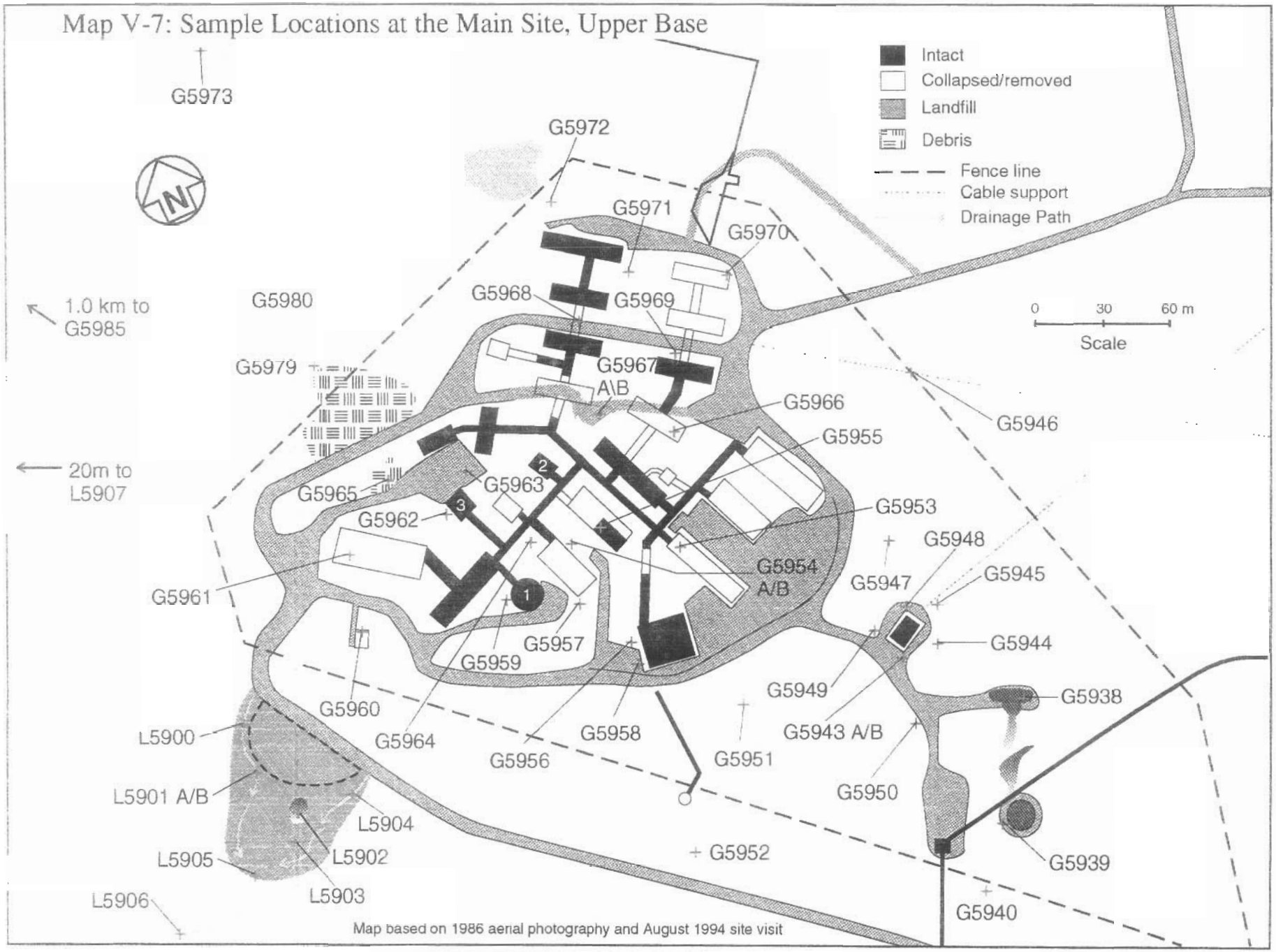

Map V-7: Sample Locations at the Main Site, Upper Base
Intact
Collapsed/removed
Landfill
Debris
Fence line
Cable support
Drainage Path
N
0 30 60 m
Scale
1.0 km to G5985
20m to L5907
G5973
G5972
G5971
G5970
G5980
G5968
G5969
G5979
G5967 A\B
G5966
G5946
G5955
G5965
G5963
G5962
G5953
G5948
G5947
G5945
G5954 A/B
G5961
G5957
G5959
G5944
G5949
G5938
G5960
G5964
G5956
G5958
G5951
G5943 A/B
G5950
L5900
L5901 A/B
L5904
L5905
L5902
L5903
G5952
G5939
L5906
G5940
Map based on 1986 aerial photography and August 1994 site visit

The sewage system at the Upper Base consisted of a partially buried pipeline that delivered waste from the Main Site to a holding tank below and southwest of the vehicle storage building (Map V-8). The holding tank has been removed, but a pipeline that conveyed the sewage to an outfall area on the southwest side of the road to the base was still in place at the time of the current investigation. From the end of the pipe the material would have flowed down the hill and pooled in a low marshy area northwest of the Remote Receiver Site (Photograph V-13). Six soil samples, including one field duplicate, were collected in the vicinity of the outfall. Vegetation in the outfall area was quite lush and included a tall broad-leaved species of grass (*Arctagrostis latifolia*), sedges (*Carex* spp.), willows (*Salix* spp.) and bistort (*Polygonum viviparum*). Five plant samples were collected in the outfall.

