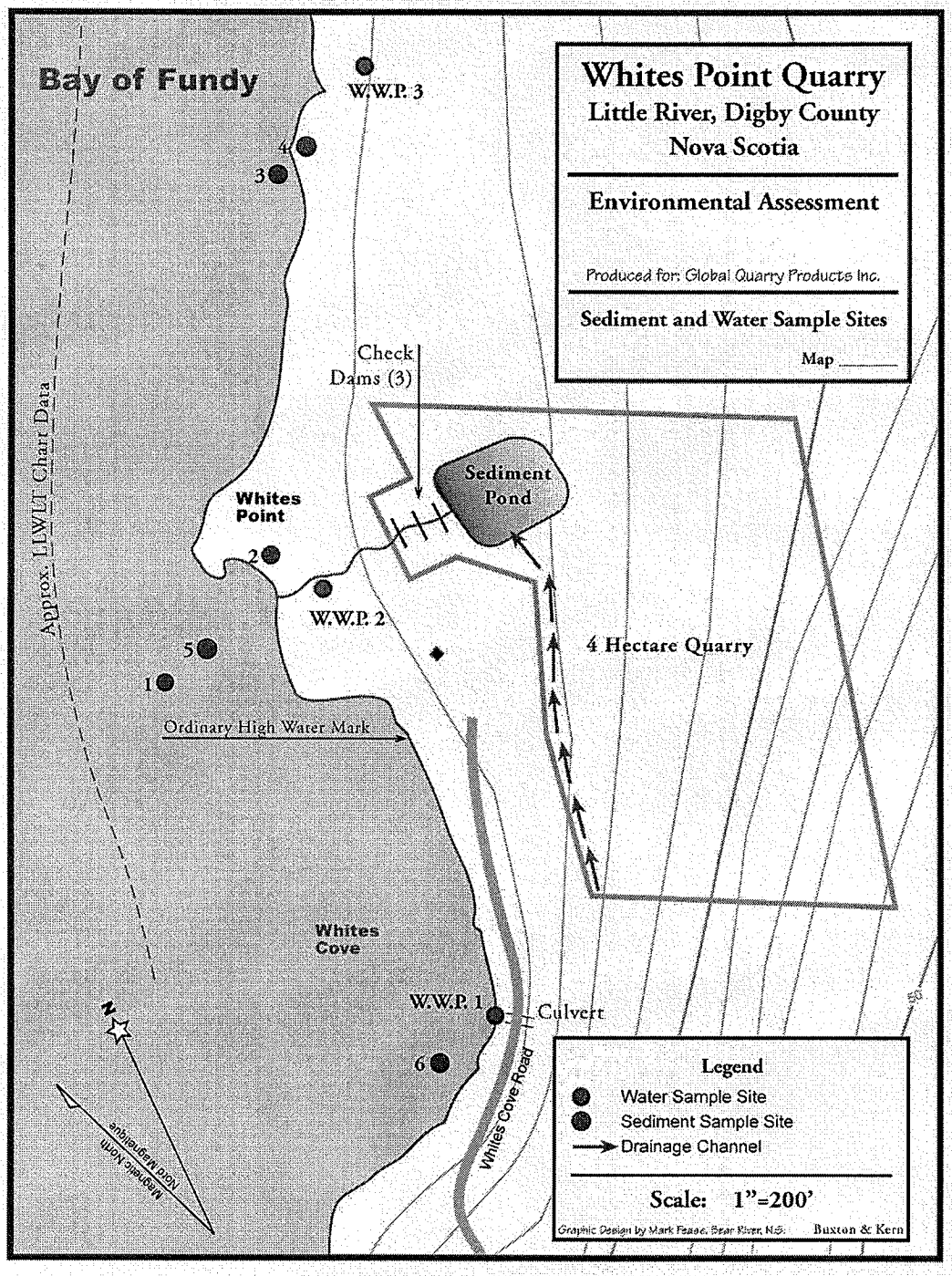


Figure 2.1. Location of sample sites.

3.0 Methodology

Water samples for TSS were collected in 500mL polyethylene containers and stored refrigerated until analysis which was carried out within 24 hours of sample collection. The samples were filtered through tared, pre-combusted Watman GF/C glass fibre filters, then oven dried at 70 °C to a constant dry weight and reweighed to determine TSS. The percent organic content was determined by measuring the loss on combustion after combusting the filters for eight hours at 500 °C.

