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香港環境輻射監測摘要
Summary of Environmental Radiation Monitoring in Hong Kong

2011

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摘要

香港天文台環境輻射監測計劃在二零一一年踏入第二十五年。本年報收錄了監測計劃在二零一一年的主要工作內容、測量方法及結果。年報亦介紹了新的工作項目、轉變和引進的新措施。

自二零一一年三月日本福島核事故後，天文台在三月底至四月底在空氣樣本中檢出微量的人工放射性核素碘及銫，但由於放射性活度極低，對人體健康並無影響，亦沒有對本港的環境輻射水平造成長遠影響。二零一一年的測量結果顯示，無論在福島核事故前後，天文台的輻射監測網絡錄得的環境輻射水平均在正常本底變化範圍之內。

事實上自廣東核電站及嶺澳核電站運作以來，香港的環境輻射水平並沒有出現明顯變化。而天文台在空氣樣本以外的其他環境及食物樣本中所測量到的微量人工放射性核素，包括銫-137、氚、鍶-90及釷-239，分析結果與廣東核電站及嶺澳核電站運作之前的結果並沒有顯著分別。除卻上述在二零一一年三月底至四月底的空氣樣本中檢測出的放射性碘及銫外，其他環境及食物樣本中的放射性核素相信主要是來自一九四五至一九八零年間的大氣核武試驗。

ABSTRACT

The Environmental Radiation Monitoring Programme of the Hong Kong Observatory entered its twenty-fifth year in 2011. This annual report incorporates salient features of the work of the programme during 2011, including report on measurement method and results, highlights of relevant new work, changes and new measures introduced.

Following the Fukushima nuclear power plant incident in Japan in March 2011, minute artificial radionuclides, namely radioactive iodine and caesium, were detected in some air samples collected by the Observatory in late March to late April. However, as the radioactivity of these radionuclides was very low, they posed no threat to human health and did not cause any long-term effects on the ambient radiation levels in Hong Kong. Based on the measurement results in 2011, the ambient radiation levels in Hong Kong as measured by the Observatory radiation monitoring network were within the normal background range both before and after the Fukushima nuclear power plant incident.

In fact there was no significant changes in the ambient radiation levels in Hong Kong since the Guangdong Nuclear Power Station and Lingao Nuclear Power Station came into operation. Traces of caesium-137, tritium, strontium-90 and plutonium-239 were also detected in some environmental samples other than air samples and also in some food samples. The levels of all these radionuclides were not significantly different from those recorded before the Guangdong Nuclear Power Station and Lingao Nuclear Power Station came into operation. Apart from the radioactive iodine and caesium detected in some air samples collected in late March to late April 2011 as mentioned above, the existence of such radionuclides could primarily be attributed to atmospheric nuclear weapon tests from 1945 to 1980.

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1. 引言

香港天文台早於一九六一年開始監測香港的環境輻射水平，並參與由國際原子能機構(IAEA)和世界氣象組織(WMO)舉辦的國際性環境輻射監測計劃。由於興建廣東大亞灣核電站，天文台於一九八三年開展了一項全面的計劃，以監測核電站運作前後香港的環境輻射水平。

該計劃包括分為兩個階段的「環境輻射監測計劃」(ERMP) 。ERMP 第一個階段為期五年，稱為「本底輻射監測計劃」(BRMP)，於一九八七年至一九九一年進行，務求在一九九四年廣東核電站（位置見圖 1）投產之前，確定香港的本底輻射水平，作為基準線，以判別核電站運作後可能為香港輻射水平帶來的影響。監測結果可參考 BRMP 的報告（香港天文台，1992）。

ERMP 的第二階段由一九九二年開始運作至今，內容涵蓋 BRMP 內的所有重要項目，並因應所得經驗於採樣及測量工作上作出修訂。ERMP 是一項持續進行的計劃，目標是監測香港環境輻射水平的長期變化，尤其是廣東核電站與嶺澳核電站分別在一九九四年及二零零二年運作後可能出現的任何變化。

ERMP 的監測結果在計劃的年報和摘要中發表（http://www.hko.gov.hk/publica/pubrmc.htm）。讀者可參閱有關報告，以瞭解計劃的採樣、測量及質量保證工作的詳情。自二零零三年開始，監測計劃的年報實行精簡化，年報只收錄計劃的重點，包括測量方法和結果的總結，及該年工作的摘要、轉變和新措施。

本報告的第 2 章介紹監測計劃的取樣和質量保證工作，以及環境輻射水平、食物和環境樣本放射性的測量方法及儀器。第 3 章則臚列二零一一年的測量結果及所得的結論。第 1 至 3 章內容主要圍繞 ERMP 的常規監測工作，有關二零一一

年三月日本福島核事故發生後天文台所進行的額外監測和分析工作，則在附錄討論。

2. 取樣、測量及質量保證

ERMP 的焦點集中在大氣、地面和水體三個主要照射途徑。測量工作主要包括兩個部份。第一部份是直接測量香港的環境輻射水平，第二部份是測量香港的環境樣本及市民日常的食物。圖 1 顯示二零一一年實時測量環境輻射的地點，圖 2 所示為二零一一年其環境伽馬輻射的測量地點及環境樣本的收集點。表 1 列載二零一一年的取樣及分析概要。

2.1 環境輻射水平的直接測量

2.1.1 輻射監測網絡

自一九九二年開始，輻射監測網絡由十個固定站組成(圖 1)，監測香港境內的環境伽馬輻射水平。每個站均裝設一個高壓電離室(Reuter-Stokes Model RSS-131 environmental radiation monitor) ，不斷測量環境伽馬輻射劑量率，並每一分鐘將數據傳送至天文台總部。

2.1.2 熱釋光劑量計網絡

香港天文台於一九八零年代末開始使用熱釋光劑量計，測量長時間累積的環境伽馬輻射劑量。在二零一一年，熱釋光劑量計網絡包括二十七個位於香港各區的固定監測點(圖 2)。這個網絡使用 Harshaw 8807 型號的氟化鋰(LiF:Mg,Ti)及氟化鈣(CaF_2:Dy)熱釋光劑量計。為確保數據的統計精確度，每個監測點均設有五個一組的劑量計。熱釋光劑量計每季更換及取讀數據一次。

2.1.3 空中輻射監測系統

香港天文台的空中輻射監測系統於一九九八年開始運作。這系統設有兩組碘化鈉(NaI)探測器，可安裝在政府飛行服務隊的直升機上，以進行測量。它能以輻射煙羽追蹤模式來測定香港上空有否出現輻射煙羽及鑑定其影響範圍。當輻射煙羽經過本港後，該系統也可以轉為地面輻射污染測量模式運作，判別受輻射沉降物污染的地區。進行監測時，該系統可在直升機上即時顯示伽馬圖譜、譜法分析結果及探測位置等資料，並會定時將資料備份。

空中輻射監測系統的優點是它可以在偏遠、陸上交通難以到達的地點進行輻射巡測。每年天文台均會利用空中輻射監測系統以上述兩種模式作常規測量，收集本底輻射水平資料及監測輻射水平隨高度的變化。

2.1.4 自動伽馬譜法系統

自一九九六年起，香港天文台在大鵬灣平洲上設置了一套自動伽馬譜法系統(圖 1) ，以便及早測量核電站可能排放的人工放射性核素。該系統由一個鍍上硫化鋅(ZnS)的塑膠閃爍器、一個高純度鍺探測器和一個碘化鈉探測器組成。系統分別利用一個迴轉空氣濾紙鼓和一個碳濾盒不斷地收集大氣飄塵及氣態碘。碳濾盒每週自動更換一次。硫化鋅閃爍器負責測量大氣飄塵中的總阿爾法及貝他活度；鍺探測器利用伽馬譜法自動分析大氣飄塵釋出的伽馬射線；碘化鈉探測器則量度碳濾盒的碘–131 活度。

系統會每五至十五分鐘將阿爾法和貝他的活度、碘－131 的活度及伽馬譜法分析結果等數據傳送至天文台總部。

2.1.5 流動輻射監測站

流動輻射監測站是一部輻射巡測車，配備多款便攜式及經特別設計的測量儀器，用作常規及應急輻射測量。車頂外置有伽馬探測器和氣管入口，利用這些裝設，測量人員可無需離開車廂便能量度車外的環境伽馬輻射水平及收取空氣樣本。

二零一一年四月，一部新輻射巡測車正式投入業務運作，代替使用了十二年的舊巡測車。新巡測車除配備多款便攜式輻射測量儀器及採樣工具外，其他輔助設施亦有所提升，而在車頂更裝置了氣象儀器收集天氣數據。

流動輻射監測站日常用於常規巡測及收集樣本，並定期到本港指定地點收取環境輻射數據。

2.1.6 高空輻射探測

天文台利用氣球攜帶 Vaisala RS92 型號探空儀及附載的輻射探測組件在京士柏進行高空輻射探測工作。每個輻射探測組件(Vaisala NSS921 型號)含有兩支蓋革彌勒(Geiger Müller)管，一支是只量度伽馬輻射的伽馬管，另一支是量度伽馬及高於 0.25 兆電子伏(MeV)貝他輻射的伽馬及貝他管。輻射探空儀傳回地面的數據經地面站的一台高空探測系統接收和處理。

天文台每年定期在不同的天氣情況下進行高空輻射探測，以收集輻射水平隨高度變化的數據。

2.2 食物及環境樣本取樣安排

常規取樣安排

2.2.1 大氣樣本

ERMP 所收集的大氣樣本包括大氣飄塵、濕沉積物(降雨)、總沉積物(濕沉積物加上乾沉積物)、氣態碘及水蒸氣。天文台每週定期在京士柏、沙頭角和元五墳(圖 2)收集一次大氣飄塵和濕沉積物樣本。此外，在其他七個輻射監測站亦裝置有這些儀器，以便在應急時收集大氣樣本。

大氣飄塵是透過高容量空氣取樣器(Hi-Q Environmental Products 4200 AFC-BRL-KIT/230 型號及 Hi-Q Environmental Products BRL-3000M 型號)內的濾紙收集。濕沉積物則由頂部設有漏斗的容器收集。在乾燥季節期內各收集點都會放置三個漏斗容器，以收集足夠雨水作測量。

天文台亦在京士柏收集總沉積物、氣態碘及水蒸氣樣本。總沉積物的取樣器是一個盛有蒸餾水的不銹鋼圓盆，樣本每週收集一次。氣態碘樣本是利用裝有浸滲銀沸石濾盒的放射性碘取樣器(Hi-Q Environmental Products CMP-0523CV/230 型號)收集的，濾盒每週收集和更換一次。

至於水蒸氣樣本，則採用裝有燥石膏濾盒的氣態流出物取樣器(Pylon Electronics Inc. VFP-20 型號)收集，每月隨機選擇一個星期間歇地收集樣本，直至取樣總時數達三十六小時為止。

天文台於二零一一年開始採用一種新方法來製備水蒸氣樣本以作氚活度測量。以往的樣本製備方法，工作人員先抽取一小部份收集了水蒸氣樣本的燥石膏，將它直接放進一個盛有閃爍液的小瓶，然後以液體閃爍計數法對小瓶內的樣本作氚活度測量。新方法的關鍵步驟是先將所有吸收了水蒸氣的燥石膏在實驗室加熱釋出水蒸氣，將釋出的水蒸氣再凝結

至液態水，最後才把液態水放進盛有閃爍液的小瓶，再以液體閃爍計數法對小瓶所盛載的水樣本作氚活度測量。

新方法的優點是加強了抽取水蒸氣的效率。測試結果顯示，新方法可使用較大量收集到的水蒸氣樣本進行測量，令計數效率由 15% 增至 25%，同時，探測下限也由每立方米 1 貝可大幅降至每立方米 0.01 貝可，測量的靈敏度亦因此大大提高。

2.2.2 食物樣本

香港天文台從主要食物分銷點、批發市場和供應商收集各類市民日常食用的陸生和水生食物樣本，並特別著眼於本港和深圳出產的食物。

表二列載二零一一年食物樣本概要。

2.2.3 飲用水、地下水及海水

經處理的飲用水樣本，是從九龍和屯門配水管，以及沙田、屯門和油柑頭濾水廠(圖 2)收集的。未經處理的飲用水，則從萬宜水庫、船灣淡水湖、木湖 B 抽水站，以及沙田、屯門和油柑頭(圖 2)濾水廠收集。水務署的工作人員每三個月抽取飲用水樣本一次，交香港天文台作輻射測量。

在房屋署職員、屋邨管理員及寺院人員等協助下，天文台於以下六個地點(圖 2)抽取地下水樣本：長康邨(青衣)、鈞樂新村(元朗)、環翠邨(港島東)、華富邨(薄扶林) 、富山邨(東九龍)及清涼法苑(屯門)。

在環境保護署協助下，天文台每年均會抽取海水樣本一次。取樣地點共有四個(圖2)，均位於香港東部沿岸，分別為橫瀾島、火石洲、大浪灣及赤洲附近的海域。海水會從三個不同深度抽取：上層(水面下2.5米)、中層(與水面及海床等距)和低層(海床上2.5米)。海水中的懸浮粒子樣本是經由薄膜過

濾海水樣本後收集。

2.2.4 土壤及沉澱物樣本

天文台在香港境內三十九個指定地點抽取土壤樣本，每一地點取樣周期為五年。每個地點抽取的土壤樣本均來自兩個不同的深度：上層由地面至 15 厘米深，下層則由 15 至 30 厘米深。二零一一年的常規取樣地點為大埔、粉嶺、沙頭角、大美督、城門水塘、荃灣、大欖涌水塘及青山發電廠(圖 2)。

