II. REMEDIATION

A. General

Excavation work continued at two areas this year. At the S1/S4 Buildings Area, remediation of the PCB contaminated soils was continued and the work is described in section C. Near the end of the season, an excavator traveled from the area formerly occupied by the furniture dump and reached the southern barrier in the S1/S4 valley. The ASU was requested by INAC to re-analyse soils from the area above the barrier. These results are presented in Chapter III section C. At the Beach Dump excavation of the remaining debris was carried out and the whole excavated area gridded, sampled and analysed for copper, lead, zinc and PCBs. Results of this work together with calculations of contaminated soil volumes and maps are presented in Section D. Section B describes the methodology for this work. QA/QC relating to the analytical work is given in Chapter III, section K.

B. Methodology

1. Excavation

The following is the general methodology that was used to excavate CEPA soils. There were changes this year with respect to gridding, mapping, reporting, documentation and protocols which have been incorporated into the following paragraphs.

Ropes and spray paint of various colours were placed on the ground to indicate the extent of PCB contamination at the >2000 ppm (green), CEPA (yellow), Tier II (blue) and Tier I (pink) levels. Spray paint was found to be more useful when heavy equipment was working in the vicinity. Soil containing >2000 ppm were excavated and placed directly into steel containers. Other CEPA soils were excavated and taken to the screening plant. Material not passing through the screener was classified as Tier II and stockpiled. The CEPA material passing through the 2 inch screen was classified as CEPA soil and taken to the main PCB storage facility. Eleven steel containers were mistakenly filled with this material. After excavating to the depth indicated from the sampling/analysis work, the soil in the area was tested to ascertain if its concentration was now below the CEPA criterion. If not, further excavation was carried out. The soils were dug up with an excavator equipped with a bucket or clam. However, the bedrock needed to be further cleared of PCB-contaminated soils which could not be excavated with heavy machinery. This was achieved by shoveling by hand and by using a vacuum truck. This work was slow and arduous, however, the new vacuum truck purchased and brought on site this year did significantly improve the process.

Gridding and mapping of excavated areas and documentation relating to these were developed this year for the S1/S4 area. These are discussed in detail in Section C.3 below.

The two old International trucks were used to transport the CEPA soils. One truck stayed in the clean area and the screened CEPA soils were loaded on to them carefully so as not to contaminate the outer parts of the truck. The wheels of the truck did not contact the soil in the storage facility because they drove to the edge of the soil pile on a piece of geotextile fabric. If the truck did contact the soil it was decontaminated. The soil within the facility was piled higher with a loader.

Decontamination centers were set up for personnel at all locations where contaminated soil and leaking barrels were being dealt with. The large decontamination trailer was used at the S1/S4 area but smaller units comprised of containers of wash water and supplies of personal protective equipment were used elsewhere. The personal protective equipment used is given in the Health and Safety Plan and was described fully in the 1999 ASU report. Tyvec suits, gloves and rubber boots were always worn when working in contaminated areas. In general, half-faced respirators were used whenever the odour of askarel (PCB mixture) was encountered; dust masks were worn whenever it was dusty.

Protocols for dealing with wood on PCB contaminated ground and for the excavation of the Beach Dump were produced and are discussed in sections C.2 and D.2 and are attached as Annexes A and B at the end of this chapter.

2. *Sampling*

Soil samples were collected using plastic scoops and placed in WhirlPak bags. Some sampling locations were marked with a six inch nail to which was attached a numbered metal disk and a piece of flagging tape. Most soil samples taken this year were composite samples for areas that had been excavated. The size of the areas from which composite samples were taken depended on the overall size of the area excavated, and the terrain. The general guidelines were to sample each 3 m by 3 m quadrant or equivalent area. Tables containing the analytical results cross reference sample numbers with location. Soil samples were generally restricted to the upper 10 cm but in order to determine the depth of contamination, test pits were also excavated (manually and by machine) and samples collected at specific depths.

Water samples were collected in 1 L Teflon bottles. Absorbent boom material was collected by cutting open a small section of boom and extracting some material by hand. The absorbent material was placed in WhirlPak bags. Care was taken to extract boom material from the center of the boom to avoid material that was in direct contact with contaminated soil (this barrier work is reported in Chapter III, Section D).

Most samples were analysed on site in the mobile laboratory. Other samples were shipped by guaranteed air freight to Queen's University for testing. In order to conform with regulations regarding sample control, a rigorous chain of custody was maintained. Chain-of-custody forms were filled out and checked for each sample before shipment from the North, and the contents of shipments were verified upon receipt in the laboratory. The relevant documentation is available on request.

3. *PCB Analysis*

Two methods were used to analyze for PCBs in soils namely the standard laboratory technique using gas chromatography with an electron capture detector (GC/ECD) and the field method using immunoassay test kits; for all other matrices only the GC/ECD method was employed. Only a few samples were analysed by test kits this year.

a) Field Test Kits (Soil Samples)

Field analyses of polychlorinated biphenyls (PCBs) were performed with Millipore EnviroGard™ PCB Test Kits. The immunoassay was carried out according to the manufacturer's instruction, but with a few minor modifications. A sub-sample was spread out on absorbent paper towels and allowed to air dry overnight. Then a 5 g portion was weighed and extracted with 5 mL methanol. The soil-methanol mixture was filtered and an aliquot of the extract used for subsequent analysis. A 25 μL aliquot was used, and the colour intensity recorded on a portable spectrometer. Results from previous studies indicated Aroclor 1260 was the principal constituent; therefore, Aroclor 1260 standards were used for calibration, rather than the Aroclor 1248 standards supplied by the manufacturer. These were prepared by dilution of a 200 ppm standard. For samples with high levels of PCBs a 1.0 g sample was taken from a well mixed soil sample, and if required the methanol extract was diluted before analysis.

b) Laboratory Analyses (GC/ECD) (Soil Samples)

The standard analytical procedure for the analysis of PCBs, namely gas chromatography with an electron capture detector (GC/ECD) was used. These analyses were performed at the Mobile Laboratory on-site and at the Analytical Services Unit, Queen's University by the following procedure. A separate soil sample was first taken for the determination of wet weight/dry weight ratio. Soils were analyzed by using approximately 10 g (dry weight equivalent), spiking it with an internal standard solution (decachlorobiphenyl) and extracting. Two extraction methods were used. The Soxhlet method used approximately 250 mL dichloromethane in a soxhlet extractor for four hours. The Shaker method used 3 times 25 mL dichloromethane with agitation on a platform shaker for 20 minutes for each extract. The shaker method was used for most soil samples while the soxhlet method was generally used for other solid matrices. The solutions obtained from either extraction method were concentrated to 1-2 mL and the solvent exchanged for hexane. This concentrate was then applied to a Florisil column (Supelco SPE tube) and the resulting eluent analyzed using an HP 5890 Series II Plus gas chromatograph equipped with electron capture detector and a 30 m SPB-1 capillary column and calibrated with Aroclor 1260 standards.

c) Laboratory Analyses (GC/ECD) (Other Matrices)

Samples of metal and barrier absorbent materials were analyzed as for soil by generally using the soxhlet extraction techniques. Water was analyzed by using approximately 800 mL of sample, spiking with internal standard and extracting three times with dichloromethane. The extract was filtered through sodium sulphate and concentrated to 1-2 mL and the solvent exchanged for hexane. This concentrate was then applied to a Florisil column for cleanup of the extract and the resulting eluent analyzed by GC/ECD. Air samples were analysed according to NIOSH Method 5503 by desorbing both the filter and absorbent with hexane and running the samples on a GC/ECD system.

