National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Monitoring of radioactivity in the Netherlands

National Radioactivity Monitoring Network – results 2019

RIVM letter report 2021-0079

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Colophon

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Synopsis

Monitoring of radioactivity in the Netherlands
National Radioactivity Monitoring Network – results 2019

In 2019, the Netherlands fulfilled its annual European obligation to measure how much radioactivity is present in the environment. Radioactivity levels measured by the National Radioactivity Monitoring Network were normal, as in previous years.

All countries of the European Union are required to perform these measurements each year under the terms of the Euratom Treaty of 1957. The Netherlands performs these measurements following the guidance issued in 2000. The measurements represent the background values for radioactivity that are present under normal circumstances. They can be used as reference values, for instance, during a nuclear emergency. The results on radioactivity in the environment are reported to the European Commission by the National Institute for Public Health and the Environment (RIVM) on behalf of the competent authority in the Netherlands.

Keywords: monitoring network, radioactivity, ambient dose equivalent rate

Publiekssamenvatting

Monitoring van radioactiviteit in Nederland
Nationaal Meetnet Radioactiviteit – resultaten 2019

In 2019 voldeed Nederland aan de Europese verplichting om elk jaar te meten hoeveel radioactiviteit in het milieu zit. De radioactiviteitsniveaus gemeten met het Nationaal Meetnet Radioactiviteit laten een normaal beeld zien, net als de jaren ervoor.

Alle landen van de Europese Unie zijn volgens het Euratom-verdrag uit 1957 verplicht om deze metingen te doen. Nederland volgt daarbij de aanbevelingen uit 2000 op om de metingen op een bepaalde manier uit te voeren. De metingen leveren achtergrondwaarden op, ofwel radioactiviteitsniveaus die er onder normale omstandigheden zijn. Deze waarden kunnen bij bijvoorbeeld calamiteiten of rampen als referentie dienen. Het RIVM brengt namens Nederland verslag uit aan de Europese Unie over radioactiviteit in het milieu.

Kernwoorden: meetnet, radioactiviteit, omgevingsdosisequivalenttempo

Contents

Summary

The National Radioactivity Monitoring Network (NMR) is used to determine the activity concentrations of gross α and artificial β (β radiation emitted by man-made radionuclides) in air dust in the Netherlands. The yearly average gross α activity concentration in air dust was 3.6 $Bq \cdot m^{-3}$. This level is comparable to previous years, with the exception of 2018, when the higher level can be attributed to the lower yearly precipitation. The yearly average of the artificial β activity concentration did not deviate significantly from zero. The NMR was also used to determine the ambient dose equivalent rate: the yearly average was 82 $nSv \cdot h^{-1}$.

1 Introduction

This report presents data on gross α and artificial β activity concentrations in air dust and ambient dose equivalent rates, as measured by the National Radioactivity Monitoring Network (Nationaal Meetnet Radioactiviteit, NMR) in 2019.

The NMR consists of 167 sites, at which the ambient dose equivalent rate is determined. At 14 measuring sites, gross α and artificial β activity concentrations are determined, as well as the ambient dose equivalent rate (at a height of 3.5 m above ground level) [1]. At the other 153 measuring sites, only the ambient dose equivalent rate is determined (at 1 m above ground level). The data on gross α and artificial β differ from the ones collected at the RIVM location in Bilthoven [2] in sample size, sampling frequency and analytical procedures (including a different approach to the contribution of short-lived natural radionuclides, i.e. radon daughters).

Since the dose equivalent rate monitors are placed differently at the 14 measuring sites (where activity concentrations are determined) with respect to the 153 sites with regard to height and surface covering, results can differ between the two types of measuring site [3]. For this reason, these 14 dose equivalent rate monitors are not taken into account when calculating the yearly average ambient dose equivalent. The reported artificial β activity concentrations are calculated from the difference between the measured gross β activity concentration and the natural gross β activity derived from the measured gross α activity concentration.

The data presented here are based on 10 minute measurements. Averages over the year (given in the Appendix) are calculated for each location using daily averages derived from the 10 minute measurements. The data on external radiation, expressed in ambient dose equivalent, contain a systematic uncertainty because of an overestimation of the cosmogenic dose rate due to the characteristics of the detectors. NMR data are not corrected for these response uncertainties.