潮間帶土樣本每季在白沙灣、尖鼻咀和沙頭角三處沿岸地區(圖2)收集。樣本從兩個不同深度層抽取，上層從表面至 15 厘米深，下層則自 15 至 30 厘米深。另外，土木工程拓展署每年在大灘海、龍蝦灣、索罟灣和西區碇泊處四個地點(圖2)協助收取海床沉澱物樣本。

加強取樣安排

因應日本福島核事故發展，天文台特別加強監測香港環境樣本(包括空氣、雨水、海水和土壤)的放射性活度。加強監測的詳細內容見附錄。

2.3 食物及環境樣本的實驗室測量

食物及環境樣本的放射性分析均於京士柏的輻射實驗室進行。表 1 列出常規監測的主要人工放射性核素。每個樣本按照不同樣本類別及測量目的，經過下列一項或多項程序分析：

(a) 以伽馬譜法測量伽馬放射性核素的活度；
(b) 以液體閃爍計數法測量氚[†]的放射性活度；
(c) 以低本底總貝他計數法測量鍶-90 的放射性活度；及
(d) 以阿爾法譜法測量鈈-239 的放射性活度。

[[†]氚主要是在宇宙射線進入大氣層時自然地形成，或在一九四五至一九八零年間大氣核武試驗中產生，而少量亦可能來自核電站運作（UNSCEAR 2000）。]

有關各種量度參數的概要，例如樣本大小、計數時間及探測下限等，載列於表 3。

2.4 本底輻射監測計劃(BRMP)及環境輻射監測計劃(ERMP)的測量值比較

在 2.1 至 2.3 節所敘述的輻射測量中，環境伽馬輻射監測網絡、自動伽馬譜法系統及部分環境及食物樣本的輻射測量在 BRMP 進行的五年間尚未開始運作，所以本報告中有關這些系統或樣本的輻射測量結果並沒有相應的 BRMP 範圍作為本底輻射比對。

雖然如此，自一九九二年 ERMP 第二階段開始運作多年來，所有 BRMP 已包含的輻射測量項目的測量值均顯示香港的環境輻射水平及樣本中的人工放射性核素活度均沒有因核電廠的運作而產生實質的變化。在這個基礎上，本報告中凡沒有 BRMP 範圍的測量項目(即在 ERMP 第二階段運作後才開始測量的項目)均以該項目首五年測量值的變化範圍作為

參考。此參考值的測量時段與 BRMP 最接近，因此在沒有其他可見的變素影響下，也可以被視為該測量項目的近似本底數值範圍。

2.5 質量保證

自一九八九年開始，天文台已參與國際及中國內地機構舉辦的測量比對及能力測試(許建忠等，2007)，當中包括國際原子能機構(IAEA)、英國國家物理實驗室(NPL)、世界衛生組織(WHO)及中國輻射防護研究院(CIRP)。

除了參加測量比對及能力測試外，天文台亦透過內部質量保證程序，確保香港環境輻射監測結果的可靠性。為了提升輻射測量工作的管理效能及品質，天文台輻射實驗室的工作程序是依據國際標準化組織所訂下的 ISO 9001:2008 標準運作和提供輻射測量服務，並於二零零九年初成功獲得認證。

其後認證機構每年對輻射實驗室作一次跟進審查，核實其輻射測量服務可繼續獲得 ISO 9001:2008 認證。天文台輻射實驗室於二零一一年一月順利通過第二次年度審查，標誌著輻射實驗室所提供的優質輻射測量服務再一次得到認可。

3. 測量結果及結論

3.1 測量結果

3.1.1 輻射監測網絡

輻射監測網絡於二零一一年所錄得的年平均環境伽馬劑量率及一分鐘平均數據的變幅載於表 4。測量結果均在本底輻射範圍之內。

自輻射監測網絡運作以來，各監測站錄得的輻射水平一般會隨著季節轉變而出現數個百分點的變化。在下雨或當熱帶氣旋影響香港的情況下，變化會明顯較大，甚至高於平時水平的一倍。

二零一一年環境伽馬劑量率的最大變幅於九月十九日錄得。當日香港受到一道冷鋒相關的雷雨影響，在平洲錄得的一分鐘平均劑量率較該年的平均值高出約百分之八十四，但仍在本底輻射範圍之內。

3.1.2 熱釋光劑量計網絡

二零一一年各熱釋光劑量計站錄得的伽馬輻射劑量率的年平均值、標準差及變幅載於表 4。所有監測站錄得的劑量率均在 BRMP 範圍之內。

3.1.3 空中輻射監測系統

在二零一一年二月，空中輻射監測系統以地面輻射污染測量模式為平洲進行本底輻射測量，測量高度按地勢而改變，並保持着距離地面約一百米。測量過程中並沒有探測到人工放射性核素，測量結果與以往相若。圖 3 為測量當天該區的鉀-40 放射性水平。

天文台於八月使用空中輻射監測系統在大鵬灣及西貢地區以輻射煙羽追蹤模式進行測量。直升機由海拔約一百米升至約一千米，測量海面及地面上的輻射水平隨高度的變化。測量過程中並沒有探測到人工放射性核素。圖4及圖5分別顯示在大鵬灣和西貢地區所錄得的垂直輻射水平分佈數據。一如以往觀測所得，在海面上所量度到的計數率在垂直方向並沒有明顯變化，基本上為本底輻射水平。而在陸地上近地面所量度到的計數率則明顯比海面上的水平高，主要是由於岩石及土壤比海水含有較多放射性物質所致。計數率數值自地面隨高度迅速遞減，直至達到相當於海面上所量度到的水平。

3.1.4 自動伽馬譜法系統

二零一一年平洲自動伽馬譜法系統錄得的數據載於表5。全年並沒有探測到人工放射性核素，而所有測量結果均在本底輻射範圍內。

3.1.5 流動輻射監測站

二零一一年天文台在船灣淡水湖共進行了四次宇宙輻射測量，平均伽馬劑量率為每小時 0.032 至 0.035 微戈(見表6)，與往年所得的數據相近。

3.1.6 高空輻射探測

天文台在二零一一年共進行了三次高空輻射探測。進行探測時的天氣情況如下：二月十七日多雲，地面吹輕微西風。九月二十二日多雲，地面吹和緩北風。十二月八日天晴，地面吹和緩北風。圖 6 顯示二零一一年三次高空輻射探測的平均大氣放射性垂直廓線，數據分析結果與以往大致相若(李新偉等，2007)。

3.1.7 食物及環境樣本

二零一一年天文台共收集了 392 個常規食物和環境樣本。表 7、8、9 和 10 分別列載常規樣本的伽馬譜法分析、氚、鍶-90 及釷-239 測量結果。因應日本福島核事故而加密採樣的環境樣本伽馬譜法分析結果則列於表 A1 及 A2。

放射性活度數據均按照取樣日期進行衰變修正。倘若取樣工作持續進行了一段較長的時間(例如一週或一月)，衰變修正便會以取樣期間的中間日期作為依據。

各表中只列出有關人工放射性核素的可測量活度結果。為方便參考，表 11 按不同的照射途徑臚列了二零一一年各主要樣本類別的測量結果。

(a) 伽馬譜法分析

由於日本福島事故的核排放，天文台在二零一一年三月底至四月底的一些大氣飄塵樣本中測量到極微量的人工伽馬放射性核素碘-131、銫-134 及銫-137，並在部分氣態碘樣本中測量出極微量的人工伽馬放射性核素碘-131。

由於氣態碘取樣器比高容量空氣取樣器更有效收集空氣中的碘，所以氣態碘樣本中測量出的碘-131 活度比大氣飄塵樣本中的活度高。

另外值得一提的是縱使伽馬譜法測量儀器的靈敏度已很高，但由於大氣飄塵樣本中的銫-134 活度極低，因此並沒有在每周的樣本中測量出來，要累積至每月樣本方可被儀器檢測出來。

在二零一一年三月底至四月底的常規每週及累積每月大氣飄塵樣本的放射性核素碘和銫活度測量結果與同期的非常規加密每日大氣飄塵樣本測量結果互相吻合(見表 7 及 A1。由於人工放射性核素碘及銫的活度極低，因此沒有對公眾健康帶來影響(見表 A1，註[**])。

另一方面，在二零一一年八月一個在京士柏收集的每週氣態碘樣本中亦測量出極微量的碘-131(採樣日期為八月十六至二十三日)。雖然無法確認該氣態碘樣本中碘-131 的來源，但由於同期的其他空氣樣本，包括京士柏、元五墳及沙頭角的大氣飄塵樣本中均沒有發現碘-131，因此可以推論氣態碘樣本中的碘-131 只源自局部地區，並非來自核事故排放。由於碘-131 亦會用於治療甲狀腺疾病，因此氣態碘樣本中的微量碘-131 的來源有可能是來自醫療方面。該氣態碘樣本中的碘-131 活度極低，並沒有對公眾健康帶來影響。而八月二十三日之後的氣態碘樣本中再沒有檢測到任何人工放射性核素。是次測量結果顯示測量碘-131 活度的儀器靈敏度很高，縱使樣本中的碘-131 活度極低，仍可以被儀器檢測出來。

二零一一年在部份食物、土壤及沉澱物樣本中發現微量的人工伽馬放射性核素銫-137，活度均在本底輻射範圍之內。樣本包括海產、土壤、潮間帶土及海床沉澱物，在 BRMP 期間及過往 ERMP 的監測工作中也曾在這幾類樣本中發現銫-137 (黃明松等，2003)，相信主要是與一九四五至一九八零年間大氣核武試驗的沉降物殘餘有關（UNSCEAR 2000）。

(b) 氚

二零一一年在部份大氣、水及食物樣本中發現微量的氚，活度均在本底輻射範圍之內。樣本包括大氣水蒸氣、濕沉積物、總沉積物、地下水、海水、飲用水、樽裝水、水果、食米、牛奶、蔬菜、家禽、肉類、海產及海藻。所偵測到的氚相信主要是因宇宙射線自然產生，而小部份則是以往大氣核武試驗的沉降物殘餘（UNSCEAR 2000）。

(c) 鍶-90

二零一一年在部份大氣、食物及土壤樣本中發現微量的鍶-90，活度均在本底輻射範圍之內。這些樣本包括大氣飄塵、濕沉積物、總沉積物、土壤、食米、牛奶、蔬菜、水果、家禽、肉類、海產及海藻。在 BRMP 期間及過往 ERMP 的監測工作中，這些樣本中也曾發現鍶-90，相信主要也是來自以往大氣核武試驗（UNSCEAR 2000）。

(d) 鈈-239

二零一一年在部份潮間帶土及海床沉澱物樣本中發現微量的鈈-239，活度均在本底輻射範圍之內。鈈-239 主要也是來自以往大氣核武試驗的沉降物（UNSCEAR 2000）。

3.2 結論

總括而言，雖然福島核事故令二零一一年三月底至四月底期間香港部分空氣樣本出現放射性碘及銫，但活度極低，並沒有影響香港整體環境輻射水平，在香港境內不同地點錄得的環境伽馬劑量率均在本底輻射範圍之內，而本港土壤樣本中的放射性銫活度在福島核事故後亦沒有增加。

與過去的情況相若，於二零一一年在其他環境及食物樣本中也測量到微量的人工放射性核素，包括銫-137、氚、鍶-90 及釙-239，惟它們的輻射水平與在廣東核電站及嶺澳核電站運作之前所收集的樣本並沒有顯著分別。

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附錄

天文台因應日本福島核事故加強輻射監測之內容及測量結果

1. 空氣

自日本福島核事故發生後，天文台特別加強監測空氣中的放射性活度。從二零一一年三月十五日開始，京士柏及元五墳的大氣飄塵樣本，由慣常的每星期取樣一次，增加至每日取樣一次，並每天對大氣飄塵樣本進行伽馬放射性核素活度測量。元五墳及京士柏的大氣飄塵樣本每天採樣和輻射測量分別持續至二零一一年五月十一日及二十五日才結束。

由於大氣飄塵樣本的取樣量由七天降至一天，為了讓儀器可以從每天的樣本中檢測出活度極低的放射性核素，天文台將每日大氣飄塵樣本的計數時間由往常檢測每週樣本的數小時延長至每天樣本的 22 小時，令檢測結果能達到一定的可靠程度。

伽馬放射性核素活度測量結果顯示大氣飄塵的每天樣本中有極微量的放射性碘-131 及銫-137，詳細測量結果見表 A1。

2. 雨水

為了加強雨水的輻射監測，天文台在二零一一年三月十五日至五月二十五日期間在京士柏額外以漏斗容器每天收集總沉積物樣本，如在取樣期間京士柏氣象站有雨量記錄，便對當天總沉積物樣本進行伽馬活度測量。結果顯示所有曾作伽馬活度測量的京士柏總沉積物樣本中均沒有人工伽馬放射性核素。

3. 海水

除了每年一次在橫瀾島、火石洲、大浪灣及赤洲附近的海域抽取海水樣本作輻射測量外，天文台因應日本福島核事故的發展，亦加強了海水的輻射監測。在環保署協助下，於二零一一年三月二十四日、四月二十七日及五月二十七日在上述取樣地點收集了額外的海水樣本，經天文台伽馬放射性核素活度測量後，顯示上述海水樣本中均沒有人工放射性核素。

4. 土壤

因應日本福島核事故的發展，天文台加強了土壤的輻射監測。於二零一一年五月六至十二日期間在本港多處地點(表 1 及圖 2)收集土壤樣本(包括上層和下層)並進行伽馬活度測量。測量結果(表 A2)顯示在某些樣本中測量出微量的人工放射性核素銫-137，但其活度均在 BRMP 相應範圍之內。

5. 空中輻射監測

日本福島核事故發生後不久，天文台額外在二零一一年三月二十一日利用空中輻射監測系統以輻射煙羽追蹤模式在大鵬灣上空進行了一次空中輻射測量，結果顯示並沒有探測到人工放射性核素，圖 A1 為上述測量所錄得的垂直輻射水平分佈數據，顯示輻射水平正常。

6. 輻射巡測

流動輻射監測站於二零一一年四月十一日在沙田進行輻射巡測，測量結果顯示環境輻射水平正常。

CONTENTS

FIGURES

TABLES

1. INTRODUCTION

Since 1961, the Hong Kong Observatory (HKO) has been monitoring environmental radiation levels in Hong Kong and participating in international programmes on environmental radiation monitoring organised by the International Atomic Energy Agency (IAEA) and the World Meteorological Organization (WMO). In response to the construction of nuclear power stations at Daya Bay in Guangdong, the HKO embarked in 1983 on a comprehensive programme to monitor the environmental radiation levels in Hong Kong before and after the power plants commenced operation.

