*3. Monitoring*

a) Water

No water was collected this year as there was no water following down the valley for most of the summer.

b) Sediment

The results of analysis of the seven sediment samples that were collected on 12 July 2005 are given in Table VI-1. The average PCB concentration of the sediment in front of the filter box was 4.8 ppm. This is much less than the value of 18 ppm found in 2004; this might be expected given that much of the soil with the highest PCB concentrations had been excavated. The high PCB concentration of 37 ppm for the sample from between the two gravel filters is due to the fact that the finer sediment particles contain the highest PCB concentration which had been separated on passing through the first gravel filter. The PCB concentration of 2.6 ppm for the clean cell beyond the filter box shows some PCB contamination beyond the barrier but it was the lowest sediment concentration found and, considering the amount of disturbance that occurred during the summer, this result is very encouraging.

The total mass of sediment removed from the barrier this year was 7 $m^3$. Thus the calculated amount of pure PCB trapped by the barrier in front of the filter box was 60 g.

**Table VI-1: PCB Concentration of Sediment From the S1/S4 Valley Barrier**

| Sample Number | Units | PCB Concentration | Location |
|---|---|---|---|
| RI05-171 | ug/g | 7.4 | In front of chevrons |
| RI05-172 | ug/g | 3.3 | Between chevrons and first gabion fence |
| RI05-173 | ug/g | 3.7 | In front of filter box |
| RI05-174 | ug/g | 1.7 | In front of first gravel filter in filter box |
| RI05-175 | ug/g | 37 | Between gravel filters in filter box |
| RI05-176 | ug/g | 9.6 | Between GAC and gravel in filter box |
| RI05-180 | ug/g | 2.6 | Clean Cell |

c) Filters

The filters were removed from the filter box on 28 July 2005. Three samples were collected from each filter representing the top, middle and bottom third sections. Results of analysis are presented in Table VI-2. The PCB concentration found in the filters was low and there was a tendency for the levels to be higher in the top third of the gravel filters. The average amount of PCB trapped in the gravel was calculated to be 149 mg per filter pair in the first row of filters and 65 mg in the second pair of filters. This result supports the notion that two gravel filters were adequate. The amount trapped by the GAC was calculated to be 23 mg on the two filters. The amount is similar to the 30 mg collected in 2004. The sediment captured by the barrier had a much lower PCB concentration this year. The fact that a similar mass of PCBs was captured indicates improved functioning of the barrier this year.

The gravel filters trapped more PCBs than the GAC filters. This supports the notion that most of the PCBs are in the particulate fraction. The barrier is functioning as designed since the contaminant is being removed as water passes through the barrier system. With further improvements, such as the re-introduction of a geotextile filter to trap the finer particles, the barrier system will be fully functional; this final step can be introduced once the sediment loadings decrease.

**Table VI-2: PCB Concentration of Filter Box Materials From the S1/S4 Valley Barrier System in Operation From 31 August 2004 to 28 July 2005**

| Sample No | Units | Medium | Location | PCB Conc. |
|---|---|---|---|---|
| RI05-320D | ug/g | Gravel | Left first filter bottom third | 1.1 |
| RI05-320 | ug/g | Gravel | Left first filter middle third | 0.9 |
| RI05-319 | ug/g | Gravel | Left first filter top third | 4.8 |
| RI05-300 | ug/g | Gravel | Right first filter bottom third | 1.7 |
| RI05-318 | ug/g | Gravel | Right first filter middle third | 1.1 |
| RI05-314 | ug/g | Gravel | Right first filter top third | 2.0 |
| RI05-120D | ug/g | Gravel | Left second filter bottom third | <0.5 |
| RI05-140D | ug/g | Gravel | Left second filter middle third | <0.5 |
| RI05-299 | ug/g | Gravel | Left second filter top third | 1.0 |
| RI05-260D | ug/g | Gravel | Right second filter bottom third | 1.3 |
| RI05-257 | ug/g | Gravel | Right second filter middle third | 0.8 |

| Sample No | Units | Medium | Location | PCB Conc. |
|---|---|---|---|---|
| RI05-259 | ug/g | Gravel | Right second filter top third | 1.0 |
| RI05-316 | ug/g | GAC | Left filter bottom third | <0.5 |
| RI05-315 | ug/g | GAC | Left filter middle third | 1.3 |
| RI05-317 | ug/g | GAC | Left filter top third | 0.8 |
| RI05-240 | ug/g | GAC | Right filter bottom third | 1.4 |
| RI05-260 | ug/g | GAC | Right filter middle third | <0.5 |
| RI05-240D | ug/g | GAC | Right filter top third | 1.2 |