C. S1/S4 Buildings Area

1. Background

The soil in the vicinity of the buildings S1, S2, S3 and S4 has been found to be highly contaminated with PCBs. The PCBs originating in the area surrounding the buildings, the S1/S4 Buildings Area, migrated over the years down the S1/S4 Valley Area and over the cliff to the S1/S4 Beach Area. In the 2001 summer season, an estimated 985 m^3 of CEPA soil was excavated from the S1/S4 Buildings Area. Of this, 115 m^3 was of material containing >2000 ppm PCBs. In addition, 12 steel containers were filled with CEPA pieces of wood. Map II-1 shows the extent of the excavation and contamination in this area at the start of the work this year.

2. Soil Excavation

Most of the contaminated soil was removed from the S1/S4 Buildings Area this year. Map II-2 shows the extent of remediation and contamination at the end of the excavation work this year. Table II-1 contains all the sample names, description of sampling locations and PCB concentrations of soil samples taken in and around the S1/S4 area for the 2001 season. Table II-2 contains similar details for wood samples from this area. The QA/QC data is compiled in Chapter III, Section K.

Early in the season there was a considerable amount of run-off resulting from the melting snow and ice. Pooling was observed in Grids G13-14 and H14-15 and many excavated holes and depressions were water filled. These hydrological events resulted in a shift of sediment and fine particles of soil and led to the re-contamination of several areas. Once the water had been pumped off, confirmatory testing was carried out to ascertain the extent of the problem. Composite samples were taken in areas where sediment had obviously been deposited: Grid References I16, H15-16 and H14, and in 2 known excavated holes located in Grids I16-J16 and H16. All were found to contain soil contaminated at > 50 ppm PCBs. Other pre-excavation samples were taken in surrounding Tier II areas (from I15, H15-16 and from the clean roadway just North of the former decontamination area, G16). The results indicated that the contamination level remained constant (Tier II level) with the exception of the entry road, which was found to be contaminated at the Tier I level.

Amongst the items left in the S1/S4 area at the end of the 2000 season were 10 red vaults. Five vaults were located in Grids F10-F11. These were filled with small pieces of wood and other debris hand-picked from the former S3 area. Analysis had shown the contents to be contaminated above the CEPA criterion and therefore these vaults were removed to the Beach PCB Storage Facility. One vault located in Grid H15 contained transformer racks which were found in 2000 to be contaminated above the 50 ppm level. This vault was also transported to the Beach PCB Storage Facility. The remaining 4 vaults located in the area between the former S1 and S2 buildings were empty. These vaults were later manually filled with wood debris from the S1 area, and transported down to the Beach PCB Storage Facility.

Water pumps were employed to displace water in areas where heavy equipment access or sediment removal was required (Photograph II-1). Water was discharged onto contaminated ground. After the water had been removed from Grids G13-14 and H14-15, the corridor connected to the S4 building was demolished and the debris taken to the non-hazardous landfill. The remaining CEPA contaminated silt and soil in this area was removed using an excavator. Samples were taken to ensure the boundary areas were lower than the CEPA criterion. A team of up to 10 people was used to manually remove rocks greater than 10 cm diameter so as to allow the vacuum truck to work unobstructed (Photograph II-2). Small pieces of insulation debris from the corridor were manually collected and this material was placed in a waste wrangler, and taken to the non-hazardous landfill. Clean fill was added to provide the vacuum truck access over the uneven bedrock and all remaining soil/sediment was removed. Three days of relatively dry weather helped dry the silt and expedite the work. The addition of clean fill provided an access way from the road (F13) and allowed the decontamination trailer to be sited (H14) (Photograph II-3). The trailer was anchored with steel cable and rock bolts. Access by personnel to the S1/S4 area required transit through the trailer.

Once the CEPA soil in this area (centered on Grid H14) had been addressed, the focus shifted to the S1 drainage area (Photograph II-4). The area leading up to the >2000 ppm zone was excavated, vacuumed and clean fill was added to provide further access. Soil from this area was kept separate from other (lower level) CEPA soil and deposited in a pile besides the screener. Vacuumed soil from this area was likewise deposited here. The CEPA soil surrounding this >2000 ppm area and the soil from an isolated CEPA area (Grids J19-20 and L19-20) was excavated from the same access point. After the >2000 ppm soil was stockpiled, it was containerized. A total of 70 containers were filled. This was broken down to 9 large flowerpots and 61 small flowerpots. These were assigned PCB labels (PN numbers), and were shipped down to the Main PCB Storage Facility. The 9 large containers were stored inside the building (some were found to leak) and the 61 smaller containers were stored outside, beside the east access door.

When no longer required, the access roads described above were removed. The third front in the S1/S4 area involved CEPA areas on the steep slopes, SSW of Troposcatter Dish B. The surface of these slopes was covered with large boulders, which made access to the soil difficult. An excavator with a clam attachment was used to remove the rocks (Photograph II-5) and these were dumped from the edge of an entry road down a steep slope (Grid G16). The quantities of rock removed, the intensive efforts required and the instability of the slope led to a partial collapse at the face. Samples taken from all along the surface indicated that the collapse had mixed the soil in the area with the net effect being the lowering of PCB concentrations. Results of analyses of soil samples from the area ranged from below 1 ppm to 33 ppm. Four test pits were dug along the collapsed face. Using the clam attachment on an excavator, depths of between 50 cm and 1 m were achieved. The results from samples taken in these areas ranged from 1.1 ppm to 34 ppm indicating that a lowering of PCB levels had resulted from disturbance caused by removing the large boulders. No further excavation was therefore required.