The programme includes the Environmental Radiation Monitoring Programme (ERMP) which consists of two phases. The first phase is known as the Background Radiation Monitoring Programme (BRMP) and was conducted in the 5-year period from 1987 to 1991 to establish the baseline radiation levels in Hong Kong prior to the operation of the Guangdong Nuclear Power Station (GNPS) in 1994 (see Figure 1 for location). These baseline levels would help to reflect any changes arising from the operation of GNPS. The monitoring results can be found in the report on the BRMP (Hong Kong Observatory 1992).

The second phase of the ERMP, implemented since 1992, contains all the essential features of the BRMP but with adjustments in sampling and measurement to take advantage of the experience gained. The ERMP is an on-going programme to detect long-term changes in environmental radiation levels in Hong Kong, if any, particularly those arising from the operation of the GNPS and the Lingao Nuclear Power Station (LNPS) since 1994 and 2002 respectively.

The monitoring results of the ERMP can be found in the respective annual reports (http://www.weather.gov.hk/publica/pubrm.htm). From 2003 onwards, the annual reports only contain the most salient features of the programme, including summaries of measurement methods and results, highlights of new work, changes and measures introduced during the year. Readers may refer to the previous reports for details of the sampling, measurement and quality assurance work.

Chapter 2 in this report describes the sampling schedule, the instruments and methods used for measuring ambient radiation levels, as well as radioactivity in food and environmental samples. A summary of the quality assurance system is also given. Measurement results and conclusion are presented in Chapter 3. Chapter 1 to 3 mainly describe the routine monitoring of ERMP; the enhanced monitoring and analysis performed in response to the Fukushima nuclear incident in March 2011 in Japan are discussed in the Appendix.

2. SAMPLING, MEASUREMENT AND QUALITY ASSURANCE

The emphasis of the ERMP is to monitor three major exposure pathways, namely the atmospheric pathway, the terrestrial pathway and the aquatic pathway. In respect of measurement, there are two major components. The first component is the direct measurement of ambient radiation levels in Hong Kong. The second is the detection of any artificial radioactive material in the environment of Hong Kong and in the foodstuff commonly consumed by Hong Kong people. The locations for real-time measurement of ambient radiation in 2011 are shown in Figure 1. The other locations for measurement of ambient gamma radiation and collection of environmental samples in 2011 are shown in Figure 2. A summary of the sampling and analysis programmes of the ERMP in 2011 is given in Table 1.

2.1 Direct measurement of ambient radiation level

2.1.1 Radiation Monitoring Network

Since 1992, the ambient gamma dose rates have been monitored by a radiation monitoring network (RMN) consisting of 10 fixed stations (Figure 1). The dose rates are measured at each station continuously by a high pressure ionization chamber (HPIC) (Reuter-Stokes Model RSS-131 environmental radiation monitor). Data are transmitted to the Observatory Headquarters every minute.

2.1.2 Thermoluminescent Dosimeter Network

A thermoluminescent dosimeter (TLD) network has been in operation since the late 1980s to measure ambient gamma doses accumulated over a long period. In 2011, the network comprises 27 monitoring points over the territory (Figure 2). The TLDs are of the lithium fluoride (LiF:Mg,Ti) and calcium fluoride (CaF_2:Dy) type (Harshaw 8807). A batch of five TLDs is placed at each site to ensure statistical accuracy. The TLDs are replaced and read on a quarterly basis.

2.1.3 Aerial Radiation Monitoring System

The Aerial Radiation Monitoring System (ARMS) has been put into operation since 1998. The system consists of two assemblies of sodium iodide (NaI) detectors that can be mounted on board a helicopter of the Government Flying Service for operation. When operating in the plume tracking mode, it has the capability to determine the existence and extent of any radioactive plume over Hong Kong. After the passage of the plume, the system using the ground contamination measurement mode can be used to identify surface areas contaminated by deposited radionuclides. Gamma spectra, spectroscopic analysis results and location information are displayed

on board the helicopter in real time and archived at regular intervals.

The merit of ARMS is that it can be used to detect radiation levels over remote areas and over regions inaccessible to land transportation. Every year, ARMS will operate in the two modes described above for routine measurement to collect data of background radiation level as well as radiation levels at various altitudes.

2.1.4 Automatic Gamma Spectrometry System

Hong Kong Observatory has been operating the Automatic Gamma Spectrometry System (AGSS) at Ping Chau, Mirs Bay since 1996 (Figure 1) for providing early alert of any releases of artificial radionuclides from the nuclear power stations. The system consists of a zinc sulphide (ZnS) coated plastic scintillator, a high purity germanium detector and a NaI detector. It continuously collects airborne particulates on a rotating filter drum and gaseous iodine in a carbon cartridge. The carbon cartridge is replaced automatically at weekly intervals. The ZnS scintillator measures the gross alpha and beta activities of the particulates collected. The germanium detector measures gamma rays emitted by the particulates and gamma spectrometry analysis is carried out automatically. The NaI detector measures the iodine-131 concentration in the carbon cartridge.

Data of alpha and beta activities, iodine-131 activity, as well as results of gamma spectrometry analysis are transmitted to a central station at the Observatory Headquarters every 5 to 15 minutes.

2.1.5 Mobile Radiation Monitoring Station

The Mobile Radiation Monitoring Station (MRMS) is a radiological survey vehicle that is equipped with portable and specially designed instruments for use in routine and emergency radiological surveys. An external gamma probe and an air inlet on the vehicle roof provide the means to measure the ambient gamma radiation levels outside the vehicle and to collect air samples without the survey team members having to leave the vehicle.

In April 2011, a new radiological survey vehicle replaced the old one which had been in service for 12 years. The new radiological survey vehicle is equipped with various portable radiation monitoring instruments and sampling tools, and supporting facilities were enhanced. A new feature was the installation of meteorological instruments on top of the vehicle for the collection of weather data.

The radiological survey vehicle is deployed for routine radiological survey and collection of samples. It also pays regular visits to selected locations in Hong Kong to measure ambient radiation levels.

2.1.6 Upper-air Radioactivity Soundings

Radioactivity in the upper atmosphere is measured at King's Park by radioactivity sensors attached to balloon-borne radiosondes (Model Vaisala RS92). The radioactivity sensor (Model Vaisala NSS921) comprises two Geiger-Müller (GM) tubes: a gamma-only tube, which measures only gamma radiation, and a gamma-plus-beta tube, which measures gamma radiation as well as beta radiation of energy higher than 0.25 MeV. Data from the radioactivity sensor is transmitted back and processed by the upper-air sounding system at the ground station.

The Observatory carried out regular radioactivity soundings under different weather conditions each year to collect data on the variation of radiation levels with altitudes.

2.2 Collection of food and environmental samples

Routine Sampling

2.2.1 Atmospheric Samples

Atmospheric samples, including airborne particulates, wet deposition (precipitation), total deposition (wet plus dry deposition), gaseous iodine and water vapour, are collected under ERMP. Airborne particulates and wet deposition are regularly collected at King's Park, Sha Tau Kok and Yuen Ng Fan (Figure 2) at weekly intervals. In addition, equipment is also installed at the other seven radiation monitoring stations for collecting atmospheric samples during emergency.

Airborne particulates are collected from a filter paper installed inside a high volume air sampler (Hi-Q Environmental Products Model 4200 AFC-BRL-KIT/230 and Hi-Q Environmental Products Model BRL-3000M). Wet deposition is collected by a carboy fitted with a top funnel. During the dry season, three sets of carboys and funnels are used at each location for collection of sufficient amount of rain for measurement.

Total deposition, gaseous iodine and water vapour are also collected at King's Park. The sampler for total deposition is a stainless-steel pan partially filled with distilled water to collect samples at weekly intervals. Gaseous iodine is sampled through a silver impregnated zeolite cartridge fitted inside a radioiodine sampler (Hi-Q Environmental Products Model CMP-0523CV/230), which is collected and replaced weekly.

Water vapour is collected using a gaseous effluent sampler (Pylon Electronics Inc. Model VFP-20) with a drierite cartridge operated intermittently during a

week-long period randomly selected in each calendar month, until the overall collection time reaches 36 hours.

The Observatory started adopting a new method for the preparation of water vapour samples for measuring the activity of tritium in 2011. In the past, the sample preparation method was to extract a small amount of drierite and put it directly into a vial with scintillation solution. The activity of tritium in the water vapour absorbed by the drierite was measured by liquid scintillation counting. In the new sample preparation method, the drierite is first heated in the laboratory to release the water vapour. The released water vapour is then condensed back to water. Lastly, the collected water is put into the vial with scintillation solution and the activity of tritium in this water sample is measured by liquid scintillation counting.

The merit of the new sample preparation method is that it increases the efficiency in extracting water vapour. Testing results indicated that a larger amount of water vapour could be collected for measurement and the counting efficiency rose from 15% to 25%. In addition, the minimum detectable activity attained was lowered significantly from 1 Bq m^{-3} to 0.01 Bq m^{-3}, thereby improving significantly the sensitivity of measurement.

2.2.2 Food Samples

Terrestrial and aquatic food samples typical of the diet of the local population are collected at main distribution points, wholesale markets and from enlisted suppliers. Particular attention has been given to food produced locally and in Shenzhen.

Food samples collected in 2011 are listed in Table 2.

2.2.3 Drinking Water, Underground Water and Sea Water

Treated drinking water is collected from distribution taps at Kowloon and Tuen Mun as well as the treatment works at Shatin, Tuen Mun and Yau Kom Tau (Figure 2). Untreated or raw drinking water is collected from the High Island Reservoir, the Plover Cove Reservoir, the Muk Wu B Pumping Station and the treatment works at Shatin, Tuen Mun and Yau Kom Tau (Figure 2). Both treated and untreated drinking water samples are collected once every three months by staff of the Water Supplies Department. The drinking water samples are passed to the Observatory for radiological measurements.

Underground water is collected at six locations (Figure 2), namely Cheung Hong Estate (Tsing Yi), Kwan Lok San Tsuen (Yuen Long), Wan Tsui Estate (East Hong Kong Island), Wah Fu Estate (Pokfulam), Fu Shan Estate (East Kowloon) and Ching Leung Nunnery (Tuen Mun) with assistance from the Housing Department, the

respective estate management and the nunnery personnel.

Sea water is sampled annually at four locations over the eastern part of the coastal waters of Hong Kong (Figure 2), namely waters off Waglan Island, Basalt Island, Tai Long Wan and Port Island. At each location, samples are collected at three depths - the upper level (2.5 metres underneath the surface), the middle level (equidistant from the surface and the seabed), the lower level (2.5 metres above the seabed) with the assistance of the Environmental Protection Department. Suspended particulates in sea water are collected by filtering the sea water samples through a membrane filter.

2.2.4 Land Soil and Sediments

Land soil is sampled at 39 designated sites throughout the territory. Each site is sampled once every five years. At each site, samples were collected from two layers, the upper layer from the surface to 15 cm deep and the lower layer from 15 cm to 30 cm deep. In 2011, land soil samples were collected from Tai Po, Fanling, Sha Tau Kok, Tai Mei Tuk, Shing Mun Reservoir, Tsuen Wan, Tai Lam Chung Reservoir and Castle Peak Power Station (Figure 2).

Intertidal sediments are sampled quarterly at three locations along the coast of Hong Kong (Figure 2), namely Pak Sha Wan, Tsim Bei Tsui and Sha Tau Kok. Two layers are taken at each sampling point, the upper layer from the surface to 15 cm deep and the lower layer from 15 cm to 30 cm deep. Sampling of seabed sediments is carried out annually with the assistance of the Civil Engineering and Development Department at four locations over the coastal waters of Hong Kong (Figure 2), namely Tai Tan Hoi, Lung Ha Wan, Picnic Bay and Western Anchorage.

Enhanced Sampling

In response to the evolving nuclear incident in Fukushima, Japan, the Observatory enhanced monitoring of radioactivity in environmental samples (including air, rain, sea water and soil) in Hong Kong. The details of enhanced monitoring can be found in the Appendix.

2.3 Measurement of food and environmental samples in laboratory

All radioactivity measurements of food and environmental samples are carried out in the Radiation Laboratory at King's Park. A list of the major artificial radionuclides routinely monitored is given in Table 1. Each sample, depending on the sample type and measurement objective, will go through one or more of the following analyses:

(a) gamma spectrometry analysis to determine the activities of gamma-emitting radionuclides;
(b) liquid scintillation counting to determine the activity of tritium[†];
(c) low-level gross beta counting to determine the activity of strontium-90; and
(d) alpha spectrometry analysis to determine the activity of plutonium-239.