A total of six sediment samples were collected from the bottom of each tide pool using a small polyethylene container and each sediment sample was placed into a 20 ml sample vial. The percent organic content of the sediment was determined by drying the samples to a constant dry weight at 70 °C, determining the total dry weight of the sample and then combusting the sample for 12 hours at 500 °C. The organic content was then calculated as the weight loss after combustion.

4.0 Results

4.1. Total Suspended Solids

Table 4.1 lists the TSS concentration and percent inorganic and organic components for water samples collected from the sediment retention pond, its outflow and each tidal pool. Figures 4.1 and 4.2 present this same information graphically. The highest TSS concentration was in the sediment retention pond and was composed largely of inorganic sediments. At the outlet from the sedimentation pond, located below the check dams, the level of TSS was much lower (about five times less than the level within the sediment pond) and the sediments were slightly greater in organic than inorganic content. TSS concentrations in the tide pools ranged between and 5.6 and 54.0 mg/L and were composed largely of organic sediments. The highest TSS level was in TP6, which is located well south of the quarry, but in close proximity to a gravel road in an area where maintenance activities had recently been completed by the Nova Scotia Department of Transportation. With the exception of this one tidal pool, there was little difference in TSS levels among the tidal pools sampled.

Table 4.1. Suspended solids concentration and composition.

Site	TSS (mg/L)	Percent Inorganic Content	Percent Organic Content
Sediment Pond	62.4	61.3	38.7
Station WWP2*	13.6	44.1	55.9
TP1	12.2	47.3	52.7
TP 2	12.4	12.9	87.1
TP 3	5.6	35.7	64.3
TP 4	12.4	6.5	93.5
TP 5	9.2	17.4	82.6
TP 6	54.0	30.6	69.4

*Outflow from sedimentation pond below check dams.

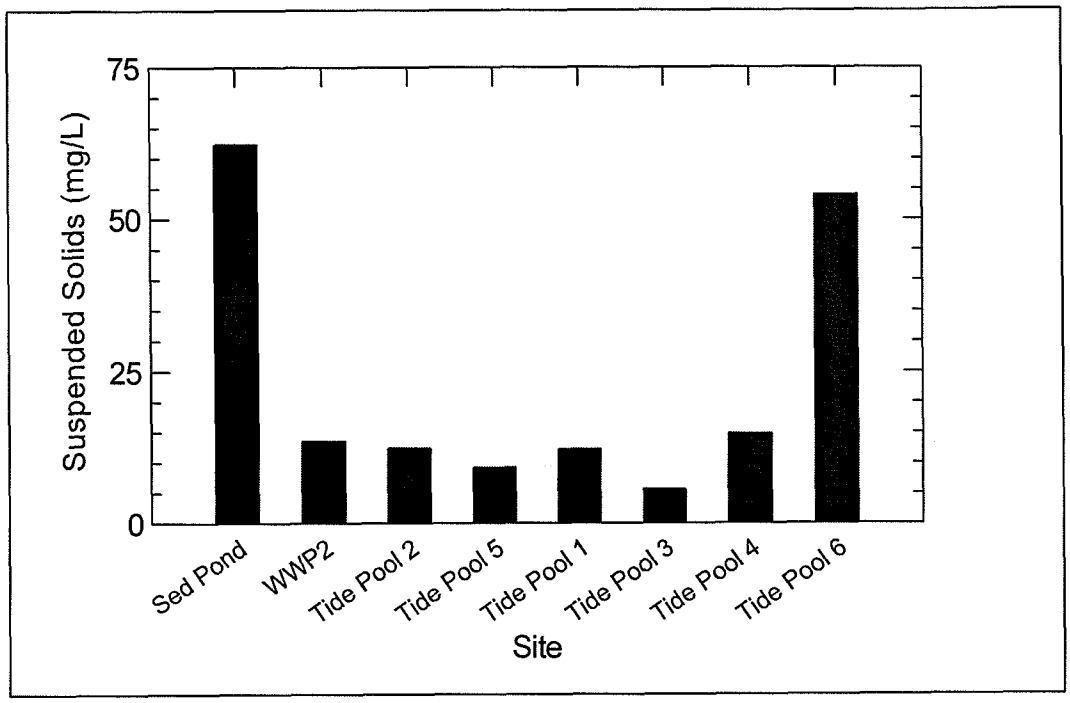


Figure 4.1. Total suspended solids concentration in water samples (tide pool samples are ordered from left to right in increasing distance from the sediment retention pond).