[1] C.J.W. Twenhöfel, C. de Hoog van Beynen, A.P.P.A. van Lunenburg, G.J.E. Slagt, R.B. Tax, P.J.M. van Westerlaak, F.J. Aldenkamp, 2005. Operation of the Dutch 3rd Generation National Radioactivity Monitoring Network. In: Automatic Mapping Algorithms for Routine and Emergency Monitoring Data, Spatial Interpolation Comparison 2004 by IES, G. Dubois (ed.), European Committee, JRC, EUR 21595 2005, 19–31.
[2] For a description see Chapter 2 of Environmental radioactivity in the Netherlands: Results in 2018, RIVM Report nr. 2019-0216, ed. CP Tanzi, published in 2020.
[3] R.O. Blaauboer and R.C.G.M. Smetsers, 1996. Variations in outdoor radiation levels in the Netherlands. Thesis University of Groningen, Groningen.

2 Results

An impression of the spatial variation in the yearly averages of the NMR data in 2019, constructed by using the RIVM's Geographical Information System (GIS), is shown in Figure 1 and Figure 3 for average gross α activity concentration and for the average ambient dose equivalent rate respectively. An inverse distance weight interpolation algorithm was applied to calculate values between the NMR stations.

In 2019, the yearly average gross α activity concentration in air dust was 3.6 $Bq \cdot m^{-3}$ (based on the yearly averages of the 14 measurement locations). Figure 2 presents the yearly averages of the gross α activity concentration since 1990. The yearly average gross α activity concentration in air dust in 2019 is comparable to the concentration in previous years, as illustrated in Figure 2, with the exception of 2018. The higher concentration in 2018 can be attributed to the lower yearly precipitation in 2018: in 2018 the surface average precipitation was 607 mm, compared to 783 mm in 2019 (source: KNMI). When comparing the 2019 value (yearly average of 3.6 $Bq \cdot m^{-3}$) with data collected before 2002, it should be noted that the measurements from 2002 onwards are 20% higher, as can be seen in Figure 2. This is attributed to a change in type of monitor.

During the second half of 2002, the 14 aerosol FAG FHT59S monitors were gradually replaced by 14 Berthold BAI 9128 monitors. Due to differences in detection method, filter transport, calibration radionuclides and algorithms, the results for the activity concentrations from the two types of monitor are not exactly the same. By running both monitors simultaneously at the same location, the measured gross α activity concentration was compared. On average, the Berthold monitor systematically reported about 20% higher values than the FAG monitor [4]. The estimated random uncertainty for both types of monitor is about 20%. No correction was applied for the difference in the gross α activity concentration between the Berthold and FAG monitors.

The yearly average of the artificial β activity concentration in 2019 does not deviate significantly from zero.

In 2019, the yearly average for the ambient dose equivalent rate was 82 $nSv \cdot h^{-1}$. Figure 4 presents the yearly averages of the ambient dose equivalent rate since 1996. Since 2004, the analysis of the ambient dose equivalent rate has been based on a set of 153 stations. All of these 153 stations were active for more than 150 days in 2019. The yearly average ambient dose equivalent rate in 2019 was calculated using all 153 stations. The yearly average of 2019 is similar to the values of 2015-2018, and is significantly higher than the values measured before 2014, as can be seen in Figure 4. This increase of the ambient dose equivalent rate coincides with and is attributable to the replacement of the monitors.

[4] C. de Hoog and R.B. Tax, 2003. Achtergronddocument bij NMR integrale rapportage 2002. RIVM Bilthoven, internal report.

From November 2014 until the end of 2015, most of the ambient dose equivalent monitors were replaced. The Bitt RS03 monitors (proportional counters) were replaced by new Saphymo XL-2-3 monitors (Geiger-Müller). The energy response, cosmic response and self-effect of the two types of monitor differ slightly. Compared with the Bitt monitor, the Saphymo monitor measurements are, on average, 8 $nSv \cdot h^{-1}$ higher at the natural background radiation level in the Netherlands. No correction for this difference is applied.

Figure 5 shows the cosmogenic contribution to the effective dose rate, which is related to the ambient dose equivalent rate, and also shows the influence of the 11-year solar cycle on the cosmogenic contribution.