[†Tritium is primarily produced naturally by cosmic rays entering the atmosphere or generated during atmospheric nuclear tests conducted from 1945 to 1980. A small amount is also produced during the operation of nuclear power stations (UNSCEAR 2000).]

A summary of key measurement parameters, including sample size, counting time and detection limits, are given in Table 3.

2.4 Comparison between BRMP and ERMP measurement results

Among the radiation measurement works described in Section 2.1 to 2.3, the Radiation Monitoring Network, Automatic Gamma Spectrometry System as well as radiological measurement of some of the environmental and food samples had not yet started operation during the BRMP 5-year period. Hence for the measurement results from these systems or samples, no corresponding BRMP ranges are available as background reference.

However, during the years of operation since the start of the second phase of ERMP in 1992, results of BRMP-covered radiation measurement of ambient radiation levels and activities of artificial radionuclides suggested that there had been no material changes in the overall environmental radiation levels in Hong Kong as a result of the operation of the nuclear power plants. On this basis, for radiation measurement without BRMP reference values (i.e. measurement started after the second phase of ERMP), the range of values in the first five years of measurement were adopted as the reference range in this report. This reference range, being closest to the BRMP period in time, can effectively be taken as the approximate baseline level of that radiation measurement in the absence of visible influences from other variables.

2.5 Quality assurance

Since 1989, the Observatory has been participating in inter-laboratory comparison exercises and proficiency tests organized by major international and national organizations (Hui *et al.*, 2007), namely the International Atomic Energy Agency (IAEA), the National Physical Laboratory of the United Kingdom (NPL), the World Health Organization (WHO) and the China Institution for Radiation Protection

(CIRP).

Other than inter-laboratory comparison exercises and proficiency tests, the quality of the environmental radiation monitoring results in Hong Kong is also assured through internal quality assurance procedures. To enhance the management efficiency and quality of its radiation measurement work, the Hong Kong Observatory Radiation Laboratory adheres to a high standard of radiation measurement services based on the International Organisation for Standardization ISO 9001:2008. Accreditation for the ISO 9001:2008 was obtained in early 2009.

The certification body will conduct annual surveillance audit of the Radiation Laboratory to ascertain that its radiation measurement services meet the requirements for the continuation of ISO 9001:2008 certification. The quality radiation measurement services provided by the Radiation Laboratory were reaffirmed after successfully passing the second Annual Surveillance Audit in January 2011.

3. RESULTS AND CONCLUSION

3.1 Results

3.1.1 Radiation Monitoring Network

The annual average ambient gamma dose rates and ranges of 1-minute averages recorded by the RMN in 2011 are tabulated in Table 4. The measurement results were all within baseline radiation levels.

Since the operation of the RMN, temporal changes in the radiation level recorded at the stations are typically a few per cent in seasonal variations. During rainy condition or episodes of tropical cyclone affecting Hong Kong, the variations can be significantly larger and may even double the usual level.

The most significant change in the ambient gamma dose rate in 2011 was recorded on 19 September. Under the influence of thundery showers associated with a cold front, the 1-minute average dose rate at Ping Chau rose to about 84% above the mean value of the year, but still within the baseline levels.

3.1.2 Thermoluminescent Dosimeter Network

The annual average, standard deviation and range of gamma dose rates measured at each of the TLD stations in 2011 are listed in Table 4. The gamma dose rates recorded at all stations were found to be within the BRMP range.

3.1.3 Aerial Radiation Monitoring System

In February 2011, a background measurement in the ground contamination measurement mode was conducted by ARMS over Ping Chau. The measurement height followed terrain, maintained at a height of about 100 metres above the ground. No artificial radionuclides were detected and measurement results obtained were similar to those in the past. Figure 3 shows the radioactivity level of potassium-40 over the area on the day of measurement.

In August, measurement flights in the plume tracking mode were carried out over Mirs Bay and Sai Kung areas. The helicopter rose from about 100 metres up to about 1000 metres above sea level to measure the change of radiation levels against altitude over the sea surface and land surface. No artificial radionuclides were detected. Figure 4 and 5 depict the vertical radiation level profiles over Mirs Bay and Sai Kung area respectively. Similar to past observations, the count rates arising from gamma rays over the sea areas reflected basically the background radiation levels and showed no significant changes with height. On the other hand, the count rates measured near land surface was significantly higher than those measured over the sea surface, as rocks and soil contained more radioactive substances than sea water. The count rates over land decreased rapidly with height before reaching a level close those measured over the sea.

3.1.4 Automatic Gamma Spectrometry System

Results obtained by the AGSS in 2011 are given in Table 5. No artificial radionuclides were detected in the year and all results were within baseline radiation levels.

3.1.5 Mobile Radiation Monitoring System

Four measurements of cosmic radiation were carried out at Plover Cove in 2011. The average gamma dose rates ranged from 0.032 to 0.035 μGy h^{-1} (Table 6), close to those measured in previous years.

3.1.6 Upper-air Radioactivity Soundings

Three radioactivity soundings were made in 2011. The weather conditions during these soundings were: cloudy with light westerly winds at the surface on 17 February; cloudy with moderate northerly winds at the surface on 22 September; fine with moderate northerly winds at the surface on 8 December. Figure 6 shows the average vertical profiles of atmospheric radioactivity from the three upper-air radioactivity soundings in 2011. The data analysis results obtained were similar to those in the past (Li *et al.* 2007).

3.1.7 Food and Environmental Samples

A total of 392 routine food and environmental samples were collected in 2011. The results of gamma spectrometry analyses, tritium measurements, strontium-90 measurements and plutonium-239 measurements are shown in Tables 7, 8, 9 and 10 respectively. Gamma spectrometry analysis results of environmental samples collected during the enhanced sampling period in response to the nuclear incident in Fukushima, Japan are shown in Table A1 and A2.

All radioactivity data are decay-corrected to the date of sampling. Where sampling is done over an extended period (for instance a week or a month), decay correction is made with reference to the mid-point of the sampling period.

Only results pertaining to artificial radionuclides are included in all tables. For ease of reference, a summary of measurement results in 2011 for the major sample types according to different pathways is given in Table 11.

(a) Gamma Spectrometry Analyses

Owing to radioactive substances released from the nuclear power plant incident in Fukushima, Japan, the Observatory detected minute amount of gamma-emitting radionuclides iodine-131, caesium-134 and caesium-137 in some airborne particulate samples and iodine-131 in some gaseous iodine samples from late March to late April 2011.

As the radioiodine sampler is more effective in extracting iodine in the air than high volume air samplers, the activity levels of iodine-131 detected in gaseous iodine samples are higher than those detected in airborne particulate samples.

Despite the very high instrument sensitivity in gamma spectrometry analysis, caesium-134 could only be detected in the bulked monthly airborne particulate samples and not in the weekly samples due to the extremely low activity levels.

The activities of radioactive iodine and caesium detected in the routine weekly and bulked monthly airborne particulate samples in late March to late April 2011 agreed well with those detected in the non-routine enhanced daily samples collected in the same period (see Table 7 and A1). Since the activities of radioactive iodine and caesium were extremely low, they had no impact on public health (see Note ** in Table A1).

Minute amounts of iodine-131 were also detected in the weekly sample of gaseous iodine collected at King's Park (sampling period: 16 – 23 August 2011).

While the source of iodine-131 in this sample could not be ascertained, it was deduced that it could have originated from a local source and not from nuclear power incidents as no iodine-131 was detected in other air samples of the same sampling period, including airborne particulate samples at King's Park, Yuen Ng Fan and Sha Tau Kok. Since iodine-131 is also used for treatment of thyroid diseases, it is possible that the presence of iodine-131 in the gaseous iodine sample may be associated with a medical source. The activity of iodine-131 in the gaseous iodine sample was very low and had no impact on public health. No artificial radionuclides were detected in gaseous iodine samples collected after 23 August 2011. The detection of such a small amount of iodine-131 in the gaseous iodine sample demonstrated the high sensitivity of the measuring instrument.

Traces of caesium-137, an artificial gamma-emitting radionuclide, were detected in some food, soil and sediment samples in 2011. The measured activities in these samples were all within the corresponding ranges of BRMP values. The samples included seafood, land soil, intertidal sediment and seabed sediment. Caesium-137 was detected in such sample types in both BRMP and ERMP (Wong *et al.* 2003). The presence of the radionuclide in environmental and food samples could generally be attributed to the remnants of fallout from atmospheric nuclear tests conducted from 1945 till 1980 (UNSCEAR 2000).

(b) Tritium

Very small amounts of tritium were detected in some atmospheric, water and food samples in 2011. The measured activities in these samples were all within the baseline radiation levels. The samples include water vapour in air, wet deposition, total deposition, underground water, sea water, drinking water, bottled water, fruits, rice, milk, vegetables, poultry, meat, seafood and seaweed. The source of tritium in the samples were attributable primarily to the natural cosmogenic processes with small contribution from the remnants of fallout from atmospheric nuclear tests (UNSCEAR 2000).

(c) Strontium-90

Traces of strontium-90 were detected in some atmospheric, food and soil samples in 2011. The activities in these samples were within the baseline radiation levels. The samples included airborne particulates, wet deposition, total deposition, land soil, rice, milk, vegetables, fruits, poultry, meat, seafood and seaweed. The presence of strontium-90 in such sample type in BRMP and ERMP could also be attributed primarily to atmospheric nuclear tests in the past (UNSCEAR 2000).

(d) Plutonium-239

Minute amounts of plutonium-239 were detected in some intertidal sediment and seabed sediment samples in 2011. The activities in these samples were all within the baseline radiation levels. Fallout from past atmospheric nuclear tests could again be the major source of plutonium-239 (UNSCEAR 2000).

3.2 Conclusion

To summarize, although radioactive iodine and caesium were detected in some air samples in Hong Kong from late March to late April 2011 in the aftermath of the nuclear power plant incident in Fukushima, the activity of the radionuclides was very low and the ambient radiation levels of the territory on the whole were not affected. The ambient gamma dose rates recorded over various parts of the territory were within the baseline radiation levels. The activity of radioactive caesium detected in the soil samples in Hong Kong showed no increase either after the Fukushima nuclear incident.

As in the past years, traces of artificial radionuclides, namely caesium-137, tritium, strontium-90 and plutonium-239, were detected in other environmental and food samples in 2011. The levels of all these radionuclides were not significantly different from those recorded before the Guangdong Nuclear Power Station and Lingao Nuclear Power Station came into operation.

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Appendix

Content and Measurement Results of the Enhanced Radiation Monitoring by the Observatory in response to the Fukushima nuclear incident in Japan

1. Air

Following the Fukushima nuclear incident in Japan, the Observatory strengthened the monitoring of radioactivity in the air. In addition to the collection of routine weekly airborne particulate samples at King's Park and Yuen Ng Fan, additional daily samples were collected at the two locations starting 15 March 2011. Measurements of the activity of gamma-emitting radionuclides were performed on the daily airborne particulate samples. The enhanced sample collection and measurements of Yuen Ng Fan and King's Park airborne particulate samples lasted till 11 May and 25 May 2011 respectively.

As the sampling period of the airborne particulate was reduced from seven days to one day, to ensure that the instrument would be capable of detecting the low-activity radionulcides in the daily sample, the counting time for airborne particulate measurement was extended from the usual counting time of a few hours for routine weekly samples to 22 hours for daily samples to meet the reliability requirement.

Measurement results of the activity of gamma-emitting radionuclides in the daily airborne particulate samples indicated that minute amounts of iodine-131 and caesium-137 were detected. Details can be found in Table A1.

2. Rain

To enhance radiation monitoring of rain, the Observatory collected additional daily samples of total deposition at King's Park using a carboy fitted with a top funnel from 15 March to 25 May 2011. When rain is registered at King's Park on the sampling day, gamma activity measurement would be carried out for the total deposition sample collected on that day. Measurement results indicated that no artificial radionuclides were detected in the King's Park total deposition samples measured.

3. Sea water

Apart from the annual sampling and radiation measurement of sea water near Waglan Island, Basalt Island, Tai Long Wan and Port Island, the Observatory also enhanced radiation monitoring of sea water in response to the development of the nuclear power plant incident in Fukushima, Japan. With assistance from the Environmental Protection Department, additional sea water samples were collected at the aforementioned locations on 24 March, 27 April and 27 May 2011. Results of gamma activity measurements indicated that no artificial radionuclides were detected in all the sea water samples.

4. Soil

In response to the development of the nuclear incident in Fukushima, Japan, the Observatory enhanced radiation monitoring of soil. Soil samples (including upper and lower layers) were collected at various locations in Hong Kong (Table 1 and Figure 2) from 6 to 12 May 2011 and gamma activity measurements were carried out. Measurement results (Table A2) indicated that caesium-137 was detected in some samples but the activities were within BRMP range.

5. Aerial Radiation Monitoring

Following the nuclear power plant incident in Fukushima, Japan, the Observatory conducted an additional ARMS measurement flight in the plume tracking mode over Mirs Bay on 21 March 2011. Measurement results indicated that no artificial radionuclides were detected. The vertical radiation level profiles of the measurement in Figure A1 showed that the radiation levels were normal.

6. Mobile Radiological Survey

MRMS carried out a radiological survey on 11 April 2011 in Shatin. The survey results indicated that the ambient radiation level was normal.