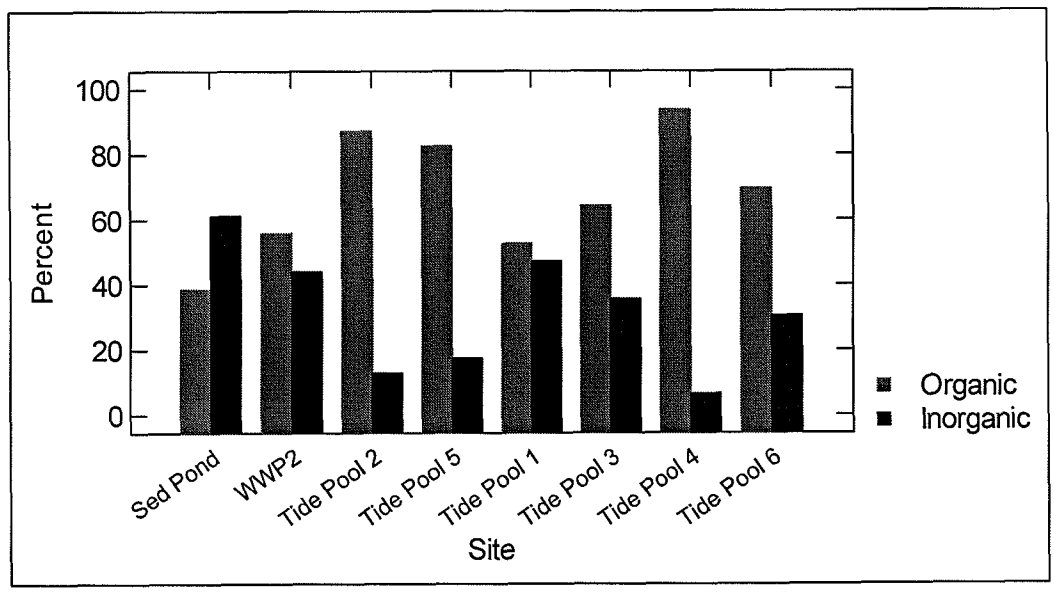


Figure 4.2. Percent organic and inorganic content of suspended sediments contained in water samples (tide pool samples are ordered from left to right in increasing distance from the sediment retention pond).

4.2. Tide Pool Sediments

Sediments contained on the bottom of the tide pools varied greatly in their extent of development and visual appearance. In all cases, the thickness of the sediment layer was only on the order of a few mm at most. In the case of Tide Pool 1, the sediment layer was so poorly developed that a sample could not be collected. The colour of the sediments varied from pale brown and orange to dark olive green (Table 4.2) and appeared to be related to the type of benthic algae growing on the bottom. Salinities within the tide pools were very low and indicate that the tide pools had not recently been subjected to tidal flushing which could have resulted in the scouring out of deposited sediments.

Table 4.2. Characteristics of tide pools sampled.

Site	Location*		Estimated Surface Area (m^2)	Depth (m)	Salinity (ppt)	Comments
	Northing	Easting				
TP 1	4927506	727203	80	0.28	0.1	Contained very little sediment on bottom
TP 2	4927519	727180	12	0.29	0.2	Pale brown sediment
TP 3	4927709	727277	5	0.10	0.5	Orange sediment
TP 4	4927546	727196	5	0.11	0.1	Appeared silty with light brown sediment
TP 5	4927492	727156	6	0.20	0.1	Olive green sediment
TP 6	4927167	727107	3	0.03	1.5	Dark green sediment

*NAD 83 UTM coordinates.

In almost all cases, the sediments were largely organic in composition (Table 4.3 and Figure 4.3). One exception was Tide Pool 3, located within the area considered not likely to be impacted by current quarry operations, which contained relatively high levels of inorganic sediments.