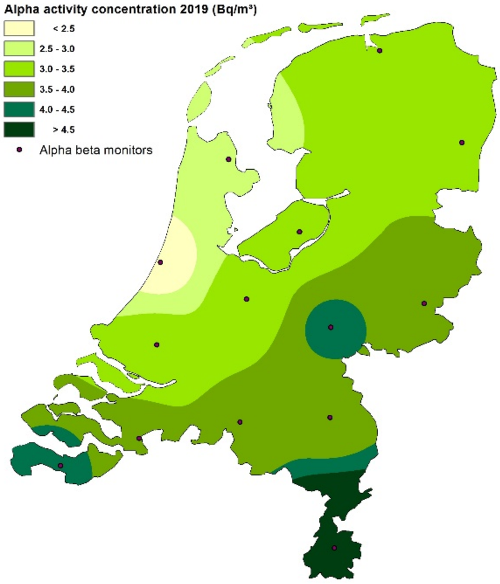

Figure 1 An impression of spatial variation in the average gross α activity concentration of (mainly) short-lived radionuclides in air dust. Dots represent the locations of the aerosol monitors.

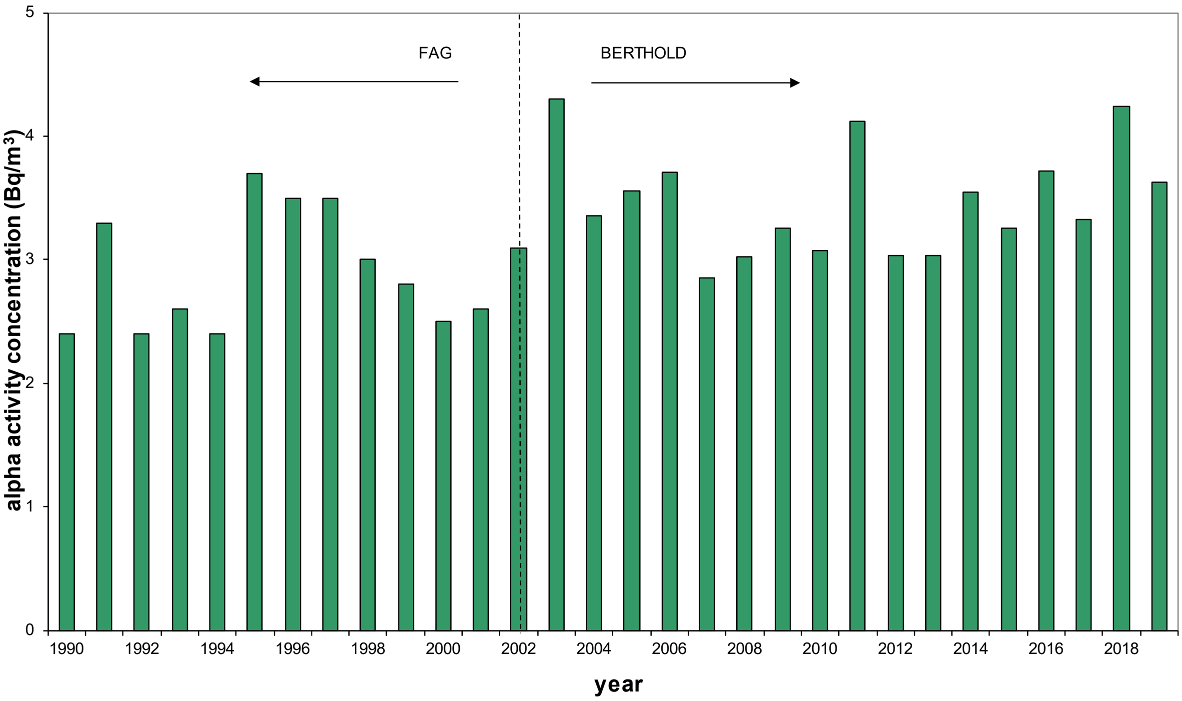

Figure 2 Yearly average gross α activity concentration of (mainly) short-lived radionuclides in air dust. During the second half of 2002, the FAG monitors were replaced by Berthold monitors.

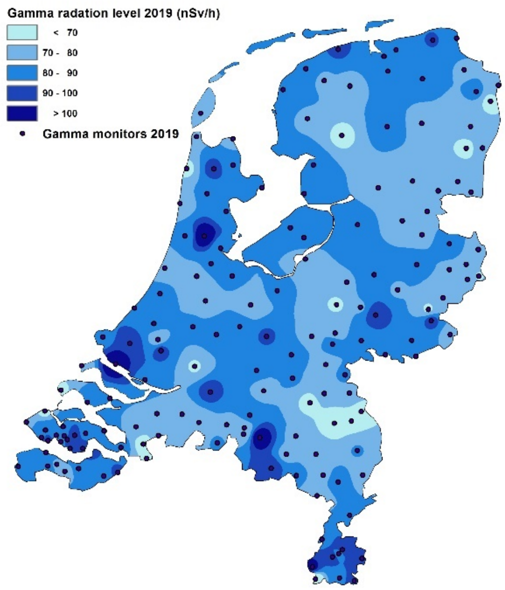

Figure 3 An impression of spatial variation in the average ambient dose equivalent rate. Dots represent the locations of the dose equivalent rate monitors.