Wood and debris removal from the areas in and around the >2000 ppm area below the lower road was undertaken (Photograph II-6). There was found to be a direct correlation between levels of PCB soil contamination, and levels of PCB contamination for wood residing in these areas. Several wood samples were taken from lower CEPA areas (50-2000 ppm) and several from higher CEPA areas (>2000 ppm). In both of these areas, samples were taken from wood in direct contact with the soil and from wood slightly elevated above the surface. The samples taken from 6 inches or more above the surface were contaminated at a Tier I level. Samples taken from direct soil contact up to 6 inches above the soil level in the lower CEPA area were found to be Tier II and samples from wood in direct contact with soil up to 6 inches above the soil level contaminated at >2000 ppm were found to be CEPA. A new protocol: 'The Resolution Island Wood Debris Protocol' evolved from this work. It was used to deal with this contaminated wood and is reproduced as Annex A at the end of the chapter.

CEPA wood from the >2000 CEPA area was placed directly into 3 large flowerpots (Photograph II-7). These were assigned PN numbers, labeled and then transported to the Beach PCB Storage Facility. The rest of the wood, contaminated to

Tier I/II levels was shredded beside the core camp, and the debris placed in a depression in the bedrock beside the shredder. To prevent leaching of the wood, a thick tarp was placed on top of the pile and it was weighed down with large boulders. Analysis of 6 samples of the shredded material gave PCB levels in the range <1.0 ppm to 2.6 ppm or Tier I (see Table II-2)

The final efforts in the S1/S4 area, focused in the immediate vicinity of Troposcatter Dish A. The rock face in front of Dish A was vacuumed to remove the CEPA soil. Due to the architecture of the dish, the use of heavy equipment was restricted to a Kubota and manual excavation was required under the dish itself. To the right of the dish, the former 'archway' was removed. A substantial amount of soil was found on the slope down to the area south of Dish A (J16). In this area, samples were taken after every 30 cm excavation. High contamination levels were found to persist all the way to bedrock, and vacuuming was required (Photograph II-8). Clean fill was used to provide the vacuum truck access to this area. After this area had been cleared, a berm was constructed to prevent the migration of silt in the future (Photograph II-9). A similar berm was constructed beside the screener (Grid location G10-H10).

3. *Mapping*

a) Construction of the Map Grid

A 20 x 20 m grid system was graphically constructed using Autocad Map 2000. The grid was labelled A to S (in a N/S orientation) and 1 to 25 (in a W/E orientation). This grid was graphically constructed to contain all of the contaminated S1/S4 areas of concern in the S1/S4 buildings and S1/S4 valley areas. For the 2001 field season, the working area was encompassed by grid co-ordinates E8 to O21 (Map II-2). Each grid reference relates to the bottom right hand corner of the relevant 20 x 20 square. The 168 co-ordinates required to set-up the grid were exported to a Reliance mapping program and uploaded as a waypoint file to a GPS FS/2 handheld controller unit. On Resolution Island, the Ashtech Reliance differential GPS mobile receiver system was operated in 'rover mode' which allowed navigation to the individual grid points to within 1 m accuracy. Individual grid points were marked with flags and an "X", using purple spray paint. The grid co-ordinates were marked in several locations within the confines of the grid, on available surfaces and rocks (Photograph II-10).

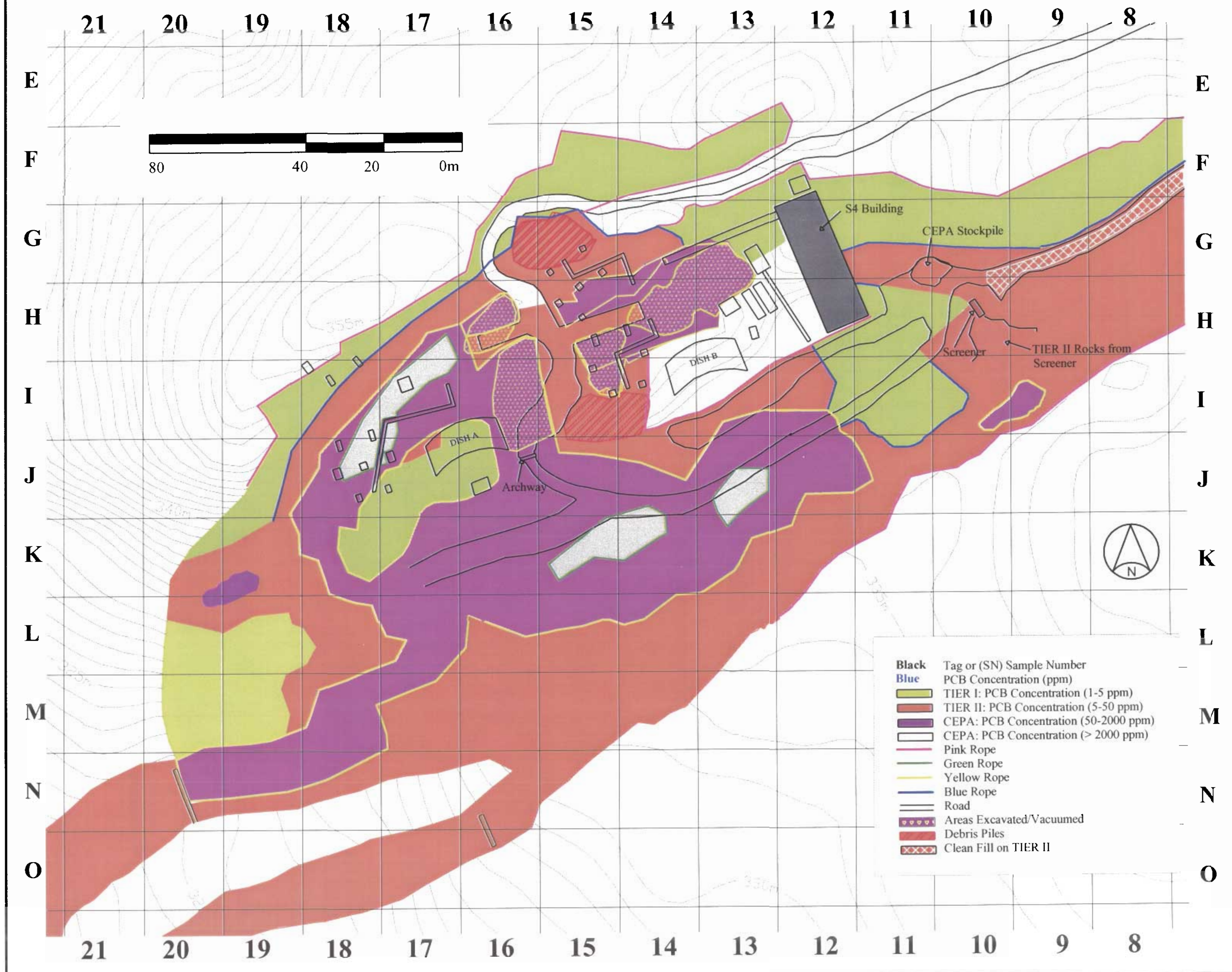
Of the 168 uploaded co-ordinates, 29 points were physically marked this field season: G13, G14, G15, H12, H13, H14, H15, H16, H17, I12, I13, I14, I15, I16, I17, I18, J12, J13, J14, J15, J16, J17, J18, K13, K14, K15, K16, K17, and K18.

