Appendix 5

INTER LABORATORY SPLIT SAMPLE QUALITY CONTROL UNDERTAKEN FOR THE MOOI RIVER (WONDERFONTEINSPRUIT) CATCHMENT RADIOACTIVITY MONITORING PROGRAMME

1. **Introduction:**

The purpose of the split sample interlaboratory quality control exercise was to test the validity of the radiological analyses of the laboratory designated as no 3, which is being used as the monitoring laboratory for the Mooi River catchment radiological monitoring programme.

Two other laboratories were used for the split sample testing, viz., another local laboratory (designated no 1) and an international laboratory (designated no 2). In addition to the three laboratories who participated in the study, three other local laboratories were invited to participate, but declined.

2. **Procedure:**

From three sample sites in the Mooi River Catchment, two sites were chosen with relatively high radioactivity levels (designated A and B), and one site with low radioactivity levels (designated C). These sites were sampled on the 2 October 1997, a single grab sample being well mixed and then split into three containers for the respective three laboratories. The samples were delivered immediately to both the two local laboratories and to the local agent of the international laboratory, where samples were filtered and acidified prior to dispatch for radiological analysis.

3. **Units of measurement:**

In order not to put unfair pressure on the laboratories, the reporting units of measurement were left up to the reporting laboratories themselves, to avoid any consequent claims of unfamiliarity with the reporting units. Laboratory 1 chose to report nuclide results in μg/ℓ (ppb), while laboratory 3 reported results of the nuclide analyses in mBq/ℓ. Laboratory 2 clearly had a problem with units of measurement, and the distinction between Bq/ℓ and mBq/ℓ, two sets of numerically identical results being reported. In the table of results given in this report all nuclide analysis results are converted where necessary into the common unit of measurement of mBq/ℓ. Gross alpha and beta activities were left in the units in which they were reported of Bq/ℓ.

4. **Discussion of results of the split sample exercise:**

1) Alpha and beta activity: Only two laboratories reported alpha and beta activities, viz. Laboratory 2 and 3. Laboratory 2 reported slightly higher alpha activity than laboratory 3. Beta activities of laboratory 3 were considerably higher than that of laboratory 2. While there is reasonable agreement between the two laboratories for gross alpha activity, there appears to be a problem with the measurement of beta activity.

2) Uranium-238: The results shown by laboratory 1 and 3 are of the same order. The first set of results given by laboratory 2 (i.e. 2a) are three orders of magnitude too low, and are not consistent with the measured alpha activity. The revised results reported by laboratory 2 (i.e. 2b) are in reasonable agreement with laboratory 1 and 3. The U-238 to U-235 activity ratio for the results on sample A were close to the expected ratio of approximately 21:1 for laboratories 2 and 3,

indicating that there is internal consistency between these two variables. The ratio for laboratory 1 was 32:1, indicating that the U-238 value reported was probably on the high side, as the U-235 values agree well between laboratories 1, 2b and 3.

3) Uranium-235: The results reported by laboratory 1 and 3, and the revised results of laboratory 2 (i.e. 2b) are in good agreement. The first set of results reported by laboratory 2 (i.e. 2a) are three orders of magnitude too low.

4) Thorium-232: The results reported by all three laboratories are in good agreement and all reported very low thorium activity concentrations.

5) Radium-224: Radium 224 was only measured by laboratories 2 and 3. Radium-224 is a daughter of the parent nuclide of the thorium-232 chain. As all three laboratories agreed that the thorium-232 values are very low, it can be reasonably assumed that the radium-224 values are also low. Laboratory 3 correctly reported low radium-224 values for all three samples, while laboratory 2 (revised results, 2b) reported a high value for radium-224 in sample C. The radium-224 value here exceeds the measured alpha activity by a factor of ten.

6) Radium-226: Radium-226 is a daughter of the uranium-238 chain, and there is consequently expected to be some relationship between the measured activities. Due to the 3 orders of magnitude uncertainty in the result of laboratory 2 (results 2a and 2b) it is impossible to draw any reliable conclusions where these differ from the laboratory 3 results.

5. **Conclusions:**

1) There appears to be reasonable agreement in the measurement of gross alpha activity, uranium-238, uranium-235 and thorium-232.
2) Agreement is poor for beta activity measurement.
3) For radium-224 and -226 it is not possible to draw firm conclusions as a consequence of the uncertainty in the laboratory 2 results.
4) Laboratory 2 needs to be more careful in reporting units and order of magnitude of the reported nuclide concentrations.
5) Apart from the known problem of the beta activity measurement, the results of the inter laboratory study confirmed the accuracy of the results of laboratory 3, in particular for alpha activity, uranium-238, uranium-235 and thorium-232. As regards the results for radium-224 and -226, these are internally consistent with the results for the three parent nuclides for laboratory 3.
6) The international laboratory (2) chosen as a reference laboratory clearly has problems both with order of magnitude or units of reporting of the results, and with internal consistency of results between the radium nuclides and the parent nuclides and needs to address this problem. The three samples, marked A, B and C, were split samples collected in one container and poured into the three containers for the three laboratories. The laboratories themselves filtered and acidified the samples on receipt.