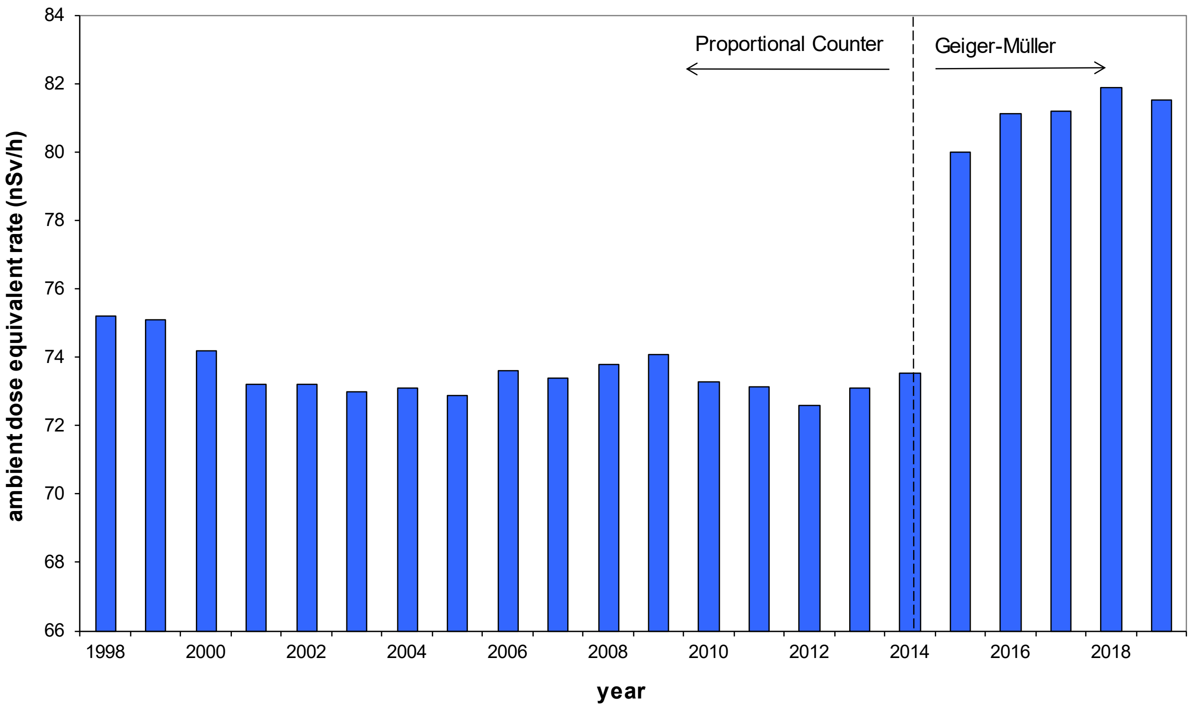

Figure 4 The yearly average ambient dose equivalent rate. During the course of 2015, most of the proportional counter monitors were replaced by Geiger-Müller monitors.