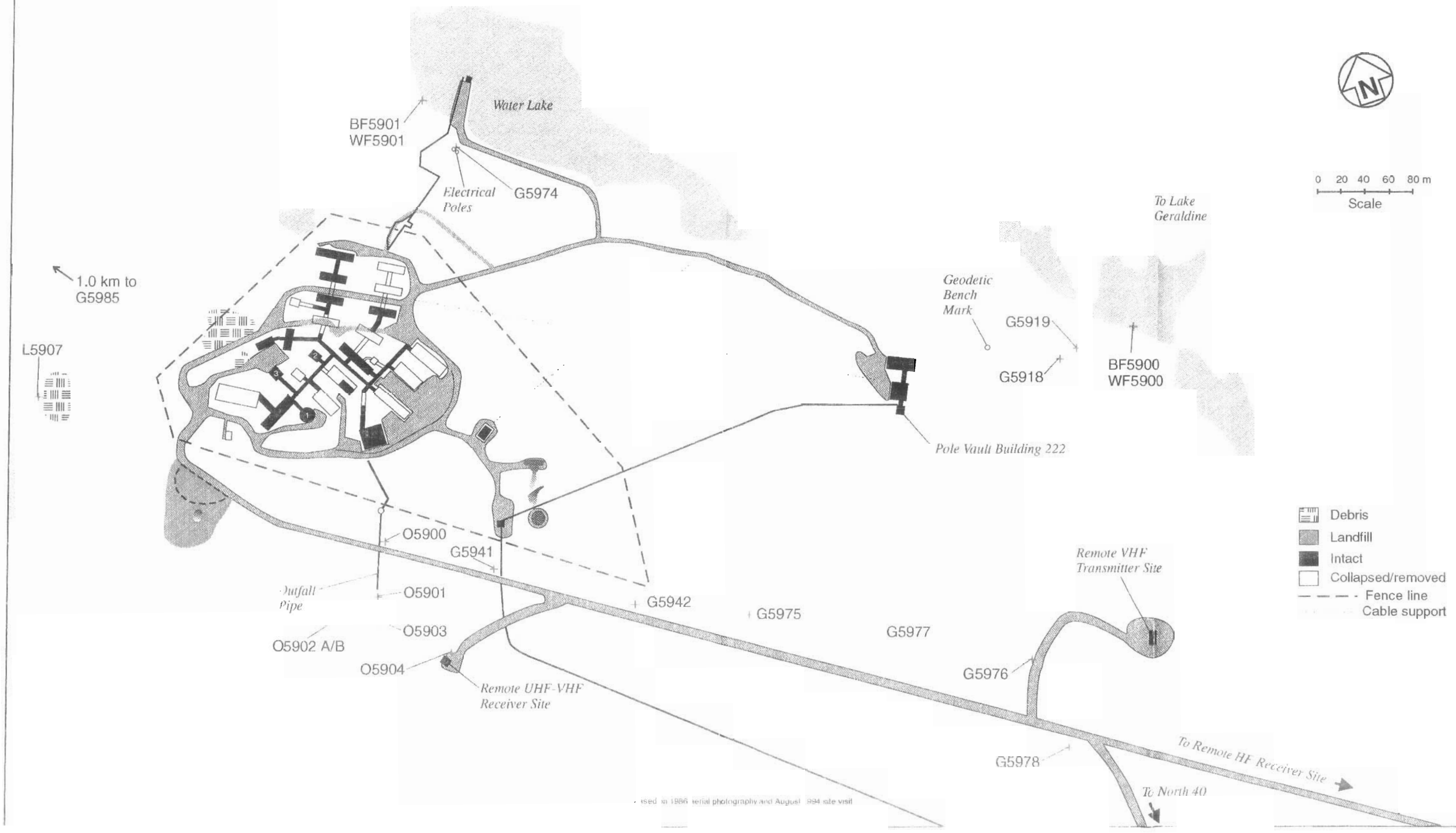
The Upper Base has the potential to influence the town's water supply lake, Lake Geraldine, located approximately 2 km southeast of the base. Three samples, including one field duplicate, and a bulk 12 litre sample were collected from the lake (see Map V-9). In addition, potable water samples were collected in three locations in town: from the Forward Operating Location (FOL) hangars, a business office, and a residence. The business and residence samples were bulk 12 litre samples, while the sample from the FOL consisted of one litre only.

Detailed descriptions of individual sampling locations and vegetation collected and surveyed are provided in Section B, Chapter IV of the Appendices.

Photograph V-12: View of the northwest toe of the Upper Base Landfill.