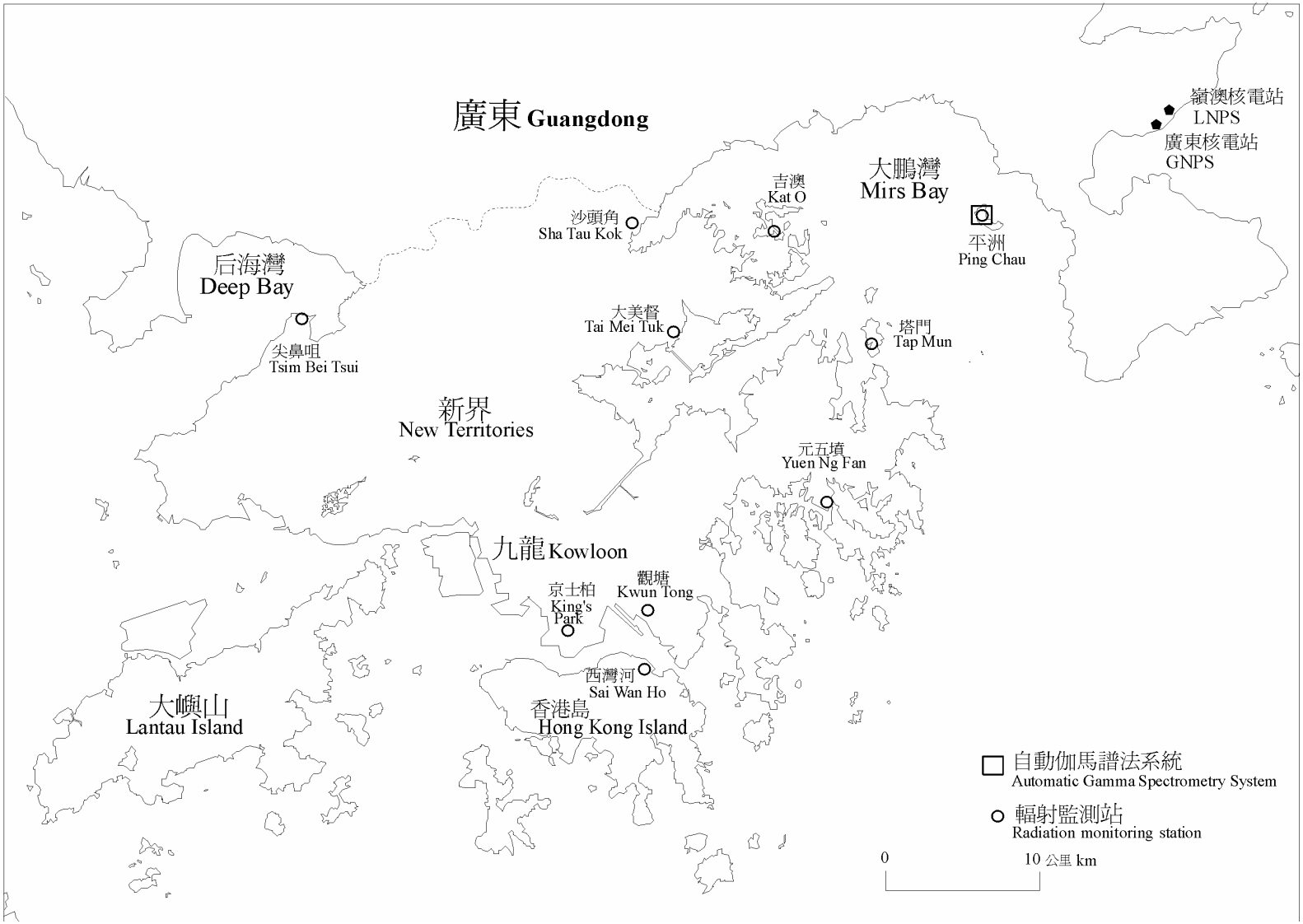


圖1. 二零一一年實時監測環境輻射的測量點。

Figure 1. Locations for real-time measurement of ambient radiation in 2011.

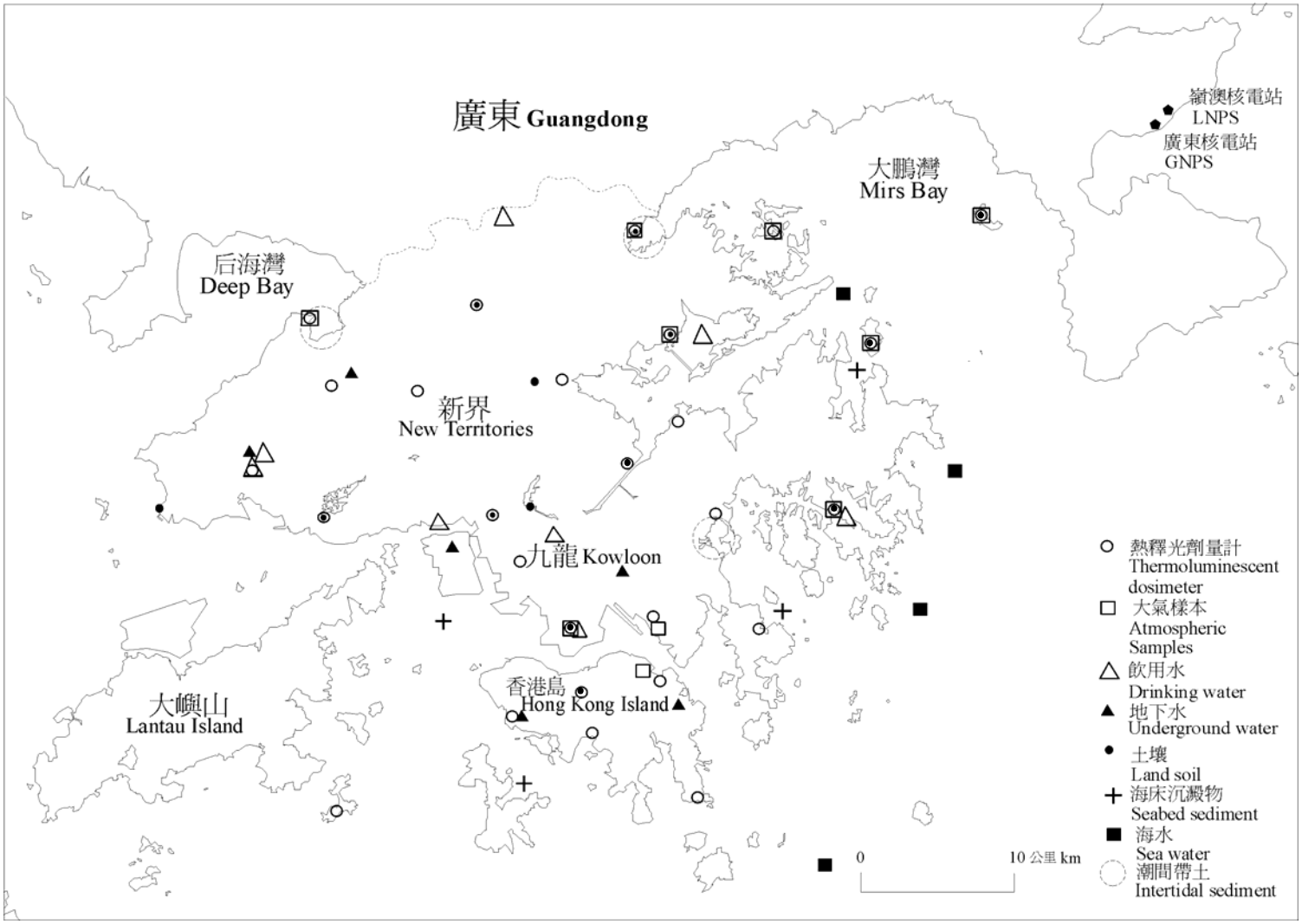


圖2. 熱釋光劑量計網絡及二零一一年環境樣本收集點。

Figure 2. Thermoluminescent dosimeter network and locations for collection of environmental samples in 2011.

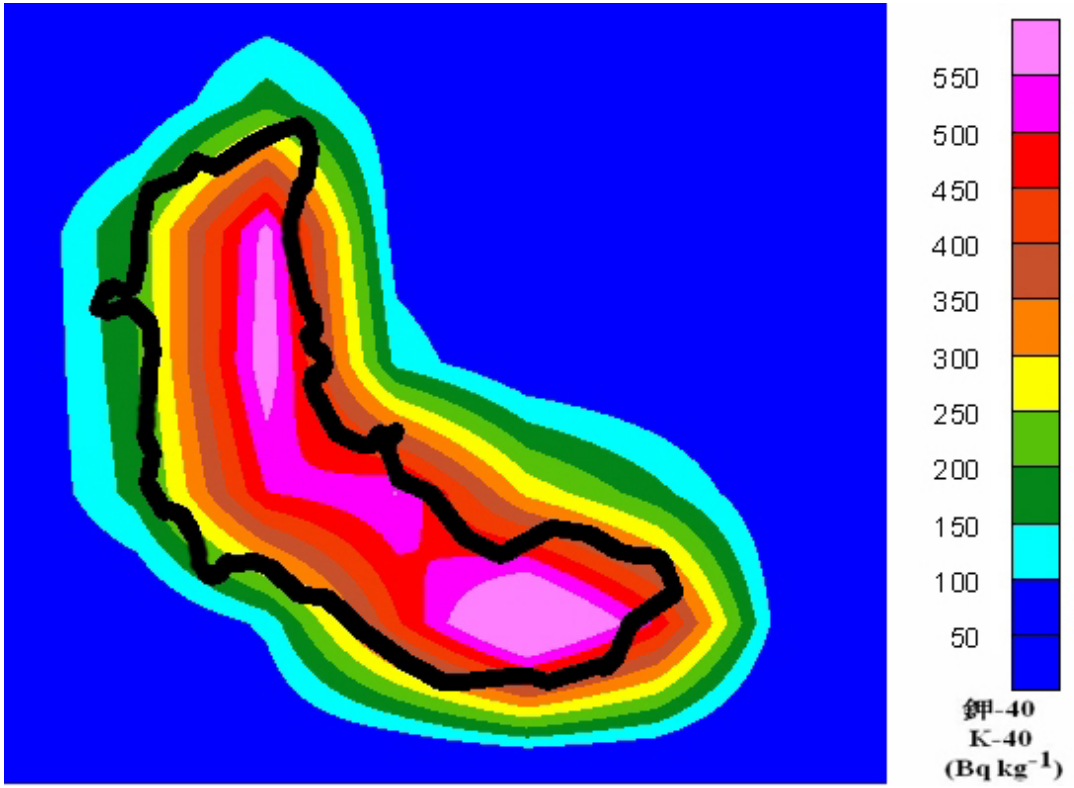


圖 3. 空中輻射監測系統在平洲上空測量到的鉀-40 放射性水平 (測量高度距離地面約一百米) (二零一一年二月十日)。

Figure 3. Radioactivity level of Potassium-40 over Ping Chau, as measured by the Aerial Radiation Monitoring System at about 100 metres above the ground on 10 February 2011.

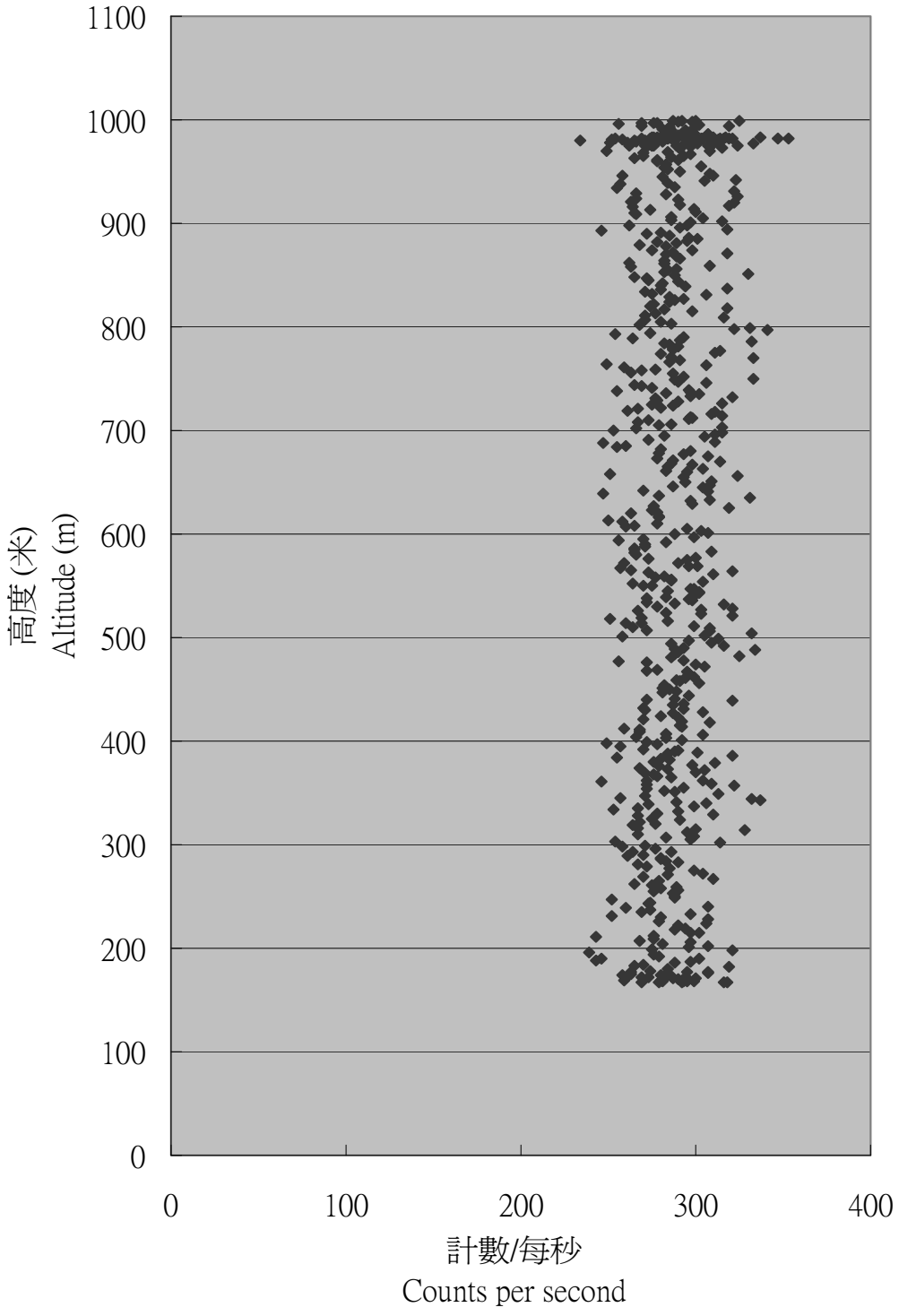


圖4. 空中輻射監測系統在大鵬灣海面上空測量到的計數率隨高度的變化 (二零一一年八月十一日)。

Figure 4. Variation of count rate with altitude at Mirs Bay, as measured by the Aerial Radiation Monitoring System on 11 August 2011.