- Laboratory 1 returned results on 3 November 1997.
- Laboratory 2 first supplied final results on 25 November 1997 (designated Lab 2a). It was pointed out to Lab 2, that the U-238 activity reported of 2,49 mBq/ℓ for sample A was not consistent with the high alpha activity found of 5,19 Bq/ℓ. Lab 2 subsequently reported a “corrected” 2nd set of results (Lab 2b),

and indicated that four nuclides, viz., U-238, U-235, Ra-224 and Ra-226 should have been given as Bq/ℓ and not as mBq/ℓ.

- Laboratory 3 returned results on 12 December 1997.

RESULTS OF SPLIT SAMPLES QUALITY CONTROL STUDY (RADIOACTIVITY): 1997

Sample A:

Variable	Lab 1	Lab 2a	Lab 2b	Lab 3
Alpha activity (Bq/ℓ)	-	5,19	5,19	3,70
Beta activity (Bq/ℓ)	-	1,63	1,63	6,30
Uranium-238	3100 mBq/ℓ (250 ppb*)	2,49 mBq/ℓ	2490 mBq/ℓ	2000 mBq/ℓ
Uranium-235	96 mBq/ℓ (1,2 ppb)	0,113 mBq/ℓ	113 mBq/ℓ	92,8 mBq/ℓ
Thorium-232	<4 mBq/ℓ (<1ppb)	<2,58 mBq/ℓ	<2,58 mBq/ℓ	1,5 mBq/ℓ
Radium-224	-	-0,00354 mBq/ℓ	-3,54 mBq/ℓ	<1,2 mBq/ℓ
Radium-226	-	0,373 mBq/ℓ	373 mBq/ℓ	156 mBq/ℓ

* 1ppb U-238 = 12,4 mBq/ℓ
1ppb U-235 = 79,7 mBq/ℓ
1ppb Th-232 = 4,0 mBq/ℓ

Sample B:

Variable	Lab 1	Lab 2a	Lab 2b	Lab 3
Alpha activity (Bq/ℓ)	-	4,07	4,07	2,90
Beta activity (Bq/ℓ)	-	0,625	0,625	6,80
Uranium-238	1984 mBq/ℓ (160 ppb*)	1,84 mBq/ℓ	1840 mBq/ℓ	1490 mBq/ℓ
Uranium-235	56 mBq/ℓ (0,7 ppb)	0,0832 mBq/ℓ	83,2 mBq/ℓ	70,6 mBq/ℓ
Thorium-232	<4 mBq/ℓ (<1ppb)	<2,58 mBq/ℓ	<2,58 mBq/ℓ	1,5 mBq/ℓ
Radium-224	-	0,0561 mBq/ℓ	56,1 mBq/ℓ	<1,4 mBq/ℓ
Radium-226	-	0,156 mBq/ℓ	156 mBq/ℓ	42,7 mBq/ℓ

* 1ppb U-238 = 12,4 mBq/ℓ

Sample C:

Variable	Lab 1	Lab 2a	Lab 2b	Lab 3
Alpha activity (Bq/ℓ)	-	0,0550 Bq/ℓ	0,0550 Bq/ℓ	<0,66
Beta activity (Bq/ℓ)	-	0,226 Bq/ℓ	0,226 Bq/ℓ	2,70
Uranium-238	30 mBq/ℓ (2,4 ppb*)	0,0571 mBq/ℓ	57,1 mBq/ℓ	31,7 mBq/ℓ
Uranium-235	<8 mBq/ℓ (<0,1 ppb)	0,00259 mBq/ℓ	2,59 mBq/ℓ	1,4 mBq/ℓ
Thorium-232	<4 mBq/ℓ (<1ppb)	<2,58 mBq/ℓ	<2,58 mBq/ℓ	1,5 mBq/ℓ
Radium-224	-	0,648 mBq/ℓ	648 mBq/ℓ	<5,3 mBq/ℓ
Radium-226	-	0,227 mBq/ℓ	227 mBq/ℓ	<4,2 mBq/ℓ

* 1ppb U-238 = 12,4 mBq/ℓ