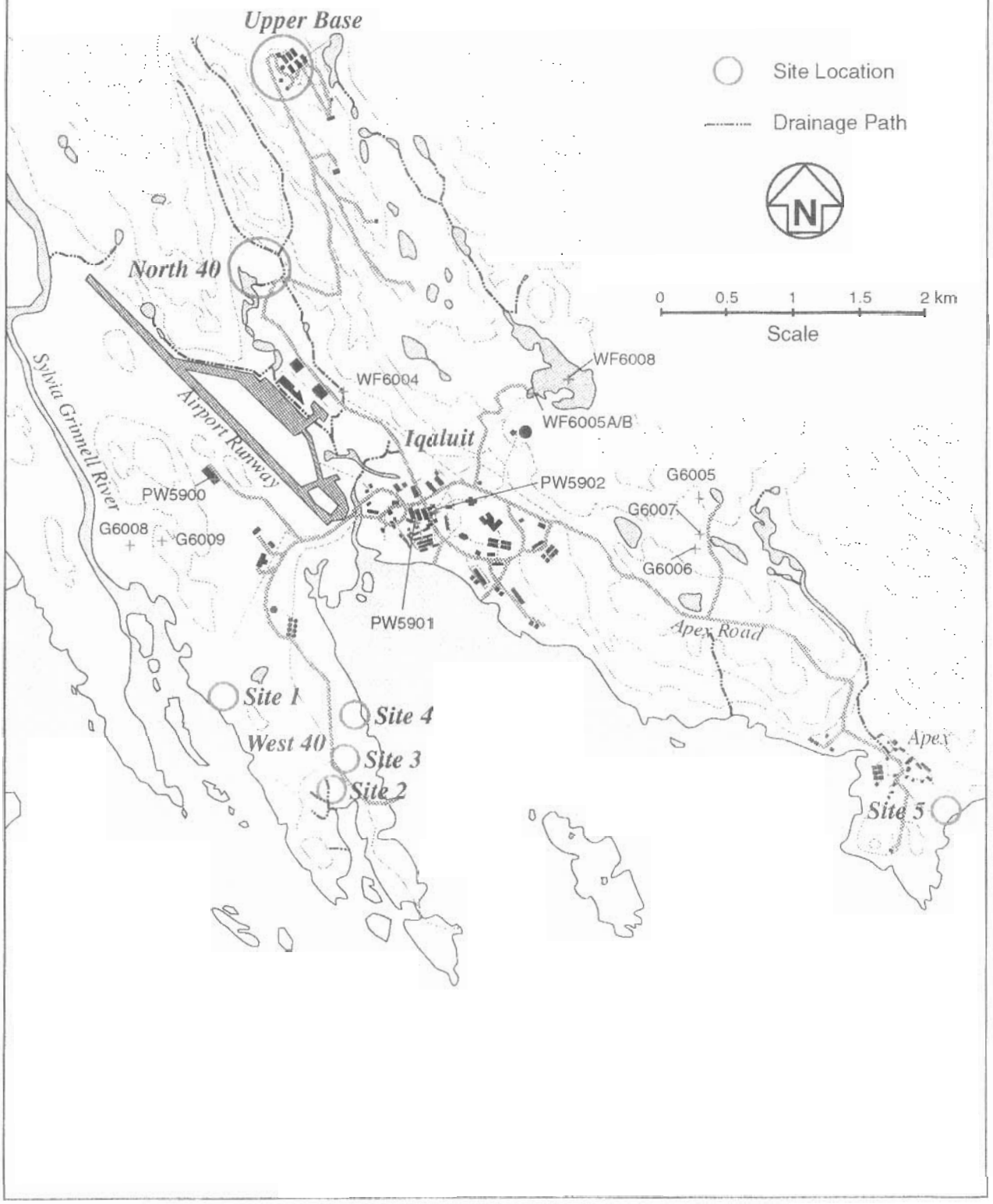
Photograph V-13: The lushly vegetated lower area of the Upper Base Outfall.

Map V-8: Outlying Assessment Sample Locations at the Upper Base



sed in 1986 aerial photography and August 1994 site visit

MapV-9: Locations of Additional Samples Collected Near Iqaluit



4. Analytical Results

To simplify the discussion of results, the Upper Base has been divided into six geographic areas as follows:

- Pole Vault Building 222;
- Communications Building S-28;
- Main Site;
- Upper Base Landfill;
- Upper Base Outfall; and
- Lake Geraldine Watershed

The analytical results for this and all other sites can be found in Chapter V of the Appendices. The total numbers of samples from the Upper Base analyzed for each parameter assessed in the current investigation are summarized in Table II-5 of the Overview (Chapter II).

i. Pole Vault Building 222

Both delineation and assessment soil samples were collected in areas around Pole Vault Building 222. Of 115 delineation soil samples, 39 contained PCBs at concentrations in violation of CEPA (>50 ppm).

A total of 13 assessment soil samples collected in the vicinity of Pole Vault Building 222 contained concentrations of inorganic elements or PCBs in excess of the DCC (Map V-10). One assessment soil sample contained pesticides in excess of the applicable criteria. Three plant samples contained PCBs at very high concentrations (maximum = 5.6 ppm).

a) Inorganic Elements

Thirty-six of the 45 soil samples collected around Pole Vault Building 222 were analyzed for inorganic contaminants. Mean concentrations of lead were elevated above DCC Tier I (Figure V-3).