Table 4.3. Summary statistics on percent inorganic matter content of tide pool sediments.

Site	Number of Samples	Range of Values	Mean	Standard Deviation
TP 1	*	*	*	*
TP 2	6	15.6 - 34.7	24.0	7.8
TP 3	6	54.1 - 62.3	57.3	2.8
TP 4	6	4.1 - 10.5	7.7	2.2
TP 5	6	0.0 - 49.2	15.8	18.4
TP 6	6	0.0 - 35.6	26.1	13.8

*Sediment layer was too shallow to collect a sample.

An Analysis of Variance (ANOVA) indicated that only Tide Pool 3 was significantly different from the other tide pools in terms of the percentage of inorganic or organic matter contained in the sediments (Tables 4.4 and 4.5).

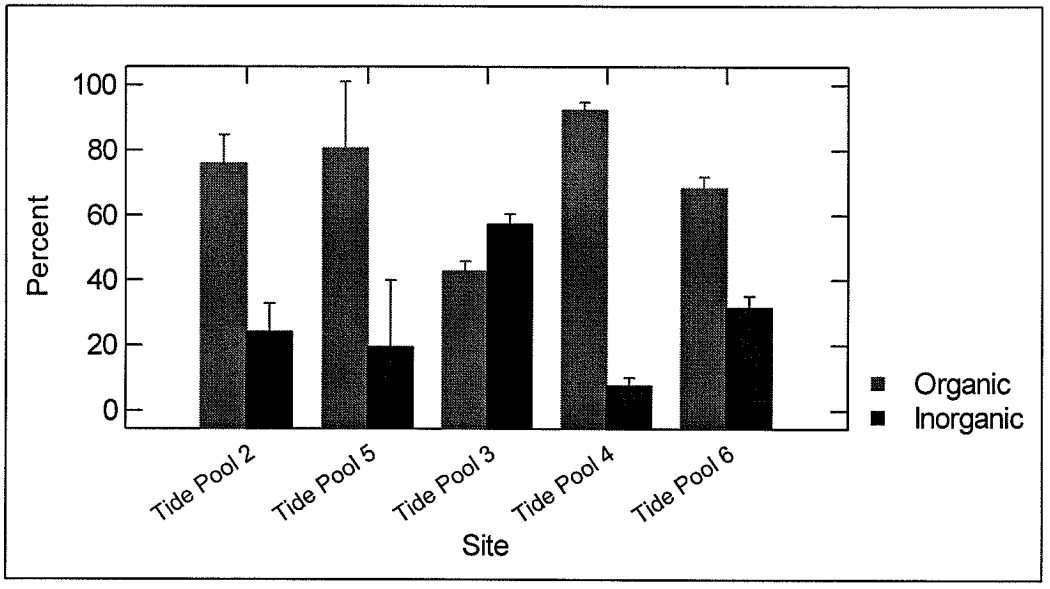


Figure 4.3. Percent organic and inorganic contents of tide pool sediments (samples are ordered from left to right in increasing distance from the sediment retention pond; error bars are one standard error of the mean).

Table 4.4. Matrix of pairwise probabilities (Bonferroni adjusted) for comparison of differences between percent inorganic content of tide pool sediments.

Site	Tide Pool 2	Tide Pool 3	Tide Pool 4	Tide Pool 5	Tide Pool 6
Tide Pool 2	1.000				
Tide Pool 3	0.000	1.000			
Tide Pool 4	0.165	0.000*	1.000		
Tide Pool 5	1.000	0.000*	1.000	1.000	
Tide Pool 6	1.000	0.000*	0.077	1.000	1.000

*significantly different at the 95% probability level.

Table 4.5. Matrix of pairwise probabilities (Bonferroni adjusted) for comparison of differences between percent organic content of tide pool sediments.

Site	Tide Pool 2	Tide Pool 3	Tide Pool 4	Tide Pool 5	Tide Pool 6
Tide Pool 2	1.000				
Tide Pool 3	0.000	1.000			
Tide Pool 4	0.165	0.000*	1.000		
Tide Pool 5	1.000	0.000*	1.000	1.000	
Tide Pool 6	1.000	0.000*	0.077	1.000	1.000

*significantly different at the 95% probability level.