At the end of the season the GAC filters that had been placed in the barrier for the summer were sampled and sent to the laboratory for analysis. Seven samples were taken per filter with two or three samples taken in each third. Results are shown in Table VI-3. The results show much higher levels in the top third of the filter; this section of the GAC was observed to be contaminated with soil. During the construction of the Tier II landfill water was pumped out and was discharged through the barrier. The fine particles floated on the surface and were collected in the GAC cassette, which accounts for the high values for PCB concentrations in the top section. The total mass of PCB collected on the filters was 76 mg.

**Table VI-3: PCB Concentration of Filter Box Materials From the S1/S4 Valley Barrier System in Operation From 28 July 2005 to 26 August 2005**

| Sample No | Units | Medium | Location | PCB Conc. |
|---|---|---|---|---|
| RI05-375;-374 | ug/g | GAC | Left bottom third | 0.8; 1.0 |
| RI05-376; -378; -373 | ug/g | GAC | Left middle third | 1.3; 0.7; 1.3 |
| RI05-377; -370 | ug/g | GAC | Left top third | 6.3; 8.9 |
| RI05-1234; -1235; -380 | ug/g | GAC | Right bottom third | 3.1; 1.2; 0.7 |
| RI05-372; -381 | ug/g | GAC | Right middle third | 2.2; 1.7 |
| RI05-379; -390 | ug/g | GAC | Right top third | 6.8; 3.7 |

The total mass of PCB removed by the filter box was 237 mg for the over winter and spring runoff period and 76 mg during the summer.

Arctic suite metals were determined in a few samples from the S1/S4 barrier system. These results are presented in Table VI-4 for cobalt, copper, nickel, and zinc. For the other 4 elements all values were low and mostly below the method detection limit. Sediment levels are as expected at the site except for the copper levels which are high. Sample 172 is from the sediment in the main catchment area while 175 was from between the two gravel filters. The high value of 186 ppm illustrates that both PCBs and metal ions are adsorbed on to GAC. For cobalt, nickel and zinc the levels found in the GAC (bottom third) in place for the summer were 2 to 3 times higher those for the winter. This might be explained by the lack of gravel in front of the summer GAC or that more metals are soluble in the warmer summer runoff water and therefore extractable. For copper the results are higher and variable.

**Table VI-4: Metal Concentrations From the S1/S4 Valley Barrier System (ppm)**

| Sample No | Date Sampled | Material | Cobalt | Copper | Nickel | Zinc |
|---|---|---|---|---|---|---|
| RI05-172 | 11 July 2005 | Sediment | <5.0 | 114 | 13.0 | 33 |
| RI05-175 | 11 July 2005 | Sediment | 9.0 | 186 | 32 | 76 |
| RI05-316 | 29 July 2005 | GAC | 5.7 | 76 | 22 | 34 |
| RI05-317 | 29 July 2005 | GAC | 7.6 | 125 | 25 | 47 |
| RI05-1234 | 6 Sept 2005 | GAC | 17.8 | 80 | 72 | 79 |
| RI05-375 | 6 Sept 2005 | GAC | 19.9 | 58 | 77 | 60 |

## C. S1/S4 Beach Barrier

### *1. General*

The discovery of very high levels of PCBs in a single sample of soil from this area in 1993 was the driving force for much of the assessment and remediation work conducted in 1994. As part of the 1994 work the whole beach area under the cliffs from the S1/S4 valley was delineated with respect to PCB levels. Some soils found had levels over 1000 ppm PCBs and Tier II levels reached all the way to the sea. Two temporary interceptor barriers were constructed across the drainage pathway in 1994 and monitored each year. No PCBs were detected in water passing through the final barrier over the period 1995-2004. Excavation of the area started in 2004 and was completed in 2005 as described in Chapter II section C. In 2004, CEPA soil was removed from the upper portions of the S1/S4 beach area but the steepest sections were too dangerous to excavate. Similarly this year areas somewhat further down the slope could not be excavated for Tier II soils due to the nature of the terrain. As a result, it is known that some CEPA and some Tier II soils remain in the steep areas of this location, as shown on Map II-2. Therefore a barrier was designed and constructed at the bottom edge of this area adjacent to the sea as described in the following section.