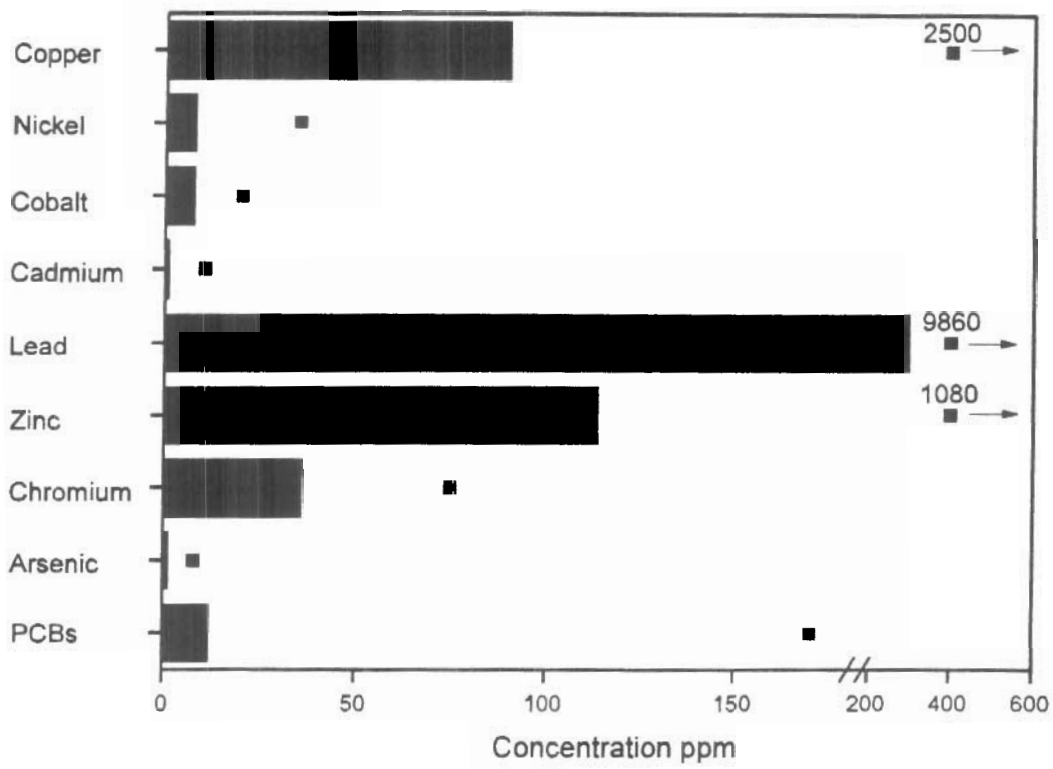
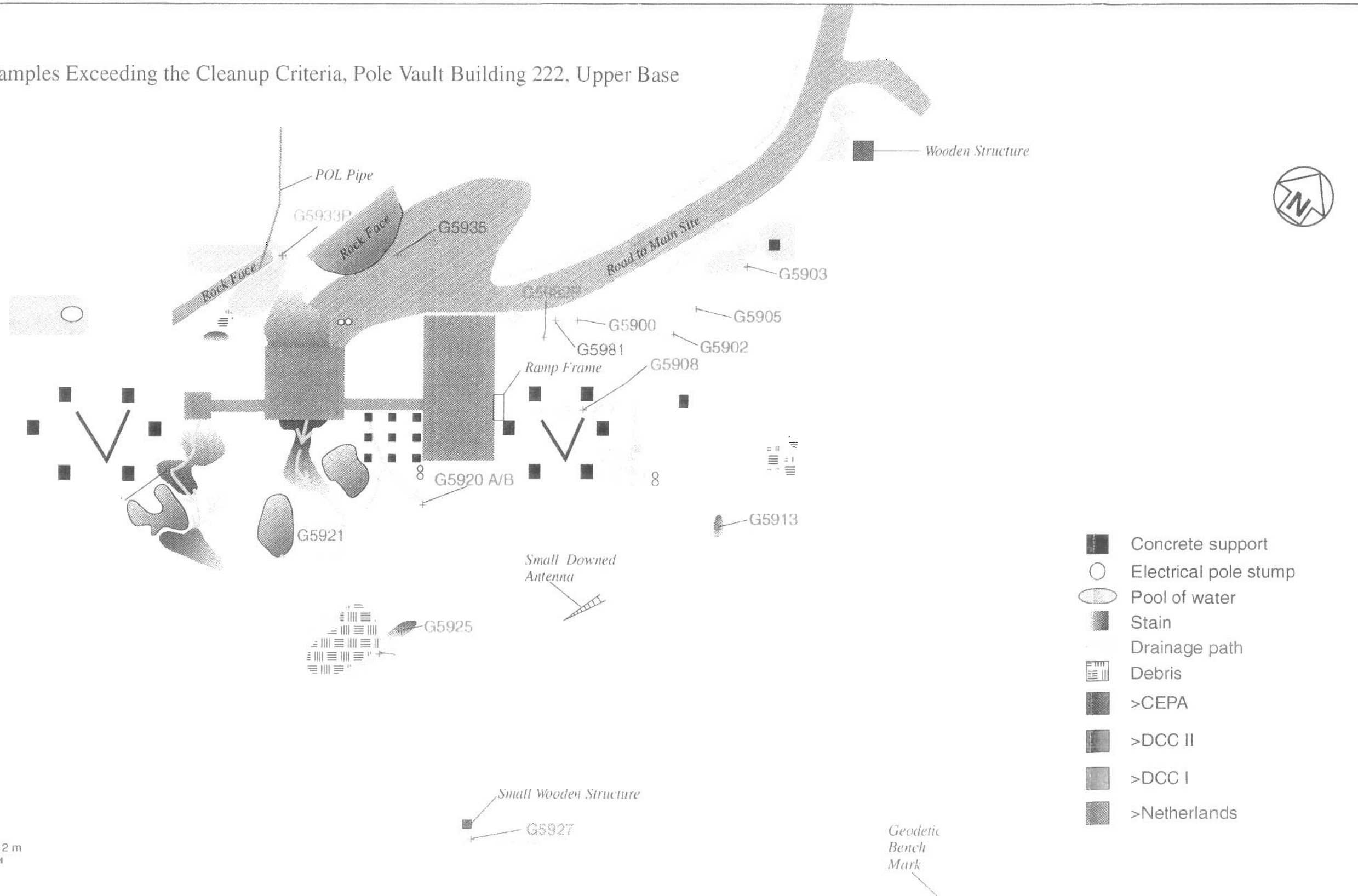


Figure V-3: Mean and Maximum Concentrations of Inorganic Elements and PCBs in Building PV222 Soil

Mean concentrations of all other analytes were below the DCC, and the mean concentrations of nickel, cobalt, cadmium, and chromium in soils from around Building PV222 were comparable to the means for background soils. Maximum concentrations, however, of copper (2500 ppm), cadmium (10.4 ppm), lead (9860 ppm) and zinc (1080 ppm) were significantly elevated above DCC Tier II. Three soil samples contained at least one of these elements at concentrations exceeding the criteria. Sample G5902, collected on the edge of a small drainage catchment, 22 m from the northeast corner of Building

Map V-10: Samples Exceeding the Cleanup Criteria, Pole Vault Building 222, Upper Base



Map based on photos taken during August 1994 site visit

PV222, contained copper (128 ppm) and lead (354 ppm) in excess of DCC Tier II and Tier I, respectively. Cadmium (10.4 ppm) was detected at levels exceeding the DCC in soil collected near the east side of the building, below the communications dish (G5908). A sample of soil and ash (G5913), collected from within a pile of burned debris approximately 35 m from the southeast corner of Building PV222, contained copper (2500 ppm), lead (9860 ppm) and zinc (1080 ppm) at concentrations which were greatly elevated above DCC Tier II (Photograph V-14).