Distances between grids were checked using a surveyors 80 m tape reel. In most cases the error was to within 1 m. In instances where multi-path distortion from structures resulted in > 1 m error, the value obtained from the tape measurement was used.

b) Implementation of the Grid System

Three map binders were constructed. The first contained individual maps for all the quadrants of interest. These maps include color coded contamination levels, previous sampling locations, tag and sample numbers and rope locations pertaining to the site as it appeared at the beginning of the 2001 Field Season. When any sampling or excavation occurred in a grid, the details were recorded on a quadrant log sheet and were sketched onto the relevant map. Where possible, samples were restricted according to the grid lines and sampling areas did not cross grid lines. At the end of each day the map and log sheet were placed in a 2nd binder 'Map Work in Progress'. A new map was used and updated for every day work occurred in that grid. When the grid had been excavated such that any remaining soil tested < 50 ppm PCBs (or was completely removed), the quadrant log sheet was dated and signed by a Queens Representative (Team Leader), an Engineering representative and a QC representative (Site Supervisor). All of the individual maps for that quadrant were attached to the log sheet and transferred to a third binder 'Completed Map Quadrants'. Copies of the completed documents were given to the engineering company (Sinanni) and to the Qikiqtaaluk Corporation. A 'working copy' map showing the progression of work and cleanup in a typical grid, G14, is illustrated (Figures II-1a and II-1b and Maps II-3a, 3b, 3c, 3d). Copies of all completed quadrant log sheets are included in Chapter V.

Map II-1: Contaminated Zones in the S1/S4 Buildings and Valley Areas at the End of the 2000 Field Season



Map II-2: Contaminated Zones in the S1/S4 Buildings and Valley Areas at the End of the 2001 Field Season

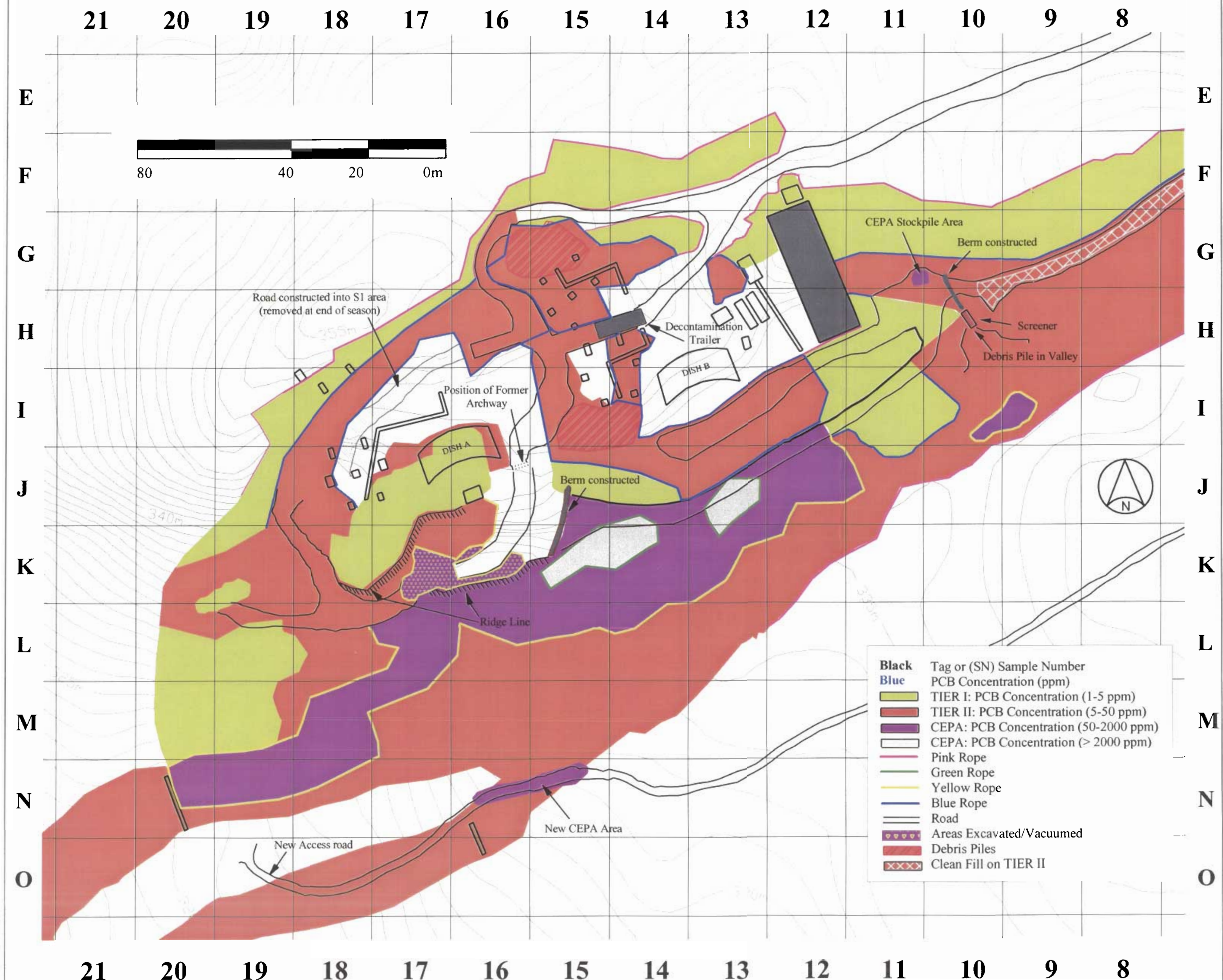


Figure II-1a: Summary Sheet for Quadrant G14

QUADRANT NUMBER G14

PAGE 1 **of** 2

DESCRIPTION OF QUADRANT / ADDITIONAL INFORMATION

EXCAVATION LOG

	Date	Type*	Location	Material #	Depth	Comments
A	July 20/01	M	All areas of grid	CEPA	0-30 cm	Debris was cleared off

* **H** Heavy Equipment, **M** Manual, **V** Vacuum # >2000 ppm, CEPA, Tier II, Tier I.

ANALYSIS LOG:

	Date	Sample△	Type◇	Results (ppm)	Comments
	July 18/01	026	S	3.7	Composite sample taken in TIER II area. Results indicate TIER I soil
	July 18/01	025	S	1.4	Composite sample taken in TIER II area. Results indicate TIER I soil.
A	July 20/01	030	S	140.2	Composite sample was taken in CEPA area (former S4 corridor area). Results indicate that vacuuming is required.