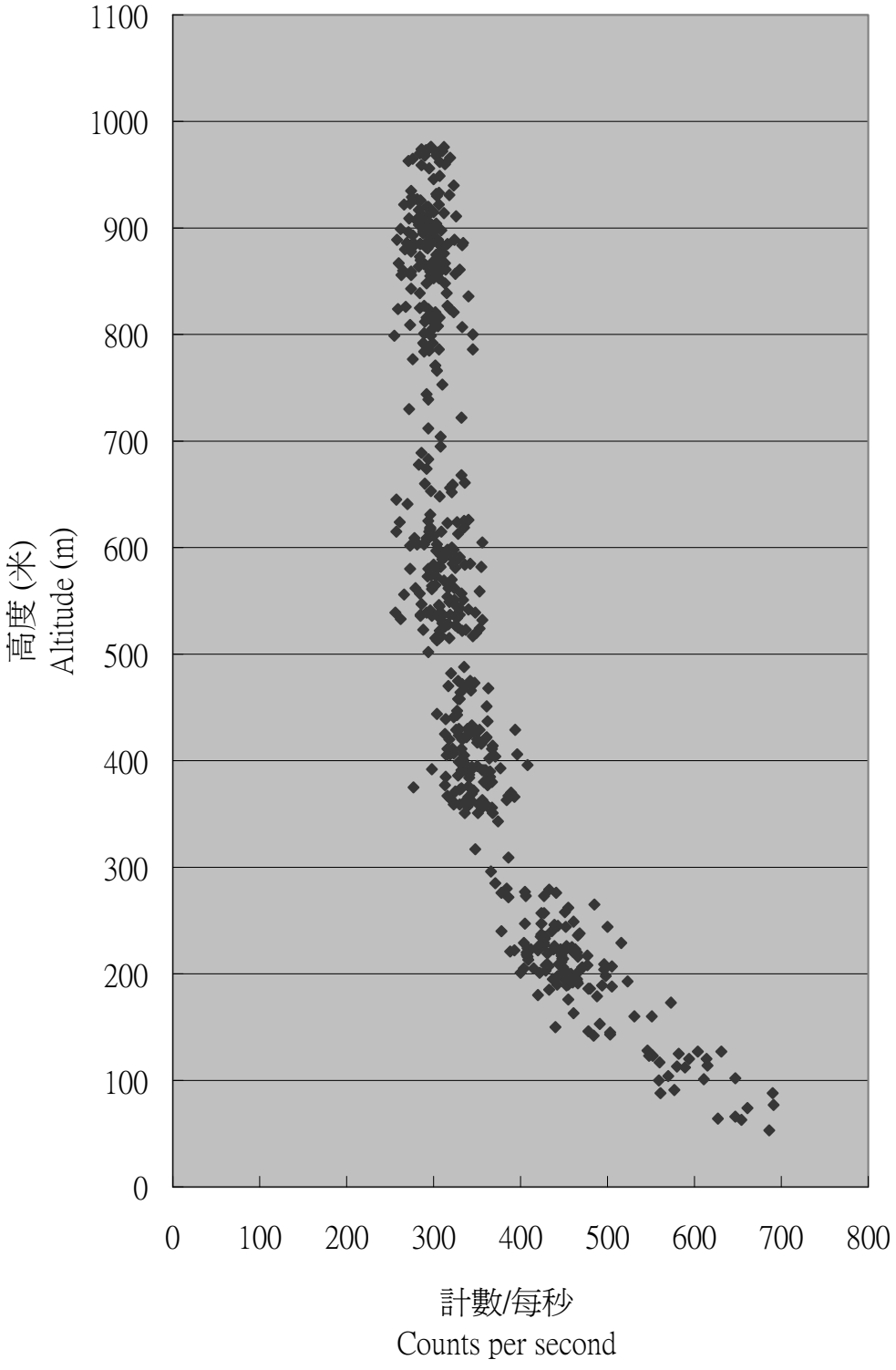


圖5. 空中輻射監測系統在西貢地區上空測量到的計數率隨高度的變化 (二零一一年八月十一日)。

Figure 5. Variation of count rate with altitude at Sai Kung area, as measured by the Aerial Radiation Monitoring System on 11 August 2011.

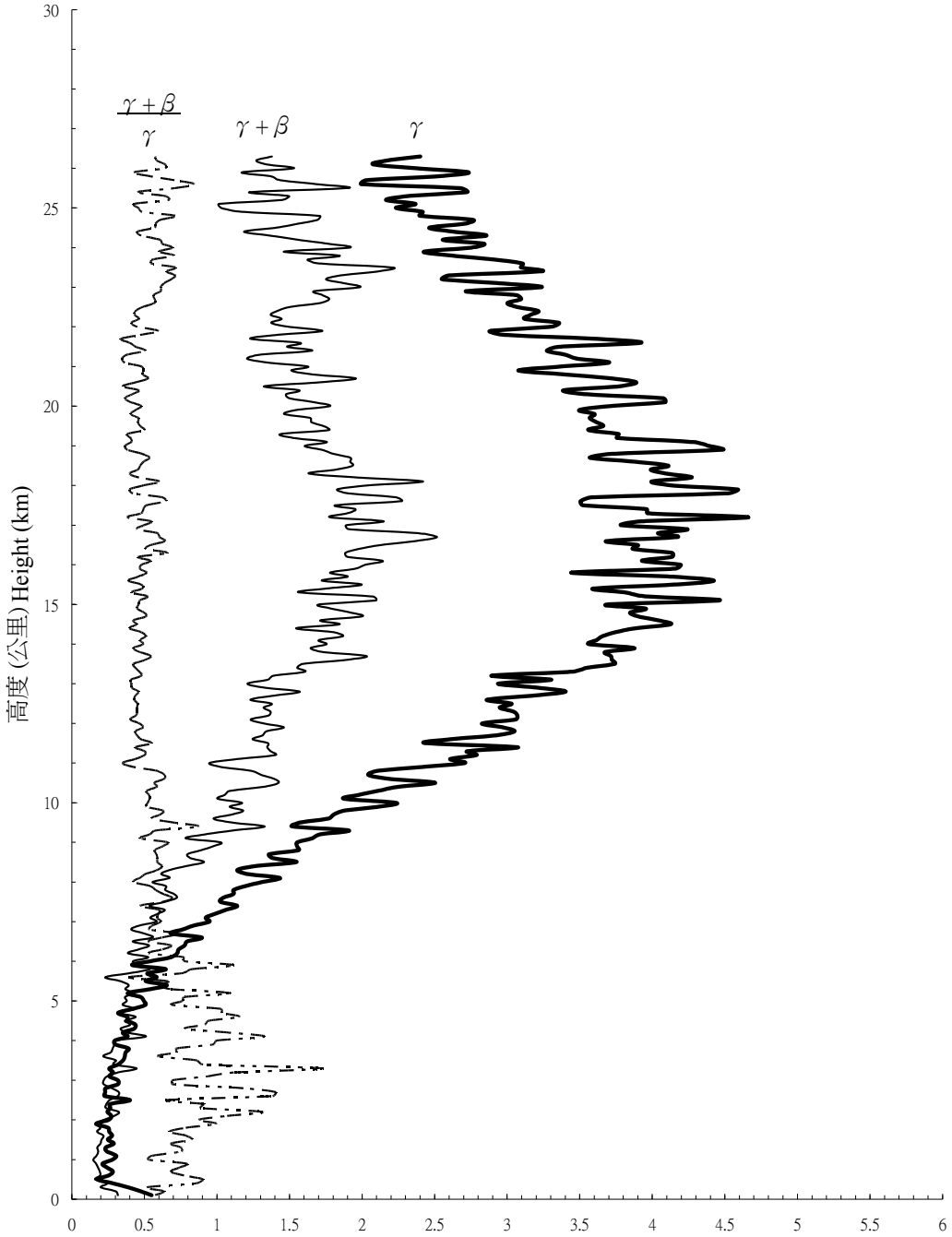
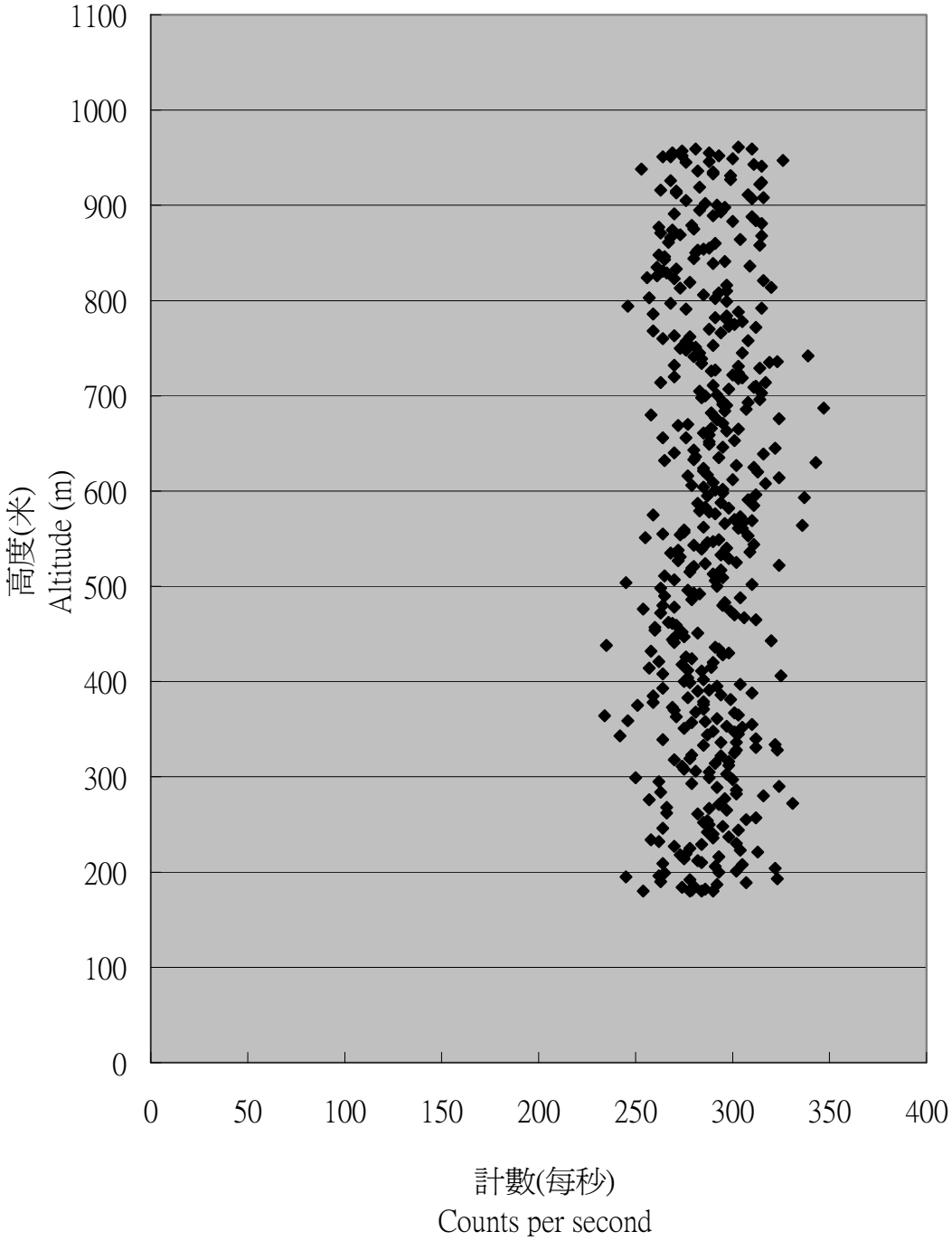


圖6. 二零一一年內在京士柏進行的三次高空輻射探測之平均大氣放射性垂直廓線 (探測日期爲：二月十七日、九月二十二日及十二月八日)。

Figure 6. Average vertical profiles of atmospheric radioactivity from three upper-air radioactivity soundings conducted at King's Park in 2011 (dates of sounding: 17 February, 22 September and 8 December).