### *2. Design and Construction*

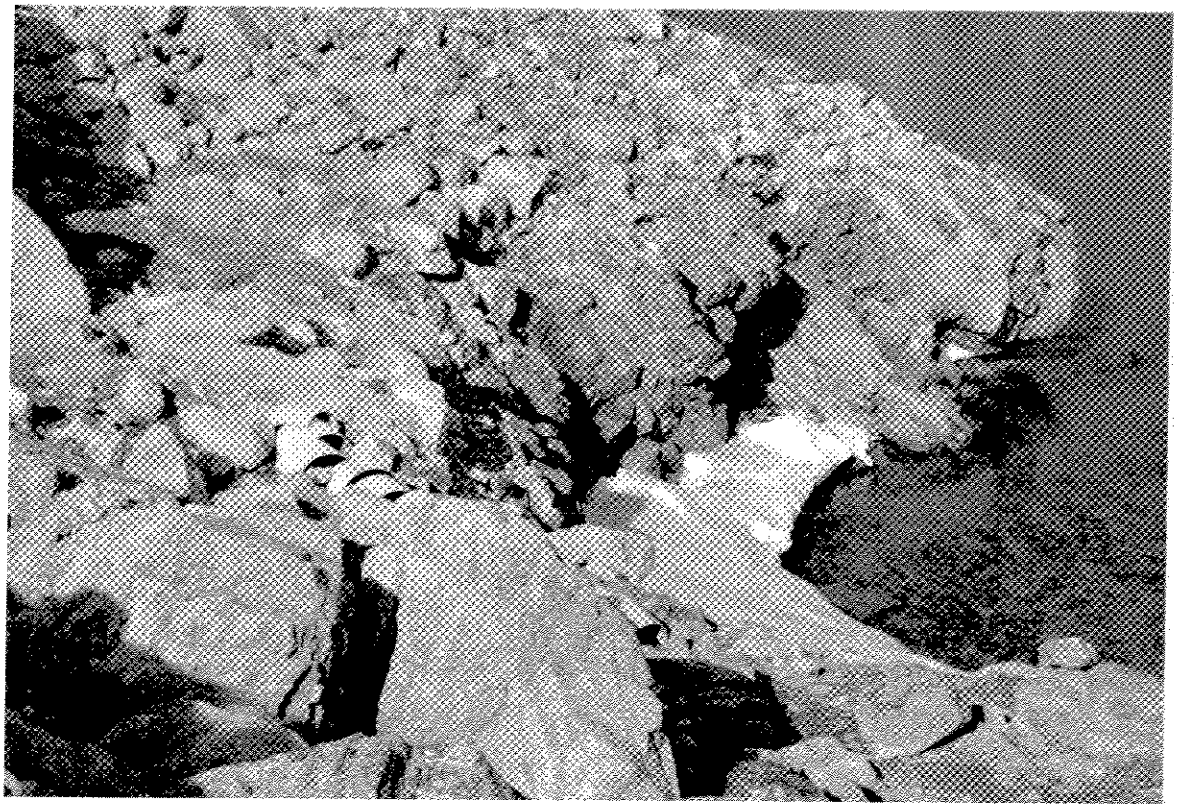
The design and construction of this barrier was based on the one built at the end of the S1/S4 Valley as shown in Figure VI-1 and on the topography of the area. The barrier was best placed at the end of the drainage pathway where the previous 1994 barrier was situated (Photograph VI-5). Water passing through the barrier thus would flow almost directly to the sea and not pass over or through potentially contaminated soil. The barrier was constructed over the period 19 to 28 August 2005.

The first step in its construction was to use an excavator to contour and define the drainage pathway for the barrier system (Photograph VI-6). The pathway chosen was not the same as the original main pathway because excavation had changed the topography of the area and it was deemed desirable to encompass a secondary drainage pathway to the north-east of the primary one. Thus the lowest part of the pathway was somewhat parallel to the shoreline. The lowest part, for the lined barrier funnel catchment area, had a gentle slope but this then was preceded by a steep slope before leveling off. A clay layer