△ Prefix RI01- ◇ **S** Soil, **W** Wood, **M** Metal, **O** Other

CERTIFICATION THAT ALL SOIL CONTAINING > 50 PPM PCBs IS REMOVED FROM QUADRANT

Queen's Representative Aug 1/01 Date

Engineer Representative 1/08/01 Date

QC Representative Aug 1/01 Date

Figure II-1b: Summary Sheet for Quadrant G14

QUADRANT NUMBER G14 **PAGE** 2 **of** 2

DESCRIPTION OF QUADRANT / ADDITIONAL INFORMATION

EXCAVATION LOG

	Date	Type*	Location	Material #	Depth	Comments
B	July 29/01	V	S3 Area	CEPA	–	Soil was vacuumed to bedrock

* **H** Heavy Equipment, **M** Manual, **V** Vacuum # >2000 ppm, CEPA, Tier II, Tier I.

ANALYSIS LOG:

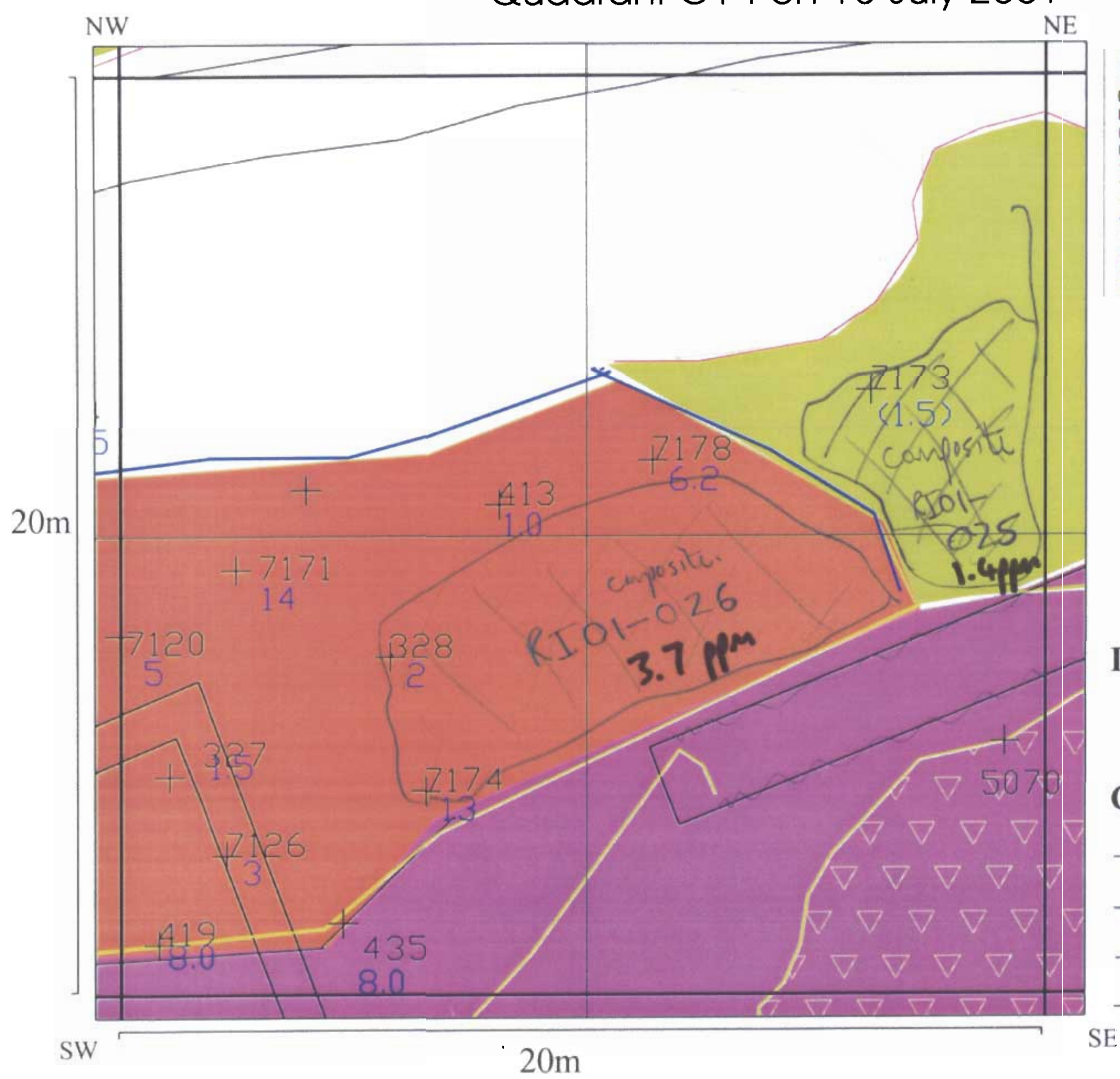
	Date	Sample△	Type◇	Results (ppm)	Comments
B	July29/01	046	S	1.99	Composite sample taken along the border of the CEPA area in S3. Results indicate that all of the CEPA soil has been removed ⇒ TIER I

△ Prefix RI01- ◇ **S** Soil, **W** Wood, **M** Metal, **O** Other

CERTIFICATION THAT ALL SOIL CONTAINING > 50 PPM PCBs IS REMOVED FROM QUADRANT

[signature] Queen's Representative	Aug 1/01 Date	[signature] Engineer Representative	1/08/01 Date
[signature] QC Representative	Date		

MAP II-3a:Composite Sampling Locations and PCB Concentrations for Quadrant G14 on 18 July 2001



Black	Tag or (SN) Sample Number
Blue	PCB Concentration (ppm)
	TIER I: PCB Concentration (1-5 ppm)
	TIER II: PCB Concentration (5-50 ppm)
	CEPA: PCB Concentration (50-2000 ppm)
	CEPA: PCB Concentration (> 2000 ppm)
	Pink Rope
	Green Rope
	Yellow Rope
	Blue Rope
	Road
	Areas Excavated/Vacuumed
	Debris Piles
	Clean Fill on TIER II