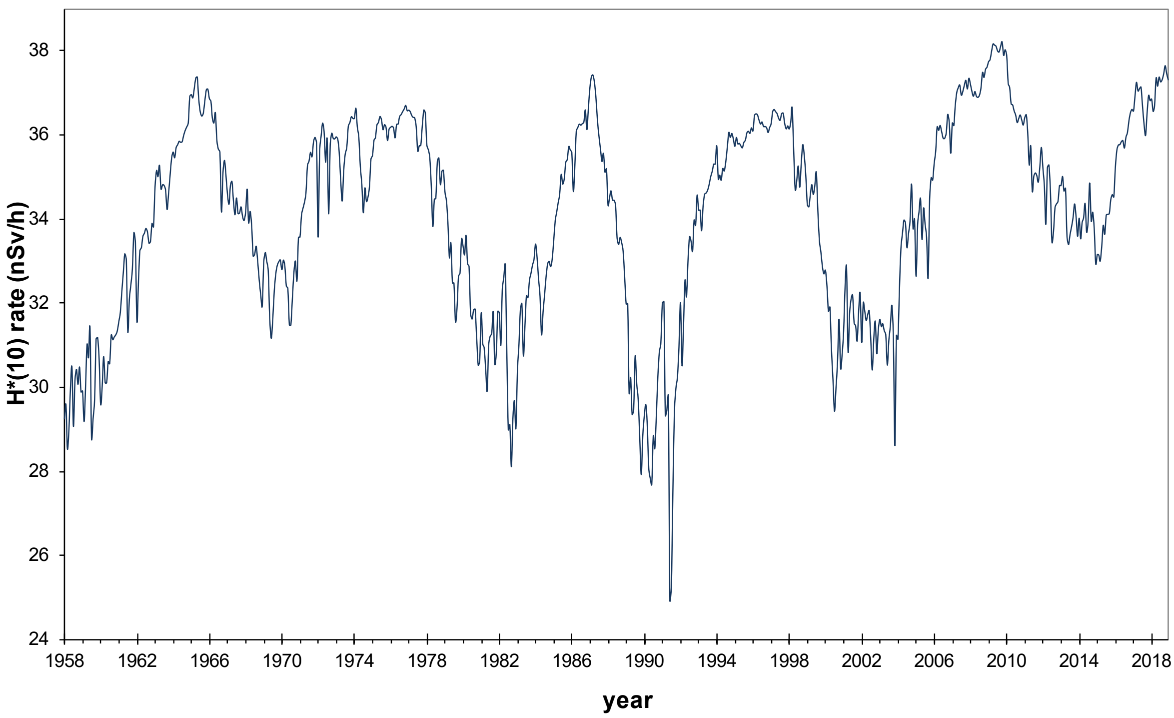

Figure 5 Cosmogenic contribution to the ambient dose equivalent rate (at sea level), influenced by the solar cycle, calculated for the location 51° 26′ north and 3° 43′ east (in the south-western part of the Netherlands) and air pressure 1033 hPa. Figure derived from data supplied by the Federal Aviation Administration [5] and calculated with CARI-7.

[5] Federal Aviation Administration. Web page: www.faa.gov/data_research/research/med_humanfacs/aeromedical/radiobiology/heliocentric/ (last accessed on 5 November 2020).

Table 1 Yearly average α activity concentration in air and ambient dose equivalent rate in 2019, as measured by the NMR stations equipped with aerosol monitors.

Station	No.	α activity concentration $Bq.m^{-3}$	Dose rate [(1)] $nSv.h^{-1}$
Rotterdam-Tarwewijk[(2)]	968	3.13	93
Arnhem	970	4.09	77
Kollumerwaard	972	3.12	89
Valthermond	974	3.25	68
Braakman	978	4.09	75
Huijbergen	980	3.60	65
Best-Houtakker	982	3.59	71
Wijnandsrade	984	7.01	86
Eibergen	986	3.88	69
De Zilk	988	2.25	72
Wieringerwerf	990	2.71	82
Vredepeel	992	3.78	64
Biddinghuizen[(3)]	994	3.15	85
Bilthoven	998	3.16	69

[(1)] These dose equivalent rate monitors are placed differently from the dose equivalent rate monitors mentioned in Table 2 with regard to height and surface covering.
[(2)] Station Rotterdam-Tarwewijk is operational from 13 August 2018.
[(3)] Station Biddinghuizen was dismantled on 1 July 2019.