圖A1. 空中輻射監測系統在大鵬灣海面上空測量到的計數率隨高度的變化(二零一一年三月二十一日)。

Figure A1. Variation of count rate with altitude at Mirs Bay, as measured by the Aerial Radiation Monitoring System on 21 March 2011.

表 1.　二零一一年樣本取樣及分析概要

Table 1.　Summary of the sampling and analysis programme in 2011

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
環境伽馬輻射 Ambient Gamma Radiation				
伽馬劑量率 Gamma dose rates	平洲 Ping Chau, 塔門 Tap Mun, 吉澳 Kat O, 沙頭角 Sha Tau Kok, 元五墳 Yuen Ng Fan, 大美督 Tai Mei Tuk, 尖鼻咀 Tsim Bei Tsui, 觀塘 Kwun Tong, 西灣河 Sai Wan Ho, 京士柏 King's Park	10	伽馬 γ	一分鐘 1-minute interval
累積伽馬劑量 Cumulative gamma doses	平洲 Ping Chau, 塔門 Tap Mun, 吉澳 Kat O, 元五墳 Yuen Ng Fan, 清水灣 Clear Water Bay, 西貢 Sai Kung, 大美督 Tai Mei Tuk, 烏溪沙 Wu Kai Sha, 鶴咀 Cape D'Aguilar, 沙頭角 Sha Tau Kok, 沙田 Shatin, 觀塘 Kwun Tong, 筲箕灣 Shau Kei Wan, 大埔 Tai Po, 京士柏 King's Park, 跑馬地 Happy Valley, 深水灣 Deep Water Bay, 石梨貝 Shek Lei Pui, 置富花園 Chi Fu Fa Yuen, 粉嶺 Fanling, 荃灣 Tsuen Wan, 石崗 Shek Kong, 長洲 Cheung Chau, 元朗 Yuen Long, 大欖涌 Tai Lam Chung, 尖鼻咀 Tsim Bei Tsui, 屯門 Tuen Mun	27	伽馬 γ	每季 quarterly

表 1. (續)

Table 1. (cont'd)

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
大氣樣本 Atmospheric Samples				
大氣飄塵 Airborne particulate	京士柏 King's Park, 沙頭角 Sha Tau Kok, 元五墳 Yuen Ng Fan	3	伽馬 γ, 鍶-90 Sr-90, 鈈-239 Pu-239	## 每週(累積一月) weekly (bulked monthly) *(每週樣本只進行伽馬分析 Weekly sample for γ analysis only)*
濕沉積物(降雨) Wet deposition (precipitation)	京士柏 King's Park, 沙頭角 Sha Tau Kok, 元五墳 Yuen Ng Fan	3	伽馬γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每週 (累積一月作分析) weekly (bulked monthly for analysis)
總沉積物 Total deposition	京士柏 King's Park	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	## 每週 (累積一月作分析) weekly (bulked monthly for analysis)
氣態碘 Gaseous iodine	京士柏 King's Park	1	伽馬 γ	每週 weekly
大氣水蒸氣 Water vapour in air	京士柏 King's Park	1	氚 H-3	每月 monthly
地面樣本 Terrestrial Samples				
食米 Rice	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
牛奶(經消毒) Pasteurized milk	深圳 Shenzhen, 沙頭角 Sha Tau Kok	2	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
菜心 Choi sum	內地 Mainland, 本地 Local	2	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
白菜 Pak choi	內地 Mainland, 本地 Local	2	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
香蕉 Banana	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
荔枝 Lychee	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	夏季 summer
柑橘 Mandarin orange	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	秋季及冬季 autumn and winter
甘蔗 Sugar cane	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	春季 spring
雞 Chicken	內地 Mainland, 本地 Local	2	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
鴨 Duck	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
牛肉 Beef	內地 Mainland	1	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
豬肝 Pig's liver	內地 Mainland, 本地 Local	2	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly
豬肉 Pork	內地 Mainland, 本地 Local	2	伽馬γ, 氚 H-3, 鍶-90 Sr-90	每季 quarterly

註: ## 日本福島核事故後加強取樣及伽馬分析，詳情見附錄。

Note: ## In response to Japan's Fukushima nuclear incident, sampling frequency and γ analysis were enhanced (see Appendix for details).

表 1. (續)

Table 1. (cont'd)

樣本類別 **Sample type**	取樣地點 **Sampling location**	地點數目 **Number of location**	分析類別 **Type of analysis**	取樣頻率 **Sampling frequency**
土壤 (上層及下層) Land soil (upper and lower level)	京士柏 King's Park#, 沙田 Shatin#, 西貢 Sai Kung, 清水灣 Clear Water Bay, 萬宜水庫西 High Island West#, 萬宜水庫東 High Island East, 北潭凹 Pak Tam Au, 白沙澳 Pak Sha O, 大埔 Tai Po*, 粉嶺 Fanling*, 沙頭角 Sha Tau Kok*, 大美督 Tai Mei Tuk*, 城門水塘 Shing Mun Reservoir*, 荃灣 Tsuen Wan*, 大欖涌水塘 Tai Lam Chung Reservoir*, 青山發電廠 Castle Peak Power Station*, 元朗 Yuen Long, 尖鼻咀 Tsim Bei Tsui, 石崗 Shek Kong, 嘉道理農場 Kadoorie Farm and Botanic Garden, 長洲 Cheung Chau, 南丫島 Lamma Island, 坪洲 Peng Chau, 銀礦灣 Silvermine Bay 東涌 Tung Chung, 石壁水塘 Shek Pik Reservoir, 大澳 Tai O, 白泥 Pak Nai, 塔門 Tap Mun#, 吉澳 Kat O, 平洲 Ping Chau#, 跑馬地 Happy Valley#, 薄扶林水塘 Pokfulam Reservoir, 香港仔下水塘 Lower Aberdeen Reservoir, 深水灣 Deep Water Bay, 大潭水塘 Tai Tam Reservoir, 鶴咀 Cape D'Aguilar, 牛頭角配水庫 Ngau Tau Kok Service Reservoir, 石梨貝水塘 Shek Lei Pui Reservoir	39	伽馬 γ, 鍶-90 Sr-90, 鈈-239 Pu-239	每一地點每 5 年採樣一次 Each location is sampled once every 5 years. * 2011 年常規採樣地點 * locations routinely sampled in 2011 # 日本福島核事故後加強輻射監測之採樣地點，取樣頻率見附錄（樣本只進行伽馬分析） # locations sampled for enhanced radiation monitoring in response to Japan's Fukushima nuclear incident, see Appendix for sampling frequency (samples for γ analysis only)

表 1. (續)

Table 1. (cont'd)

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
水體樣本 Aquatic Samples				
飲用水(經處理) Drinking water (treated)	九龍配水管 Kowloon distribution tap, 屯門配水管 Tuen Mun distribution tap, 沙田濾水廠 Shatin Treatment Works, 屯門濾水廠 Tuen Mun Treatment Works, 油柑頭濾水廠 Yau Kom Tau Treatment Works	5	伽馬 γ, 氚 H-3	每季 quarterly
飲用水(未經處理) Drinking water (untreated)	萬宜水庫 High Island Reservoir, 船灣淡水湖 Plover Cove Reservoir, 木湖 B 抽水站 Muk Wu B Pumping Station, 沙田濾水廠 Shatin Treatment Works, 屯門濾水廠 Tuen Mun Treatment Works, 油柑頭濾水廠 Yau Kom Tau Treatment Works	6	伽馬 γ, 氚 H-3	每季 quarterly
樽裝水(蒸餾水) Bottled water (Distilled)	本地 Local	1	伽馬 γ, 氚 H-3	每季 quarterly
樽裝水(礦泉水) Bottled water (Mineral)	本地 Local	1	伽馬 γ, 氚 H-3	每季 quarterly
地下水 Underground water	長康邨 Cheung Hong Estate, 鈞樂新村 Kwan Lok San Tsuen, 環翠邨 Wan Tsui Estate, 華富邨 Wah Fu Estate, 富山邨 Fu Shan Estate, 清涼法苑 Ching Leung Nunnery	6	伽馬 γ, 氚 H-3	每年 yearly
海水(上層、中層及低層) Sea water (upper, middle and lower level)	橫瀾島 Waglan Island, 火石洲 Basalt Island, 大浪灣 Tai Long Wan, 赤洲 Port Island	4	伽馬 γ, 氚 H-3	每年 yearly 日本福島核事故後加強取樣及伽馬分析(詳情見附錄)。 In response to Japan's Fukushima nuclear incident, sampling frequency and analysis are enhanced (see Appendix for details).
海水中懸浮粒子 (上層、中層及低層) Suspended particulate in sea water (upper, middle and lower level)	橫瀾島 Waglan Island, 火石洲 Basalt Island, 大浪灣 Tai Long Wan, 赤洲 Port Island	4	伽馬 γ, 鍶-90 Sr-90, 鈈-239 Pu-239	每年 yearly

表1. (續)

Table 1. (cont'd)

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
水體樣本 Aquatic Samples				
大魚 *Aristichthys nobilis* (Big-head carp)	深圳 Shenzhen, 元朗 Yuen Long	2	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
瓜三 *Nemipterus japonicus* (Melon coat)	大亞灣 Daya Bay, 香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	3	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
牛鮸 *Platycephalus indicus* (Bartail flathead)	大亞灣 Daya Bay, 香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	3	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
牙帶 *Trichiurus haumela* (Hair tail)	大亞灣 Daya Bay, 香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	3	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
三點蟹 *Portunus sanguinolentus* (Three-spotted crab)	香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	2	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
赤米蝦 *Metapenaeopsis barbata* (Fire prawn)	香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	2	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
魷魚 *Loligo edulis* (Squid)	大亞灣 Daya Bay, 香港以西海域 Seas west of Hong Kong, 香港水域 Hong Kong Waters	3	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
墨魚 *Sepia spp.* (Cuttlefish)	香港水域 Hong Kong Waters	1	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
蜆 *Tapes philippinarum* (Clam)	長洲 Cheung Chau, 吐露港 Tolo Harbour	2	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
青口 *Perna viridis* (Green-lipped mussel)	長洲 Cheung Chau, 吐露港 Tolo Harbour, 大亞灣 Daya Bay	3	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
東風螺 *Babylonia formosae* (Gastropod)	香港水域 Hong Kong Waters	1	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	每季 quarterly
石蒓 *Ulva lactuca* (Sea lettuce)	布袋澳 Po Toi O	1	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	冬季及春季 winter and spring

表1. (續)

Table 1. (cont'd)

樣本類別 Sample type	取樣地點 Sampling location	地點數目 Number of location	分析類別 Type of analysis	取樣頻率 Sampling frequency
水體樣本 Aquatic Samples				
滸苔 *Enteromorpha prolifera* (Sea hair)	吐露港 Tolo Harbour	1	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	冬季 winter
長紫菜 *Porphyra dentata* (Red algae)	蒲台島 Po Toi Island	1	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	冬季 winter
半葉馬尾藻 *Sargassum hemiphyllum* (Brown algae)	布袋澳 Po Toi O	1	伽馬 γ, 氚 H-3, 鍶-90 Sr-90, 鈈-239 Pu-239	冬季及春季 winter and spring
潮間帶土(上層及下層) Intertidal sediment (upper and lower level)	白沙灣 Pak Sha Wan, 尖鼻咀 Tsim Bei Tsui, 沙頭角 Sha Tau Kok	3	伽馬 γ, 鈈-239 Pu-239	每季 quarterly
海床沉澱物 Seabed sediment	大灘海 Tai Tan Hoi, 龍蝦灣 Lung Ha Wan, 索罟灣 Picnic Bay, 西區碇泊處 Western Anchorage	4	伽馬 γ, 鈈-239 Pu-239	每年 yearly

表2. 二零一一年食物樣本概要

Table 2. Summary of food samples in 2011

類別 Type	**地點 Location**	**收集樣本總數 Total no. of sample collected**
食米 Rice	內地(珠江三角洲) Mainland (Pearl River Delta)	4
牛奶(經消毒) Pasteurized milk	深圳 Shenzhen	4
	沙頭角 Sha Tau Kok	4
菜心 Choi sum	內地(深圳) Mainland (Shenzhen)	4
	本地 Local	4
白菜 Pak choi	內地(深圳) Mainland (Shenzhen)	4
	本地 Local	4
香蕉 Banana	內地(廣東) Mainland (Guangdong)	4
荔枝 Lychee	內地 Mainland	1
柑橘 Mandarin orange	內地(廣東) Mainland (Guangdong)	2
甘蔗 Sugar cane	內地(廣東) Mainland (Guangdong)	1
雞 Chicken	內地(深圳) Mainland (Shenzhen)	4
	本地 Local	4
鴨 Duck	內地(深圳) Mainland (Shenzhen)	4
牛肉 Beef	內地 Mainland	4
豬肝 Pig's Liver	內地(廣東) Mainland (Guangdong)	4
	本地 Local	4
豬肉 Pork	內地(廣東) Mainland (Guangdong)	4
	本地 Local	4
大魚 *Aristichthys nobilis* (Big-head carp)	深圳 Shenzhen	3
	元朗 Yuen Long	3
瓜三 *Nemipterus japonicus* (Melon coat)	大亞灣 Daya Bay	1
	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
牛鰍 *Platycephalus indicus* (Bartail flathead)	大亞灣 Daya Bay	1
	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
牙帶 *Trichiurus haumela* (Hair tail)	大亞灣 Daya Bay	1
	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
三點蟹 *Portunus sanguinolentus* (Three-spotted crab)	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3

表2. (續)

Table 2. (cont'd)