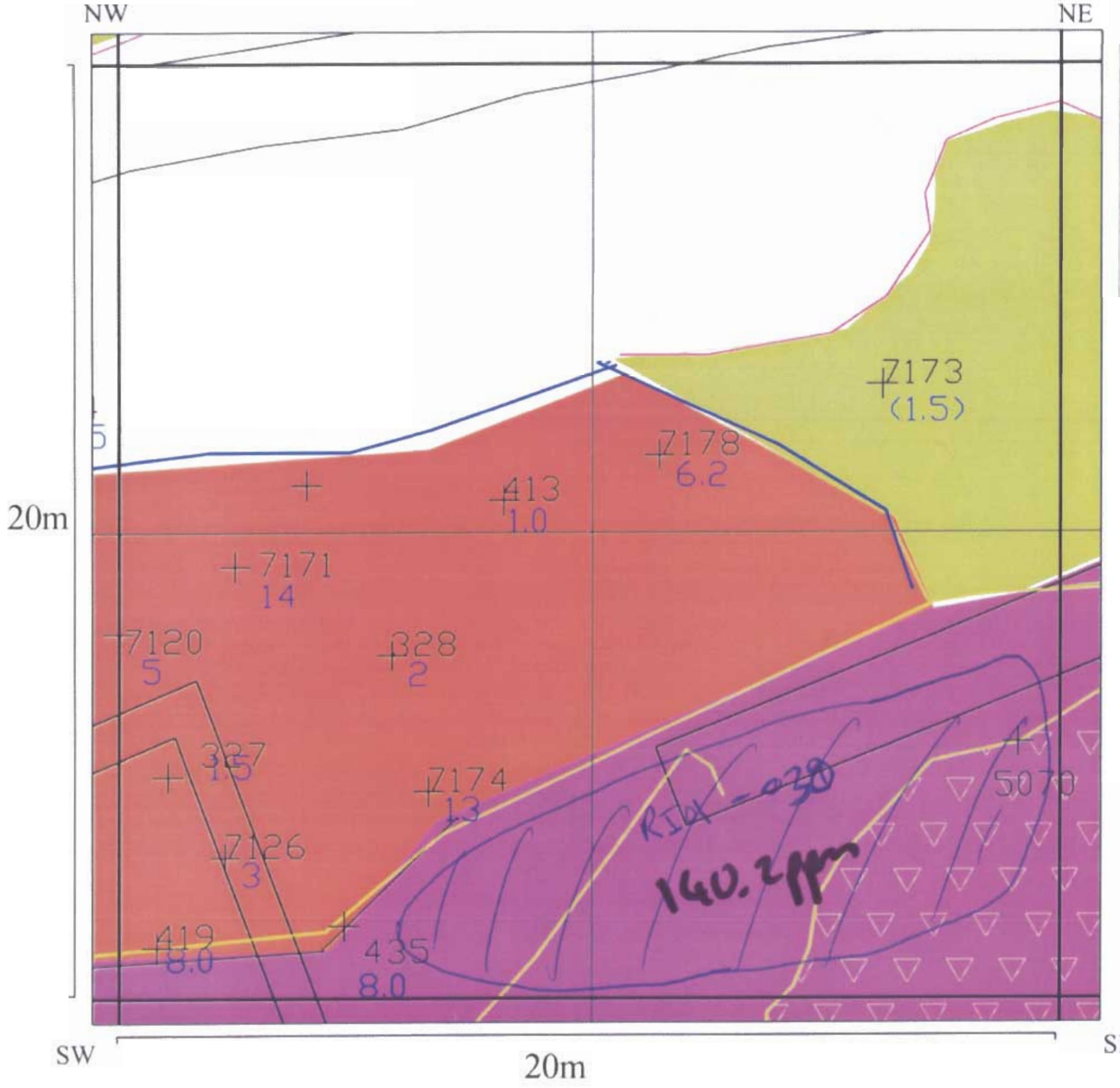
N

G14

DATE: 18 July 01.

COMMENTS: Test to see if only road can be built here is it still TIER I.

MAP II-3b:Composite Sampling Locations and PCB Concentrations for Quadrant G14 on 20 July 2001



Black Tag or (SN) Sample Number
Blue PCB Concentration (ppm)
TIER I: PCB Concentration (1-5 ppm)
TIER II: PCB Concentration (5-50 ppm)
CEPA: PCB Concentration (50-2000 ppm)
CEPA: PCB Concentration (> 2000 ppm)
Pink Rope
Green Rope
Yellow Rope
Blue Rope
Road
Areas Excavated/Vacuumed
Debris Piles
Clean Fill on TIER II