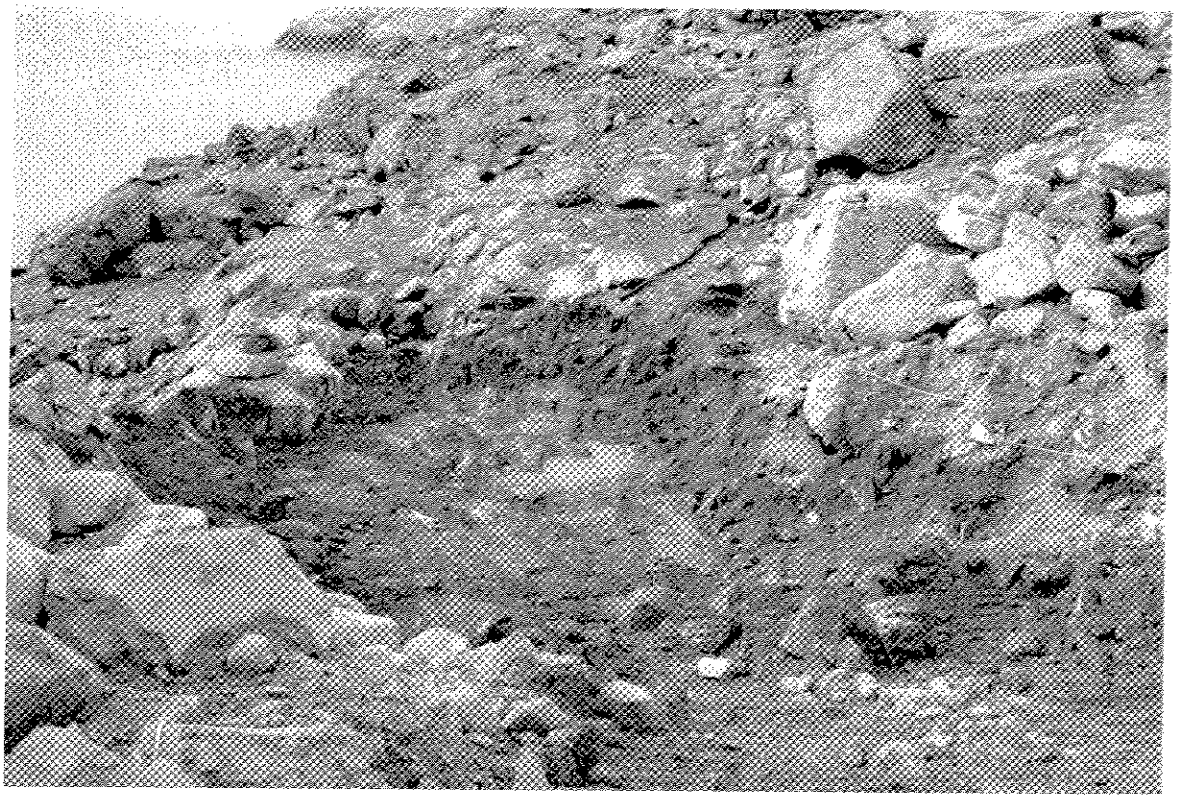
(Photograph II-8) was discovered beneath the pathway leading to the barrier. This layer will ensure that all water will be directed to the barrier.

The first task once the area had been excavated was to prepare the ground for the filter box. The box had to be very securely fastened to the bedrock located in this area. This was achieved by securing six lengths of threaded stainless steel rod into the bedrock using rock bolts and adhesive (Photograph VI-7) and then pouring a concrete base around them. Access to this area was by way of a narrow path down which the concrete was transported in a wheel barrow (Photograph VI-8). During excavation a berm was constructed on the south-east side and large rocks were placed in front of the gate. The sides of the funnel were then created by filling gabions which were backed by the natural and contoured ground (Photograph VI-9). Two layers of GCL (Geocomposite Clay Liner Bentofix CNSL obtained from Terrafix Geosynthetics Inc., Toronto) were then placed over the entire area including the gabions and the berm on the sea side of the structure. This was then wetted to activate the bentonite (Photograph (VI-10). Finally a black synthetic plastic layer (laminated polyurethane, nylon and polypropylene – 8130 XR-5 obtained from Quatrex Environmental Ltd., Laval) was placed on top of the GCL and held in place by sandbags (Photograph VI-11). Both the GCL and the black plastic extended on to the filter box platform. The stainless steel filter box, three units wide, was then secured in place and the GCL and plastic layers secured to its sides thus sealing the system and forcing all water entering it to flow through the filter box. The front edges of the liners were placed in a small trench and buried. Finally a gabion was placed across the lined area about 2 meters from the box.