Three of the 26 plant samples collected in the vicinity of Building PV222 were analyzed for inorganic elements. Two of the analyzed samples were root and shoot subsamples from the same location. Mean concentrations of all inorganic analytes, except cadmium, were not significantly elevated above the mean calculated for background plants. The mean concentration of cadmium in plants collected from around Building PV222 (7.6 ppm, Figure V-4) was seven times the mean concentration calculated for background plants (1.1 ppm, Figure V-2). Levels of cadmium in vegetation collected near Building PV222 were elevated above the mean concentration in background plants in all three analyzed plant samples. G5908P (*Salix arctica*) contained concentrations of cadmium 13 times greater than the mean background plant level; the soil sample (G5908) collected in the same location contained cadmium in excess of the DCC. Concentrations of cadmium in the root (4.8 ppm) and shoot (3.8 ppm) tissues of G5902P (*Salix arctophila*) were 4.4 and 3.5 times, respectively the mean for whole background plants. Cadmium concentrations in these plants were higher than concentrations in soil from the same location (2.5 ppm).

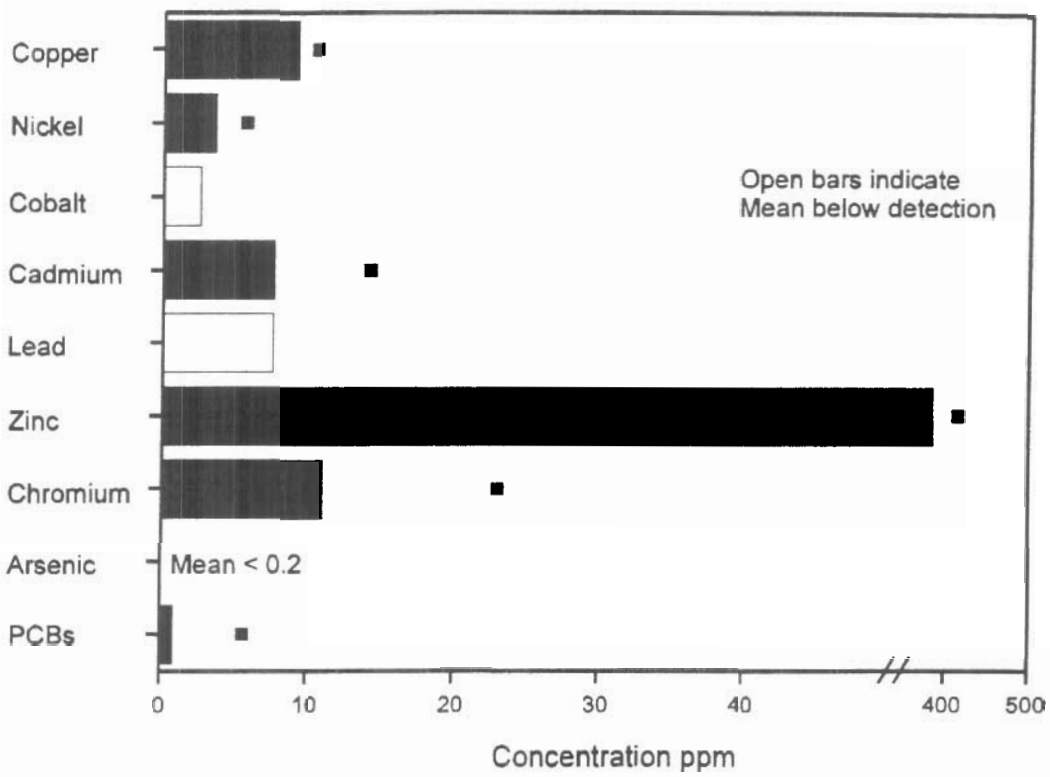


Figure V-4: Mean and Maximum Concentrations of Inorganic Elements and PCBs in Building PV222 Vegetation

The water sample collected from a small lake southeast of the base Water Supply Lake which receives drainage from Pole Vault Building 222 (WF5900) was analyzed for inorganic contaminants. None of the analytes were detected.

In summary, concentrations of inorganic elements including cadmium, copper, lead and zinc were elevated above the DCC in only three soil samples collected near Building PV222. Cadmium was detected at concentrations elevated above the Impact criteria in plants collected near the building. Inorganic elements were not detected in a water sample collected from a lake receiving drainage from the area around Building PV222.

b) Polychlorinated Biphenyls

All 115 delineation soil samples were analyzed for PCBs by test kit. Confirmatory analysis by GC/ECD was carried out on 53 of the delineation samples. Interpretation of the test kit results for delineation soil samples was based on a 50% recovery (see Methods, Chapter II of the Appendices). It was found in the course of the delineation investigation that results from test kit analysis of soils containing a high content of oil were low. Therefore, all oily samples were re-analyzed in a southern laboratory by GC/ECD. In the following discussion, when results were available for both types of analysis the GC/ECD result has been used. PCBs were detected at concentrations exceeding the level regulated under CEPA (50 ppm) in 39 samples.