N

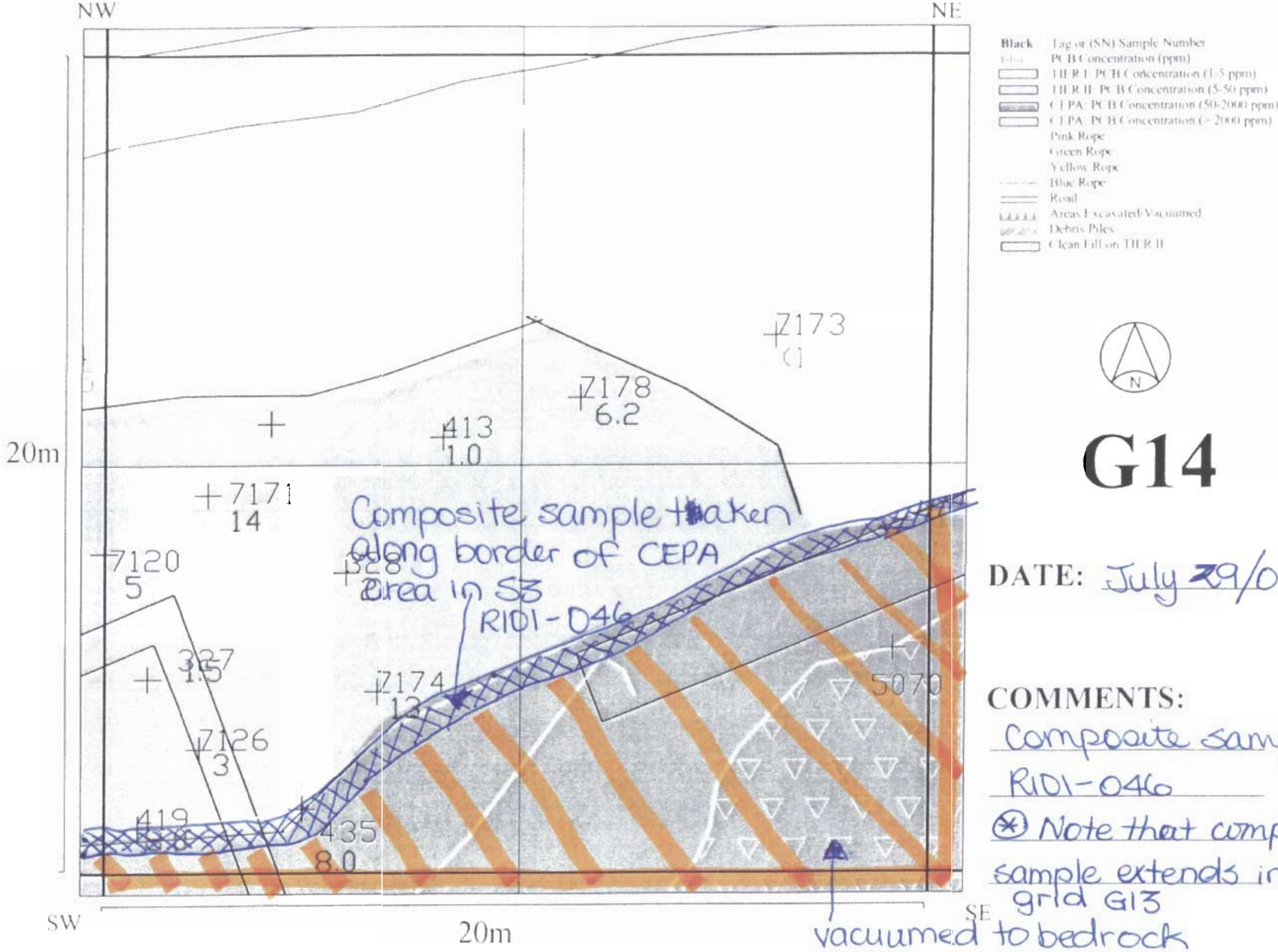
G14

DATE: 20 July 01

COMMENTS:

Composite of where
corridor was. NB people
were picking up debris all day.

MAP II-3c:Composite Sampling Locations and PCB Concentrations for Quadrant G14 on 29 July 2001

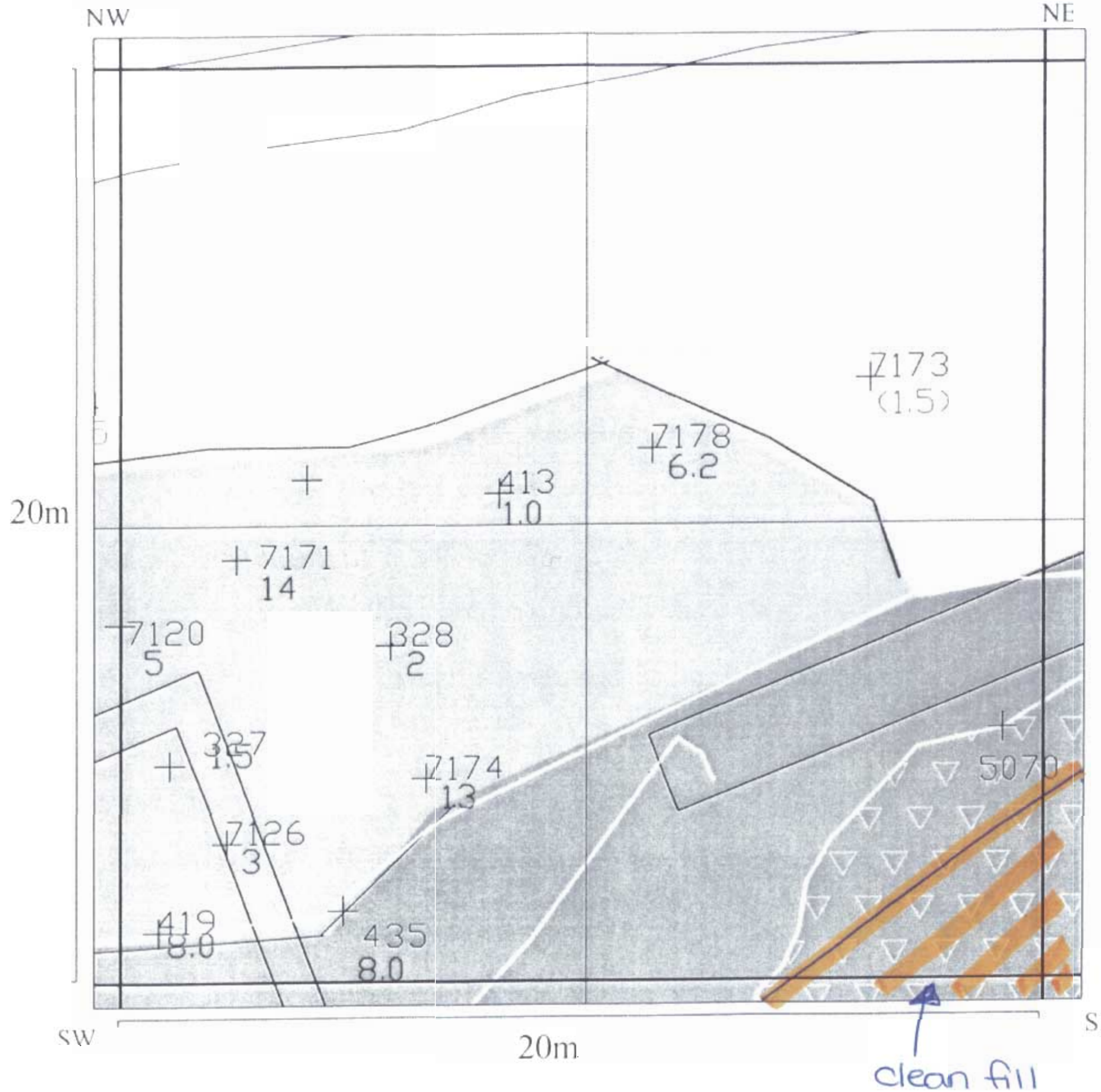


G14

DATE: July ~~2~~9/01

COMMENTS:
Composite sample
RI01-046
(*) Note that composite sample extends into grid G13

MAP II-3d:Composite Sampling Locations and PCB Concentrations for Quadrant G14 on 30 July 2001



Black Tag or (SN) Sample Number
Blue PCB Concentration (ppm)
TIER I: PCB Concentration (1-5 ppm)
TIER II: PCB Concentration (5-50 ppm)
CEPA: PCB Concentration (50-2000 ppm)
CEPA: PCB Concentration (> 2000 ppm)
Pink Rope
Green Rope
Yellow Rope
Blue Rope
Road
Areas Excavated/Vacuumed
Debris Piles
Clean Fill on TIER II