A second gabion sediment trap was constructed at the top of the steep slope as shown in Photograph VI-12. In addition the channel leading to this gabion wall was lined with cobbles (Photograph VI-13). Finally a sediment trap comprising a geosynthetic, Curlex, wrapped around a pyramidal form was placed across the front of the barrier where the front edges of the liners were buried as shown in Photograph VI-14 near the completion of the barrier facility; this type of sediment trap was used in the Chevrons in the S1/S4 valley and constructed from on site materials. Gravel and GAC filters were then placed in the filter box.

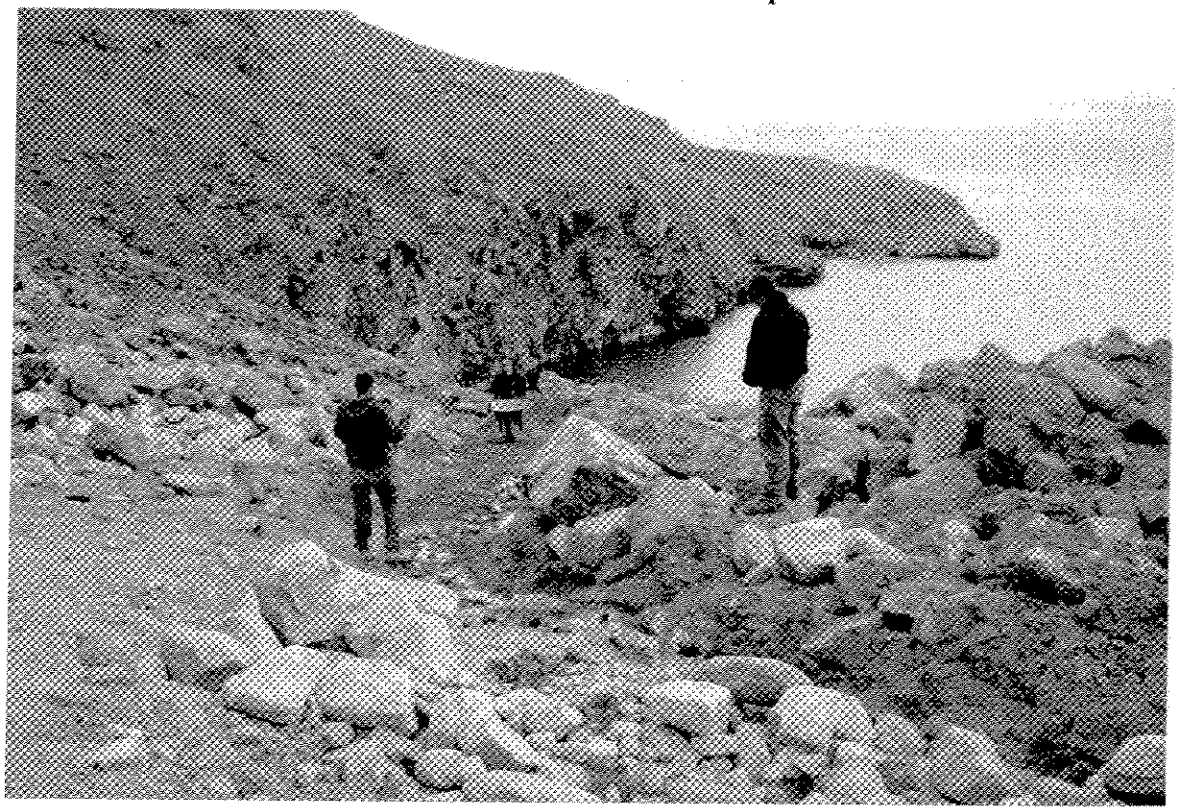


**Photograph VI-5: The S1/S4 Beach Barrier Next to the Sea Constructed in 1994 Prior to Excavation of PCB Contaminated Soil**



**Photograph VI-6: After All the PCB Contaminated Soil had been Removed from the S1/S4 Beach Area, a Drainage Channel was Excavated and Contoured**

**Photograph VI-7: The Ground was then Prepared for Attachment of the Filter Box at the End of the Channel Just Above the Four Meter Drop to the Sea**



**Photograph VI-8: Access to the Base of the New Barrier was Via a Steep Track**