5.0 Results of Monitoring at the Sedimentation Pond Outflow

In accordance with the Nova Scotia Department of Environment and Labour (NSDEL) quarry permit requirements, monitoring for TSS is being carried out at the outflow of the sediment retention pond (Station WWP2) on a weekly basis. The permit requirements stipulate that the maximum TSS level should not exceed 50 mg/L at any time, and that the monthly arithmetic average should not exceed 25 mg/L. Table 5.1 list the results obtained to date which are well below the permit requirements.

Table 5.1 Results of TSS monitoring at the outflow of the sediment retention pond (station WWP2).

Date	TSS (mg/L)
6 May 2003	<0.5
13 May 2003	2.2
20 May 2003	<0.5
27 May 2003	4.2
5 June 2003	10.0
10 June 2003	19.5
17 June 2003	7.0

6.0 Discussion and Conclusions

The lack of any evidence of elevated TSS concentrations and inorganic sediment accumulation in tide pools located in closest proximity to the sediment retention pond indicates that there has been little, if any, export of sediments into tidal pools located within the upper intertidal area. This result is encouraging considering that the survey was carried out during the construction phase of the sediment retention pond, a time when the maximum mobilization of sediments would be expected. Once this phase has been

completed, sediment loading of the retention pond is expected to occur at a much reduced rate making it even less likely that there will be significant sediment export into the adjacent intertidal area.

TSS levels at the outflow of the sediment retention pond are well below the levels stipulated in the permit requirements issued by NSDEL.

Whether or not the sedimentation pond is operating efficiently enough to satisfy current CCME suspended sediment guidelines is a bit more difficult to evaluate. CCME guidelines for the protection of aquatic life are based on ambient suspended sediment levels measured during clear flow[1] periods prior to the initiation of any anthropogenic activities that may elevate suspended sediment levels. For short-term periods (24 hours or less), TSS concentrations should not increase by more than 25 mg/L over ambient levels. For long term periods (30 days or more), average TSS levels should not be increased by more than 5 mg/L over ambient levels. The only data collected during the current survey that is applicable to these criteria is that collected at site WWP2, which is located below the check dams at the outflow of the sediment retention pond. The level of TSS at this site was 13.6 mg/L, considerably below the total increase allowable for the short-term guideline, but above the allowable increase of 5 mg/l for the long-term guideline. To determine if the long-term guideline has been exceeded requires knowledge of the average ambient clear flow levels prior to the initiation of quarry activities. The only data available on TSS levels at this site prior to quarry activities is for two samples collected during May and June of 2002. In both cases TSS levels were less than 0.5mg/L, but it is not known if these values represent those for periods of clear flow conditions. If they do, it is likely that the long-term TSS guideline were being exceeded at the time of the survey.

7.0 Recommendations

It is important that monitoring of sediment loading to the intertidal zone continue on a weekly basis during normal operations and perhaps more frequently during periods of activity that have the potential to create increased sediment mobilization (such as during the construction stage of the sedimentation pond and ditch construction).

It is clear that a better database of ambient TSS levels must be developed in order to determine if CCME suspended sediment guidelines for the protection of aquatic life are being met. This should involve TSS sampling at all identifiable outflows from the quarry site during clear flow periods and should be carried out to ensure an adequate assessment of the seasonal variation in TSS levels.