Two large areas on the northeast side of Building PV222 were delineated using the PCB results (Map V-11). The westernmost of these areas contaminated by PCBs in excess of the CEPA level is the location of the 1982 Askarel spill. The pattern taken by the easternmost section of highly contaminated soil appears to have resulted from the migration of PCBs away from the original spill site. The northernmost sample delineating the affected area was collected as part of the assessment sampling program (Map V-10). Two additional areas which affect a smaller volume of soil are present on the northern side of Building PV222. One is situated immediately southeast of the staircase leading from the east-facing doorway near the north side of the building. The second small affected area was identified from a sample collected as part of the assessment sample program (Map V-10) and is located beside a large rock outcrop across the road from the building. This is likely the site of a localized spill, as samples collected in drainage from the affected area (see Map V-6) did not contain PCBs in excess of the criteria.

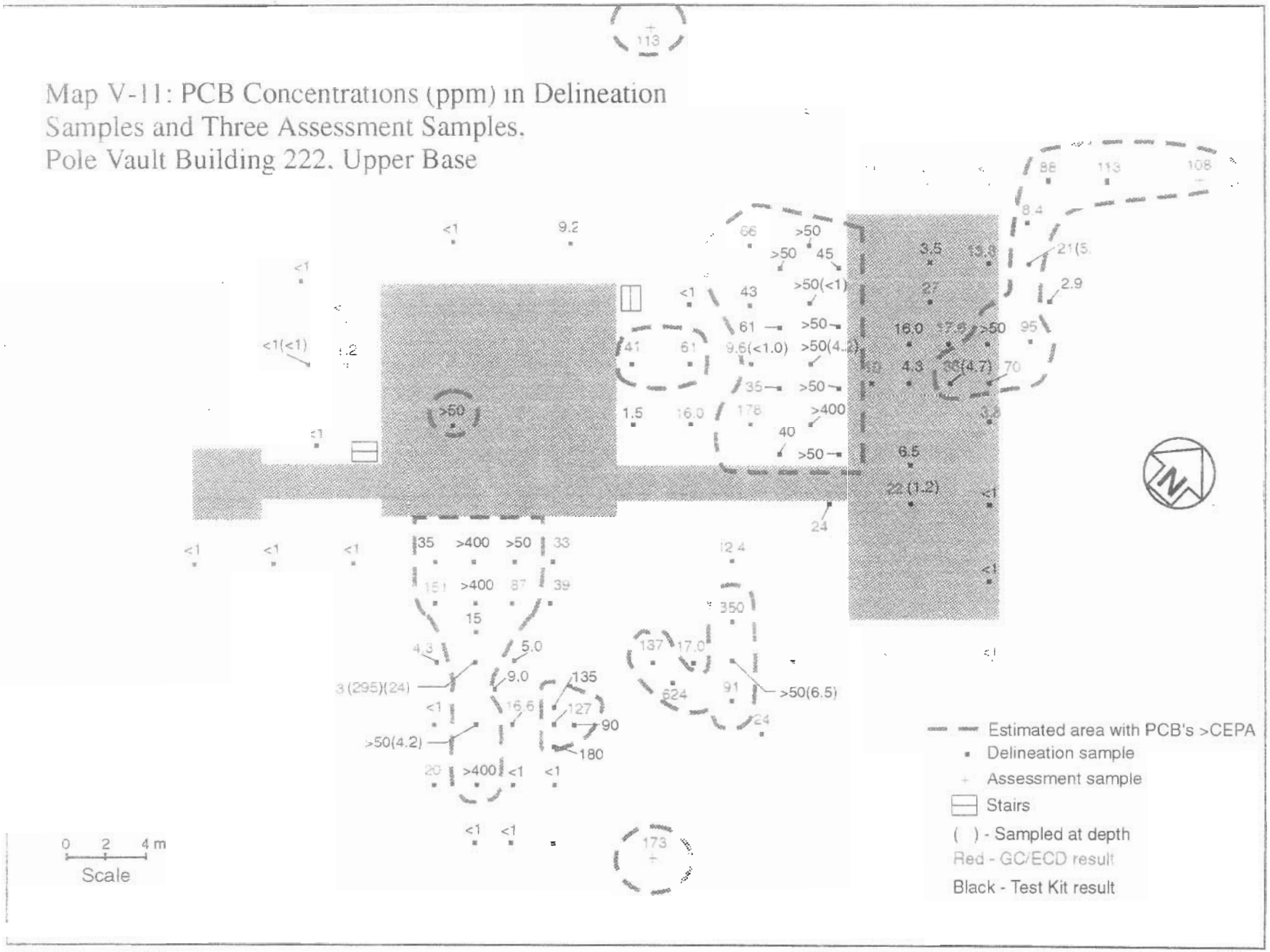
Four areas on the south side of Building PV222 were found to contain PCBs at concentrations exceeding CEPA. The largest affected area is immediately south of the westernmost half of the building and is delineated by a very dark stain (Photograph V-15). A second location where soil PCB concentrations exceed the CEPA level is also evidenced by the presence of staining on the surface of the soil. This "Y" shaped stain has resulted

from the migration of the black oil along two drainage paths which converge and flow toward a rock that prevents the migration of the staining compound past its northern edge (see Map V-10). Finally, two smaller areas of CEPA level contaminated soil were detected between the two larger affected areas on the south side of Building PV222, and east approximately 10 m from the largest stained area, respectively. The soil sample from the easternmost of the two smaller affected areas was collected as part of the assessment sampling program (Map V-10).