G14

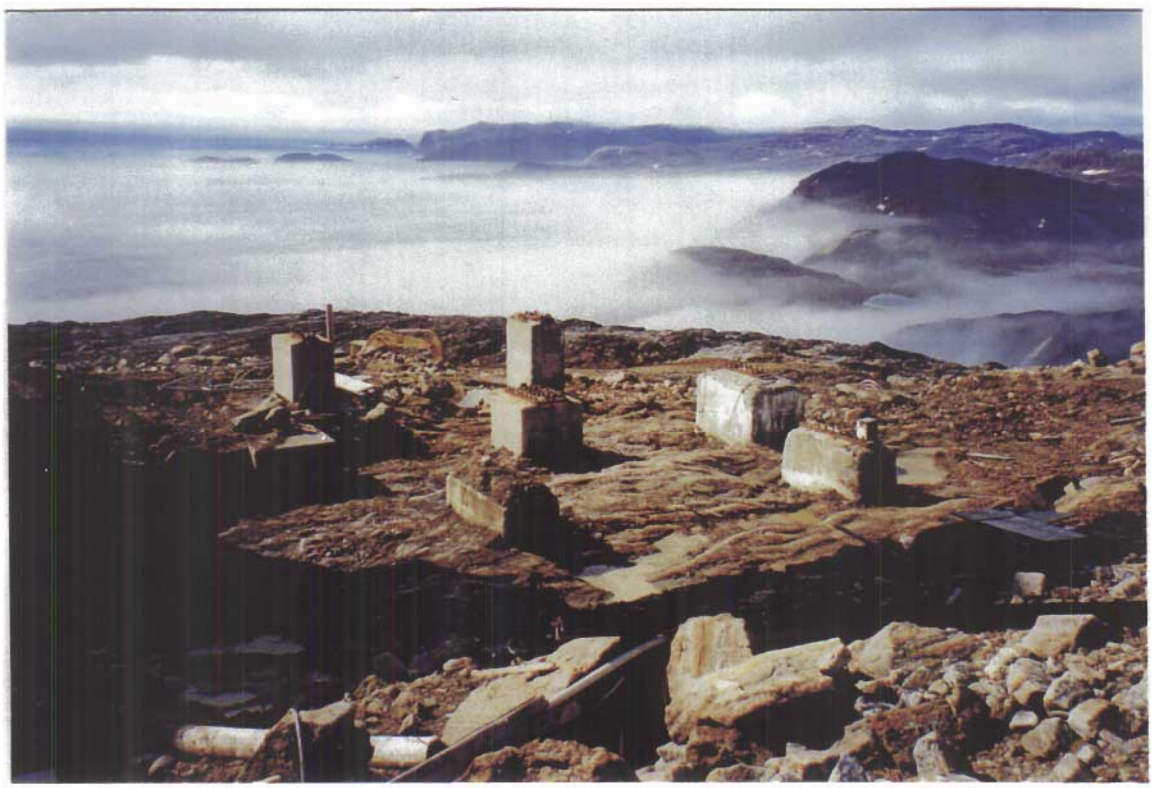
DATE: July 30/01

COMMENTS: Clean fill put onto bedrock to make way for decon trailer

Photograph II-1: Demolition of the Corridor That Links Buildings S3 and S4; and Pumping Water From the S3 Area.

Photograph II-2: The New Vacuum Truck Removing Fine Material From Bedrock.

Photograph II-3: The Decontamination Trailer was Placed in the S3 Area After Removal of PCB Contaminated Soils.



Photograph II-4: All CEPA Soil was Remediated From the Heavily PCB-Contaminated Region which Drained the Area where Building S1 Previously Stood.

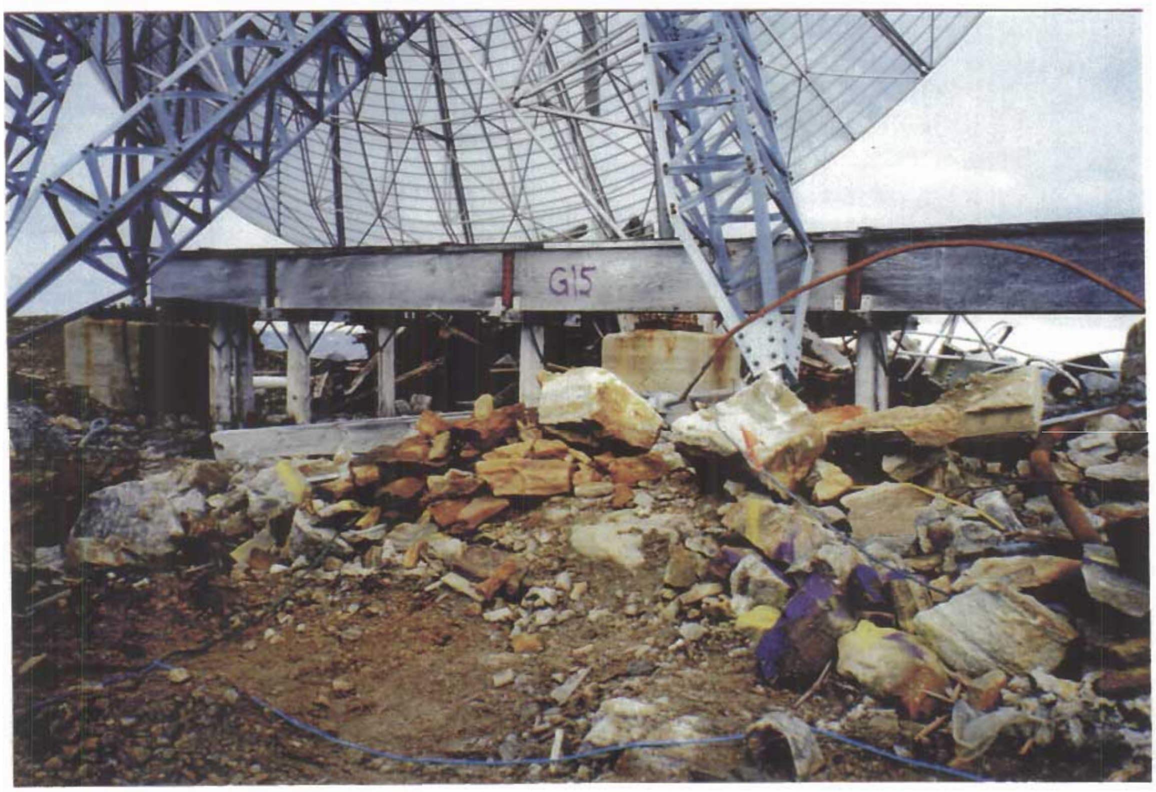
Photograph II-5: Excavating Large Boulders From the Steep Slope Along the Road From the Screening Plant Below the Buildings Area.

Photograph II-6: Pieces of Wooden Debris Lying on Soil Much of Which is Contaminated with PCB above the 2000 ppm Level.

Photograph II-7: Contaminated Wood Lying on Soil Contaminated with PCBs Above the 2000 ppm Level was placed in Steel Containers.

Photograph II-8: Cleaned Area Below the Large Troposcatter Dish Near S1

Photograph II-9: Uncontaminated Soil was Placed on Cleaned Ground and a Berm Constructed to Prevent Recontamination of the Area Over Winter.



Photograph II-10: The Whole Contaminated Area Was Gridded at 20 Meter Intervals; Grids Where Labels (G15) and Corners Marked With Purple Paint.