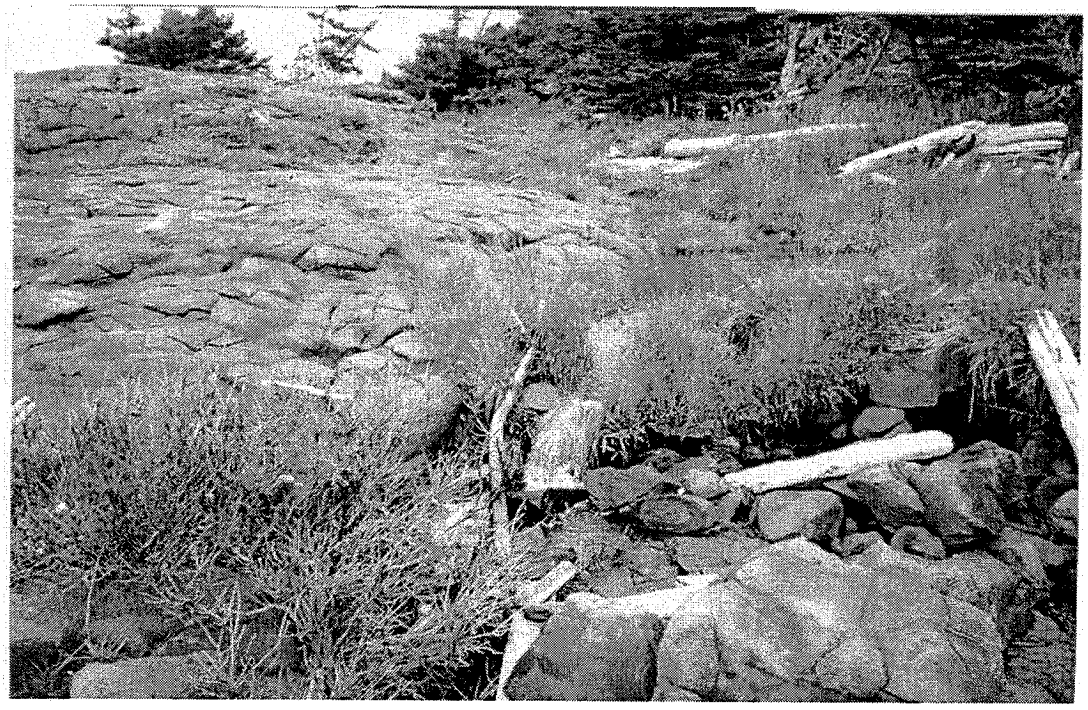
Additional monitoring of sediment characteristics at a number of upper intertidal pools should also be carried out. This should include measurements of TSS as well as the inorganic and organic composition any accumulated sediments. At least six tide pools

[1] Clear flow periods refers to 'normal' flow periods and specifically excludes both low flow and high flow conditions.

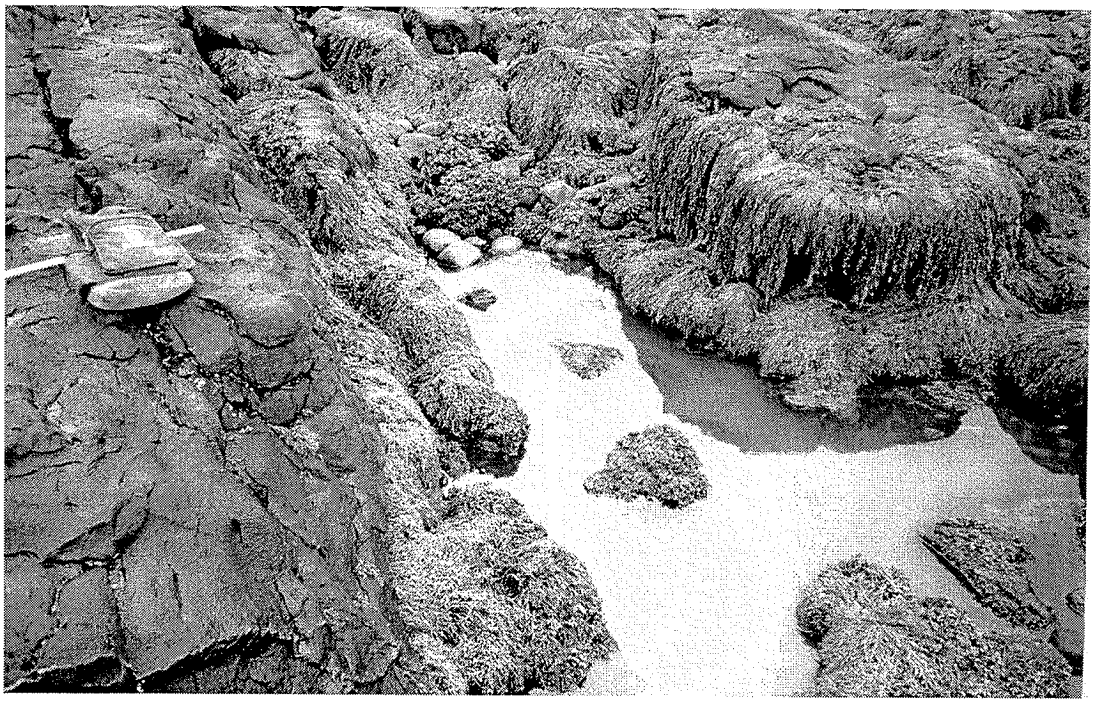
should be sampled, three located in areas most likely to be impacted by quarry operations, and three in areas unlikely to be impacted by quarry operations.