Concentrations of PCBs in excess of DCC Tier II and Tier I levels were also detected as part of the delineation sampling program. Concentrations of PCBs were elevated above DCC Tier II (5 ppm) in 42 of the delineation soil samples. Ten of the delineation soil samples contained PCBs in excess of DCC Tier I (1 ppm).

Forty-two of the 45 assessment soil samples collected in the vicinity of Pole Vault Building 222, including four sets of field duplicates, were analyzed for PCBs. The mean concentration of PCBs (12 ppm) in assessment soils collected near Building PV222 exceeded DCC Tier II (Figure V-4). The maximum concentration of PCBs in the assessment samples (170 ppm) exceeded the level regulated under CEPA (>50 ppm). As outlined in the above section on delineation samples, a total of three assessment soil samples collected near PV222 contained concentrations of PCBs elevated above the level regulated under CEPA (Map V-10). Concentrations in six of the assessment samples exceeded DCC Tier II for PCBs, and concentrations in two exceeded DCC Tier I. Four of the soil samples with PCB concentrations exceeding the Tier II level (G5900, G5902, G5903 and G5905) were collected in the drainage from the northeast corner of the building where the greatest volume of soils with CEPA violations was located. G5908, which contained concentrations of cadmium in excess of DCC Tier II, contained PCBs at concentrations above the Tier I level. One sample exceeding Tier I (G5924) and two samples exceeding Tier II (G5920A and B) were collected on the south side of the building and also in drainage pathways from the areas with concentrations of PCBs in violation of CEPA.

Map V-11: PCB Concentrations (ppm) in Delineation Samples and Three Assessment Samples.
Pole Vault Building 222, Upper Base



Twenty-one of the 25 plant samples collected near Building PV222 were analyzed for PCBs. Mean (0.9 ppm) and maximum (5.6 ppm) concentrations of PCBs in plants collected in this area were 1525 and 9500 times the mean and maximum concentrations in background plants (Figure V-4). The lowest PCB concentration (0.0054 ppm) in a plant sample collected in the vicinity of Building PV222 was nine times the mean background plant concentration. G5920P (*Salix arctica*) contained an especially high concentration of PCBs (5.6 ppm) which exceeded even the DCC Tier II criteria **for soils**. The average concentration of PCBs in soils at the same location (7.7 ppm) also exceeded the Tier II level.

Five plant samples had concentrations of PCBs that exceeded the DCC Tier I level as outlined for **soils**. G5900P (*Salix arctica*) was collected in the contaminated soils (PCBs >DCC Tier II) near the northeast corner of Building PV222 and contained a concentration of PCBs (3.2 ppm) 5400 times the mean background concentration (Photograph V-16). G5921P (*Salix arctica*), which was collected in soil contaminated with PCBs in excess of 50 ppm on the south side of the building, contained PCBs (3.8 ppm) at 6500 times the mean concentration in background plants and greater than the DCC Tier I level for **soils**.

Three plant samples taken from areas where the soil did not contain high levels of PCBs (G5931P, G5933P and G5982P), however, had accumulated high concentrations of PCBs. The concentration of PCBs in soil sample G5931 was only 0.27 ppm, while 1.3 ppm of PCBs were detected in the corresponding plant sample (G5931P, *Salix arctica*). Soil sample G5933, collected in a hydrocarbon stain on the north side of Building PV222, contained levels of PCBs approaching DCC Tier I (0.76 ppm), while the concentration of PCBs in the plant sample collected in the same location (G5933P, *Salix arctica*) was higher (1.1 ppm). Plant sample G5982P (*Salix arctica*) also contained a greater concentration of PCBs (1.9 ppm) than the soil in which it was growing (0.49 ppm).

The water sample collected on the edge of the small lake in the drainage from Pole Vault Building 222 was analyzed for PCBs. Aroclor 1260 was detected in the sample

(0.003 ppb) at levels well below the Canadian Drinking Water Quality Guideline (3 ppb). The levels of PCBs in this small lake do, however, exceed the more stringent CCME FAL Remediation Criteria (0.001 ppb).

The nine swabs taken in Building PV222 were all analyzed for PCBs. None of the swabs contained concentrations of PCBs elevated above the US EPA guideline for interior solid surface contamination (10,000 ng/100 cm^2).

The area around Pole Vault Building 222 is highly contaminated with PCBs. PCB concentrations exceeding the level regulated by CEPA were detected in 36 of the delineation soil samples and three of the assessment soil samples. However, the concentrations of PCBs in soils quickly decrease with increasing distance from the building. Soil requiring remediation does not extend more than 40 m from the building and PCBs were undetectable in all soil samples greater than 75 m from the building including sediment collected from the small lake below the building. Elevated concentrations of PCBs in vegetation collected near Building PV222 suggest that the impact of soil contamination on local biota may be significant and is not limited to plants growing directly in contaminated soil.

c) Other Organic Contaminants

Nine assessment soil samples collected in the vicinity of Pole Vault Building 222 were analyzed for polychlorinated dibenzodioxins and dibenzofurans (referred to collectively as "dioxins"). Dioxins were detected in all nine samples. The maximum concentration of dioxins (2,3,7,8-TCDD TEQs[1] = 0.82 ppb) in soils collected near Building PV222 was detected in a sample collected on the northeast side of the building (G5981), and approached the CCME R/P Remediation Criteria (1 ppb). PCBs were

---

[1] TEQs = toxic equivalents which are used to express the concentrations of polychlorinated dibenzodioxins and dibenzofurans collectively, based on their relative toxicities as compared to the most toxic dioxin congener 2,3,7,8-tetrachlorodibenzodioxin.

present in the same soil sample at a level higher than the CEPA regulation and will therefore be removed. The remaining soils in which dioxins were detected at elevated levels also contained PCBs at elevated concentrations.