Table 2 Yearly average ambient dose equivalent rate for the NMR stations in 2019

Station	No.	Dose rate $nSv.h^{-1}$	Station	No.	Dose rate $nSv.h^{-1}$
Den Burg	1001	77	Lelystad	1103	83
Den Helder	1002	78	Urk	1105	85
Den Oever	1003	78	Eemshaven	1106	83
Petten	1006	68	Uithuizen	1107	90
Kolhorn	1007	94	Wagenborgen	1109	79
Egmond aan Zee	1009	71	Winschoten	1110	82
Heerhugowaard	1011	83	Ter Apel	1111	73
Nederhorst Den Berg	1015	83	Stadskanaal	1112	74
Velsen	1016	81	Nieuweschans	1113	79
Enkhuizen	1018	83	Bellingwolde	1114	67
Oosthuizen	1019	81	Groningen	1116	84
Zaandam(1)	1021	113	Leens	1117	88
Gouda	1024	81	Grijpskerk	1118	82
Dordrecht	1027	69	Meppel	1125	76
Zuid Beijerland	1028	88	Hoogeveen	1126	71
Zierikzee	1029	85	Steenwijksmoer	1129	74
Rotterdam-Schiebroek	1031	74	Nw. Amsterdam	1130	80
Pijnacker	1032	83	Nw. Schoonebeek /Weiteveen	1131	71
Maasvlakte	1035	84	Laren (Gld)	1134	79
Maassluis	1037	98	Hengelo (Ov)	1135	79
Hellevoetsluis	1038	111	Vroomshoop	1138	76
Ouddorp	1039	71	Enschede	1139	75
Hoenderloo	1040	69	Losser	1140	70
Wageningen	1043	76	Oldenzaal	1141	78
Amersfoort	1046	82	Rijssen	1143	84
Harderwijk	1050	76	‘s Heerenberg	1144	81
Wijk bij Duurstede	1056	91	Dinxperlo	1145	89
Nieuwegein	1062	88	Varsseveld	1146	80
Zegveld	1063	74	Groenlo	1147	94
Lopik (Cabauw)	1064	86	Deventer	1148	89
Apeldoorn	1066	79	Etten-Leur	1154	75
Heerenveen	1071	68	Den Bosch	1157	77
Oosterwolde	1072	87	Raamsdonkveer	1159	95
Bergum	1074	76	Ulvenhout	1160	73
Harlingen	1076	85	Baarle Nassau	1161	80
Sneek	1077	80	Mill	1163	73
St Jacobiparochie	1081	87	Volkel	1164	68
Holwerd	1082	91	Oss	1167	81
Leeuwarden	1085	79	Nuenen	1172	78
Zwolle	1088	84	Bergeijk	1174	100
Ommen	1093	75	Waalre	1175	77
Hardenberg	1095	75	Someren (Dorp)	1176	76
Assen	1097	76	Oisterwijk	1178	86
Rutten	1099	87	Riel	1179	79

Table 2 Continued

Station	No.	Dose rate $nSv.h^{-1}$	Station	No.	Dose rate $nSv.h^{-1}$
Oostelbeers	1180	112	Gennep	1228	76
Hilvarenbeek	1181	74	Elst (Gld)	1229	84
Venray	1183	67	Zevenaar	1230	83
Nieuw-Bergen	1184	67	Nijmegen	1231	76
Sevenum	1185	80	Amstelveen	1233	84
Reuver	1188	77	Amsterdam	1234	81
Nederweert	1189	78	Aalsmeer(3)	1236	72
Heythuysen	1190	85	Nispen	1237	73
Mariahoop	1191	80	Groesbeek	1240	82
Stramproy	1192	72	Tubbergen(3)	1243	89
Eerbeek	1193	79	Haaksbergen	1244	71
Leiden	1196	83	Scheveningen	1247	85
Hulst	1197	86	Zaltbommel	1251	81
Terneuzen	1199	82	IJzendijke	1252	85
Sluis	1201	81	Ritthem	1253	97
Vlissingen	1202	86	Vlissingen Haven	1254	81
Halsteren	1204	74	Nieuwdorp	1255	84
Oud Gastel	1206	77	‘s-Heerenhoek(4)	1256	96
Goes	1207	82	Driewegen	1257	97
Bruinisse	1209	82	Arnemuiden	1258	86
Burgh-Haamstede	1211	69	Heinkenszand	1259	98
Vrouwenpolder	1212	67	Baarland	1260	99
Yerseke	1213	89	Biervliet	1261	78
Middelburg	1215	89	Nummer Een	1262	89
Westkapelle	1216	75	Rilland	1263	86
Maasband	1218	88	Putte(3)	1264	69
Maastricht	1220	104	Nieuw Namen	1265	92
Ravensbos	1221	93	Beneden Leeuwen	1272	87
(Arensgehout)			Denekamp	1278	74
Vaals	1222	98	Winterswijk	1279	76
Gulpen	1223	86	(Kotten)		
Kerkrade	1224	95	Bilthoven	1280	64
Hoensbroek	1225	94	Gastel (Maarheze)	1281	82
Eijsden(2)	1227	59			

(1) The Zaandam station showed a significantly higher value than most other stations. This is due to a higher background level of the surrounding surface at the site since the end of 2014.
(2) The Eijsden station has been added to the NMR network in 2019.
(3) The stations Aalsmeer, Tubbergen en Putte were refurbished in the course of 2019. As a consequence, the 2019 values differ from the values registered in 2018.
(4) The ‘s-Heerenhoek station was moved a few meters from its original location on 6 May 2019. Before that date it showed a significantly higher value than all other stations due to a higher background level of the ground surface at the site.

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