Appendix 1

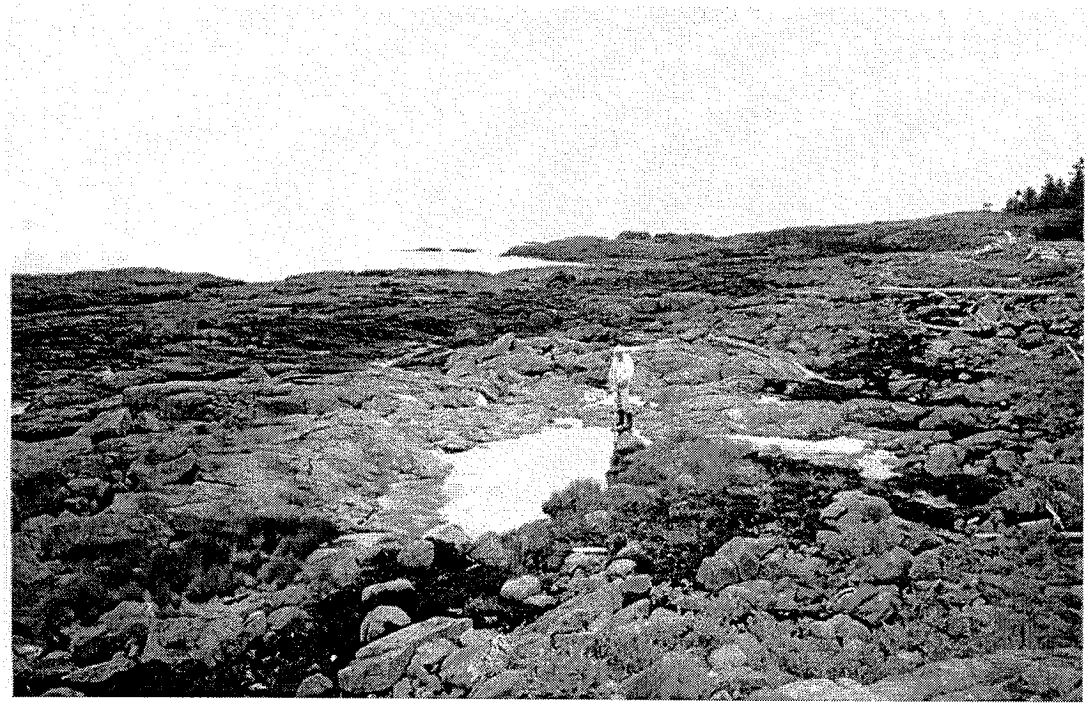
Photographs of Sampling Sites



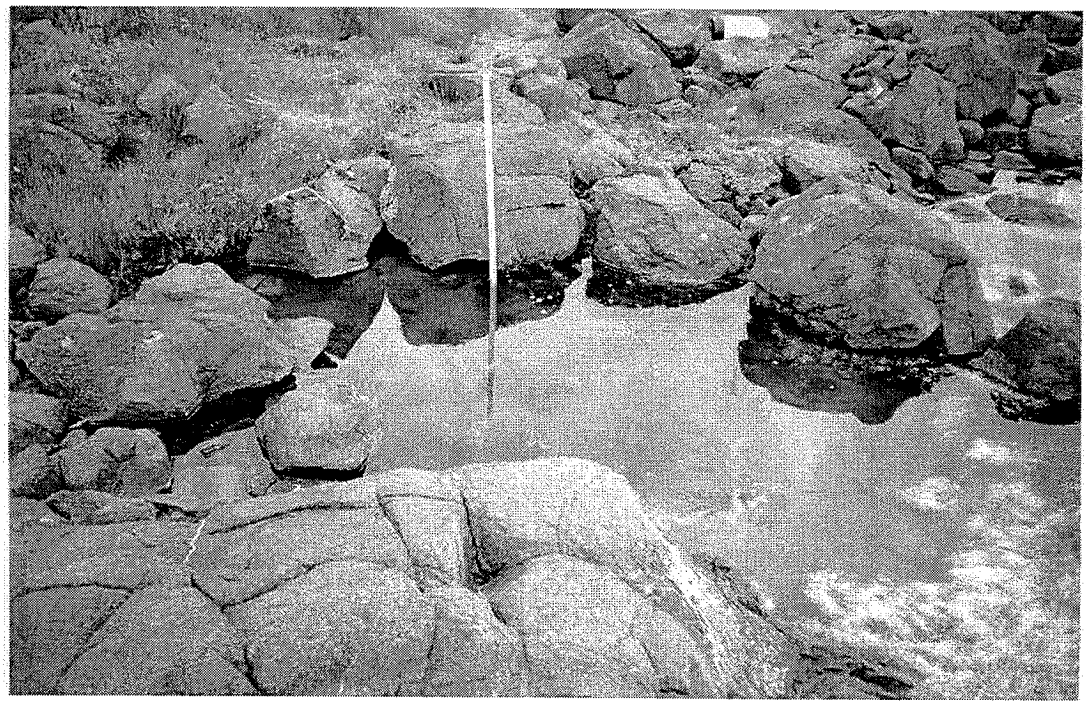
Outflow From Sedimentation Pond