Six plant samples collected in the vicinity of Pole Vault Building 222 were analyzed for dioxins. Soil samples corresponding to these plant samples had also been analyzed for dioxins. The maximum concentration of dioxins (0.034 ppb) detected in a plant collected near Building PV222 was only 15% of the concentration detected in the corresponding soil sample (0.23 ppb). Dioxin levels in the plants were generally between 1 and 15% of the concentration of dioxins in the corresponding soil.

Two soil samples collected in the vicinity of Pole Vault Building 222 were analyzed for pesticides. The total concentration of pesticides (5.5 ppb) in G5924, collected in drainage approximately 30 m south of the building, did not exceed the BC (2 ppm), Québec (2 ppm) or Netherlands (3 ppm) Level B remediation criteria. G5927, which was collected further along the same drainage as G5924 and approximately 65 m south of the building, contained levels of pesticides (1.5 ppm) approaching the BC (2 ppm) and Québec (2 ppm) Level B remediation criteria. While eleven of the 22 pesticide analytes were detected, the widely used insecticide 2,2-*bis*-(*p*-chlorophenyl)-1,1,1-trichloroethane (*p,p'*-DDT) was the principal compound (1.4 ppm) detected and exceeded the Netherlands criteria for individual chlorinated pesticides (0.5 ppm). Use of DDT was both common and extensive in the 1950s and 60s due to its effectiveness in killing insect pests, but it was virtually phased out in the 70s. It is likely that it was applied in wetter areas of the Upper Base to control mosquitoes.

One soil sample (G5935) collected across the road from and north of Building PV222, was analyzed for the Acid/Base/Neutral (ABN) suite of chemicals. All analytes were below the limits of detection in this sample.

Four soil samples collected in the vicinity of the Pole Vault building were analyzed for polycyclic aromatic hydrocarbons (PAHs). Although many of the PAHs are included in the ABN suite of analyses, the specificity of the targeted PAH analyses increases the

accuracy of the reported results. Concentrations of compounds for which a surrogate[2] standard was used were corrected for percent recovery before comparison to the criteria. Three of the samples analyzed did not contain any of the PAH analytes at levels exceeding the CCME R/P or BCMOE Level B remediation criteria. Sample G5925, collected in the stained bottom of a dry drainage catchment, contained two compounds in excess of the criteria (Photograph V-17). Benzofluoranthenes (2.2 ppm) were present in excess of the BCMOE Level B criteria for this compound (0.001 ppm) and indeno(1,2,3-cd)pyrene (1.2 ppm) was detected at levels exceeding the CCME R/P Remediation Criterion (1 ppm). The concentration of chrysene (0.99 ppm) in this sample approached the BCMOE Level B Remediation Criterion (1 ppm). This sample also contained PCBs in excess of DCC Tier II.

Alkylated PAH data is presented in Table V-16 of the Appendices and includes mono- through penta-alkylated isomers of naphthalene, phenanthrene and anthracene combined (e.g., C1 phen,anth), and fluoranthene and pyrenes combined (e.g., C1 fluor,pyrenes). No criteria presently exist which address the environmental impact of the alkylated forms of PAHs, and debate surrounding the bioavailability of the various isomers is ongoing. This data does however form part of a signature (i.e. the ratios of the various isomers) from which information regarding the source of the contaminants can be discerned. In this case, the signature is that of common petroleum products as would be expected for the stained soils which make up these samples. Furthermore, impact can be assessed by comparing the reported levels of these compounds to those expected under background conditions. The concentrations of alkylated PAHs in samples G5925 and G5932 were generally elevated above the levels detected in soils which were not as heavily stained. No background soils were analyzed for PAHs, as these compounds are only found

---

[2] Surrogate standards, which are the analytes of interest containing a radioactive isotope of carbon, are spiked into all blanks, standards and some samples prior to analysis. The percentage recoveries of surrogate standards are calculated to determine the efficiency of the analysis.

in areas impacted to some extent by the use of petroleum products; hence their presence reflects the a man-made disturbance.

In summary, dioxins were detected in soils collected near Pole Vault Building 222, but at concentrations below the CCME R/P Remediation Criteria. In general, soil containing dioxins at elevated concentrations also contained PCBs at levels requiring remediation under the DCC or which were in violation of CEPA. There is evidence of dioxin uptake by plants in the area around Building PV222. Removal of the PCB contaminated soils should be effective in remediating the dioxin contamination.

Analysis of soils collected in the vicinity of Pole Vault Building 222 for pesticides confirms the use of the insecticide DDT at the Upper Base. The concentrations of pesticides in a low wet area southeast of the building were significantly elevated above the Netherlands criteria for individual chlorinated pesticides.

Contamination by PAHs and ABNs in the area around PV222 is a minor concern; elevated levels of some PAHs will be remediated along with PCBs in excess of DCC Tier II present in the same location.

d) Asbestos

The sample of insulation taken from the westernmost room of Pole Vault Building 222 was analyzed for asbestos content and was found to contain both 25-50% chrysotile and 5-25% amosite asbestos.

e) Conclusions

PCBs are the main contaminant of concern detected in the vicinity of Pole Vault Building 222 and are present at concentrations violating the Canadian Environmental Protection Act in soils on both sides of the building. Biota, in the form of plants growing near Building PV222, have been shown to be impacted by the presence of high

concentrations of PCBs. Soils near the building containing other contaminants at elevated concentrations also generally contain high concentrations of PCBs; the contaminants will therefore be removed along with the PCB contaminated soil. Isolated areas contaminated by pesticides and inorganic elements will need to be addressed specifically.