and Check Dams (Station WWP2)



Tide Pool 1



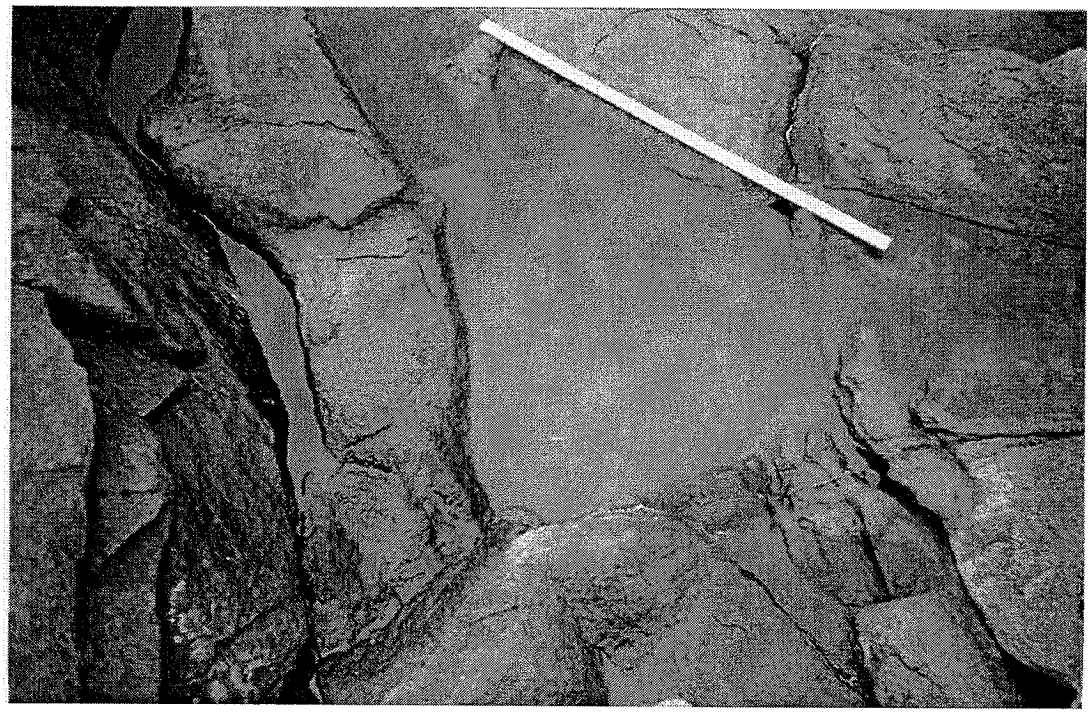
Tide Pool 2



Tide Pool 3

Tide Pool 4

Tide Pool 5



Tide Pool 6