類別 Type	地點 Location	收集樣本總數 Total no. of sample collected
赤米蝦 *Metapenaeopsis barbata* (Fire prawn)	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
魷魚 *Loligo edulis* (Squid)	大亞灣 Daya Bay	1
	香港以西海域 Seas west of Hong Kong	1
	香港水域 Hong Kong Waters	3
墨魚 *Sepia spp.* (Cuttlefish)	香港水域 Hong Kong Waters	3
蜆 *Tapes philippinarum* (Clam)	長洲 Cheung Chau	1
	吐露港 Tolo Harbour	3
青口 *Perna viridis* (Green-lipped mussel)	長洲 Cheung Chau	2
	吐露港 Tolo Harbour	3
	大亞灣 Daya Bay	1
東風螺 *Babylonia formosae* (Gastropod)	香港水域 Hong Kong Waters	3
石蒓 *Ulva lactuca* (Sea lettuce)	布袋澳 Po Toi O	2
滸苔 *Enteromorpha prolifera* (Sea hair)	吐露港 Tolo Harbour	1
長紫菜 *Porphyra dentata* (Red algae)	蒲台島 Po Toi Island	0
半葉馬尾藻 *Sargassum hemiphyllum* (Brown algae)	布袋澳 Po Toi O	2

表 3. 二零一一年樣本之主要量度參數概要 *

Table 3. Summary of key measurement parameters for samples in 2011 *

測量類別 Measurement type		樣本大小 Sample size	計數時間(秒) Counting time (second)	本底 Background (CPM)	計數效率 Counting efficiency (%)	化學復得率 Chemical recovery (%)	探測下限 # Minimum Detection Activity # (MDA)		
							碘-131 I-131	銫-137 Cs-137	銫-134 Cs-134
伽馬放射性核素 Gamma emitting radionuclides	大氣飄塵 Airborne particulate	12000 m^3 (累積每月樣本 bulked monthly sample)	55000	-	-	-	10 μBq m^{-3}	10 μBq m^{-3}	10 μBq m^{-3}
		3000 m^3 (每週樣本 weekly sample)	20000				50 μBq m^{-3}	50 μBq m^{-3}	100 μBq m^{-3}
		480 m^3 (每日樣本 daily sample)	79200				100-200 μBq m^{-3}	100-200 μBq m^{-3}	150-200 μBq m^{-3}
							碘-131 I-131	銫-137 Cs-137	
	氣態碘 Gaseous Iodine	400 m^3	55000	-	-	-	300 μBq m^{-3}	-	
	濕沉積物 Wet deposition	4 L	55000	-	-	-	0.2 Bq L^{-1}	0.2 Bq L^{-1}	
	總沉積物 Total deposition	0.03 m^2	55000	-	-	-	15 Bq m^{-2}	15 Bq m^{-2}	
		0.09 m^2 (每日樣本 daily sample)	55000	-	-	-	5 Bq m^{-2}	5 Bq m^{-2}	
	食米 Rice	4 kg	20000	-	-	-	0.2 Bq kg^{-1}	0.2 Bq kg^{-1}	
	牛奶 Milk	1 L	55000	-	-	-	0.2 Bq L^{-1}	0.3 Bq L^{-1}	
	蔬菜 Vegetable	1 kg	20000	-	-	-	0.3 Bq kg^{-1}	0.4 Bq kg^{-1}	
	水果 Fruit	2 kg	20000	-	-	-	0.3 Bq kg^{-1}	0.3 Bq kg^{-1}	
	家禽 Poultry	2 kg	20000	-	-	-	0.2 Bq kg^{-1}	0.2 Bq kg^{-1}	
	肉類 Meat	1 kg	20000	-	-	-	0.4 Bq kg^{-1}	0.4 Bq kg^{-1}	
	土壤 Land soil	1 kg	20000	-	-	-	1.0 Bq kg^{-1}	1.5 Bq kg^{-1}	
	水樣本 Water samples	4 L	55000	-	-	-	0.1 Bq L^{-1}	0.1 Bq L^{-1}	
	海水中懸浮粒子 Suspended particulate	5 L	55000	-	-	-	0.02 Bq L^{-1}	0.02 Bq L^{-1}	
	海產 Seafood	2 kg	72000	-	-	-	0.1 Bq kg^{-1}	0.1 Bq kg^{-1}	
	海藻 Seaweed	0.5 kg	20000	-	-	-	1 Bq kg^{-1}	2 Bq kg^{-1}	
	潮間帶土/海床沉澱物 Sediment	2 kg	20000	-	-	-	0.5 Bq kg^{-1}	0.5 Bq kg^{-1}	

表 3. (續)

Table 3. (cont'd)

測量類別 Measurement type		樣本大小 Sample size	計數時間(秒) Counting time (second)	本底 Background (CPM)	計數效率 Counting efficiency (%)	化學復得率 Chemical recovery (%)	探測下限 # Minimum Detection Activity # (MDA)
氚 Tritium	濕沉積物 Wet deposition	0.007 L	18000	2	25	-	4 Bq L^{-1}
	總沉積物 Total deposition	0.0001 m^2	18000	2	25	-	300 Bq m^{-2}
	水蒸氣 Water vapour	2 m^3	18000	2	25	-	0.01 Bq m^{-3}
	食米 Rice	0.08 kg	18000	2	25	-	0.3 Bq kg^{-1}
	牛奶 Milk	0.007 L	18000	2	25	-	4 Bq L^{-1}
	蔬菜 Vegetable	0.008 kg	18000	2	25	-	3 Bq kg^{-1}
	水果 Fruit	0.01 kg	18000	2	25	-	3 Bq kg^{-1}
	家禽 Poultry	0.01 kg	18000	2	25	-	3 Bq kg^{-1}
	肉類 Meat	0.01 kg	18000	2	25	-	3 Bq kg^{-1}
	水樣本 Water samples	0.007 L	18000	2	25	-	4 Bq L^{-1}
	地下水 Underground water	0.1 L	18000	2	25	-	0.3 Bq L^{-1}
	海產 Seafood	0.02 kg	18000	2	25	-	1 Bq kg^{-1}
	海藻 Seaweed	0.05 kg	18000	2	25	-	1 Bq kg^{-1}
鍶-90 Strontium-90	大氣飄塵 Airborne particulate	5000 m^3	30000	1	75	90	1 μ Bq m^{-3}
	濕沉積物 Wet deposition	2 L	30000	1	75	100	0.002 Bq L^{-1}
	總沉積物 Total deposition	0.01 m^2	30000	1	75	100	0.5 Bq m^{-2}
	米 Rice	3 kg	30000	1	75	90	0.002 Bq kg^{-1}
	牛奶 Milk	1 L	30000	1	75	90	0.005 Bq L^{-1}
	蔬菜 Vegetable	1 kg	30000	1	75	90	0.005 Bq kg^{-1}
	水果 Fruit	2 kg	30000	1	75	90	0.003 Bq kg^{-1}
	家禽 Poultry	2 kg	30000	1	75	90	0.003 Bq kg^{-1}
	肉類 Meat	1 kg	30000	1	75	90	0.005 Bq kg^{-1}
	土壤 Land soil	0.005 kg	30000	1	75	90	1 Bq kg^{-1}
	海水中懸浮粒子 Suspended particulate	3 L	30000	1	75	90	0.002 Bq L^{-1}
	海產 Seafood	1.5 kg	30000	1	75	90	0.004 Bq kg^{-1}
	海藻 Seaweed	0.05 kg	30000	1	75	90	0.1 Bq kg^{-1}

表 3 (續)

Table 3. (cont'd)

測量類別 Measurement type		樣本大小 Sample size	計數時間(秒) Counting time (second)	本底 Background (CPM)	計數效率 Counting efficiency (%)	化學復得率 Chemical recovery (%)	探測下限 # Minimum Detection Activity # (MDA)
鈽-239 Plutonium-239	大氣飄塵 Airborne particulate	6000 m^3	220000	0.003	20	40	0.2 μ Bq m^{-3}
	濕沉積物 Wet deposition	2 L	220000	0.003	20	60	0.0004 Bq L^{-1}
	總沉積物 Total deposition	0.01 m^2	220000	0.003	20	60	0.07 Bq m^{-2}
	土壤 Land soil	0.003 kg	220000	0.003	20	50	0.3 Bq kg^{-1}
	海水中懸浮粒子 Suspended particulate	3 L	220000	0.003	20	50	0.0003 Bq L^{-1}
	海產 Seafood	0.5 kg	220000	0.003	20	40	0.002 Bq kg^{-1}
	海藻 Seaweed	0.05 kg	220000	0.003	20	60	0.01 Bq kg^{-1}
	潮間帶土 / 海床沉澱物 Sediment	0.003 kg	220000	0.003	20	50	0.3 Bq kg^{-1}

註:

* - 表內所列是 ERMP 在二零一一年主要量度參數的典型數值，僅供參考之用。視乎實際操作情況，量度參數可能有變化。在特別情況下，部份樣本會使用與上表頗爲不同的參數進行量度。

\# - 測量的探測下限是指一個測量系統在該次測量時實際能測量到的最低活度水平。探測下限的數值取決於多個因數，包括個別測量系統的特質、測量方法、樣本的特質及測量的情況，所以探測下限會隨著個別樣本和測量而改變。表內所示的探測下限爲在一般測量情況下的典型數值，僅供在理解此報告的結果時作簡易參考之用。有時在個別樣本的測量情況下，可能測量出遠低於探測下限的活度水平。

Note:

* - The values given in the table are typical values of key measurement parameters in the ERMP in 2011. The values may vary in practice, and should thus be used as reference only. Under special circumstances, some samples may be measured under substantially different conditions.

\# - The minimum detection activity (MDA) of a measurement is the lowest activity level that is practically achievable by the counting system for that measurement. MDA values depend on the characteristics of the measurement system, method of measurement, sample characteristics and measurement conditions, and thus vary with individual samples and measurements. The listed MDAs are typical values under "typical" measurement conditions and serve as a quick reference in interpreting results in this report. Under individual measurement conditions, activity much lower than the typical MDA would sometimes be measured.

表 4. 輻射監測網絡及熱釋光劑量計網絡在二零一一年錄得的環境伽馬劑量率。(單位爲每小時微戈)

Table 4. Ambient gamma dose rates recorded by the radiation monitoring network and thermoluminescent network in 2011 (dose rate in μGy h^{-1})

輻射監測網絡
Radiation Monitoring Network (RMN)

輻射監測網絡始於一九九二年，首五年運作參考數值爲一九九二至一九九六年輻射監測網絡錄得的環境伽馬劑量率的範圍：每小時 0.062 – 0.271 微戈。

Radiation monitoring network started operation in 1992. Reference values of first 5 years of operation, i.e. the range of the ambient gamma dose rates recorded by the radiation monitoring network from 1992 to 1996, are: 0.062 – 0.271 μGy h^{-1}.

監測站 Station	**年平均值 Annual Average**	**標準差 Standard Deviation**	**一分鐘平均值範圍 Range of 1-min Average**
吉澳 Kat O	0.104	0.002	0.085 – 0.134
京士柏 King's Park	0.136	0.003	0.123 – 0.211
觀塘 Kwun Tong	0.127	0.003	0.109 – 0.160
平洲 Ping Chau	0.097	0.004	0.083 – 0.178
西灣河 Sai Wan Ho	0.096	0.002	0.086 – 0.135
沙頭角 Sha Tau Kok	0.102	0.002	0.091 – 0.157
大美督 Tai Mei Tuk	0.114	0.002	0.103 – 0.156
塔門 Tap Mun	0.085	0.003	0.067 – 0.143
尖鼻咀 Tsim Bei Tsui	0.130	0.003	0.107 – 0.197
元五墳 Yuen Ng Fan	0.117	0.003	0.098 – 0.167

表 4. (續)

Table 4. (cont'd)

熱釋光劑量計網絡

Thermoluminescent Dosimeter (TLD) Network

BRMP 參考數值爲熱釋光劑量計網絡於 BRMP 期間所錄得的伽馬劑量率的範圍：

每小時 0.03 – 0.29 微戈。

BRMP reference values, i.e. the range of the ambient gamma dose rates recorded by the thermoluminescent dosimeter network during BRMP, are: 0.03 – 0.29 μGy h^{-1}.

監測點 Location	年平均值 Annual Average	標準差 Standard Deviation	範圍 Range
鶴咀 Cape D'Aguilar	0.13	0.02	0.12 – 0.16
長洲 Cheung Chau	0.12	0.01	0.11 – 0.14
置富花園 Chi Fu Fa Yuen	0.16	0.01	0.14 – 0.17
清水灣 Clear Water Bay	0.10	0.01	0.09 – 0.12
深水灣 Deep Water Bay	0.14	0.01	0.13 – 0.15
粉嶺 Fanling	0.11	0.01	0.11 – 0.13
跑馬地 Happy Valley	0.09	0.01	0.08 – 0.10
吉澳 Kat O	0.11	0.01	0.10 – 0.12
京士柏 King's Park	0.14	0.01	0.13 – 0.16
觀塘 Kwun Tong	0.15	0.02	0.13 – 0.17
平洲 Ping Chau	0.12	0.01	0.10 – 0.13
西貢 Sai Kung	0.13	0.01	0.11 – 0.14
沙頭角 Sha Tau Kok	0.09	0.01	0.08 – 0.10
沙田 Shatin	0.13	0.01	0.12 – 0.15
筲箕灣 Shau Kei Wan	0.14	0.01	0.13 – 0.15
石崗 Shek Kong	0.11	0.01	0.10 – 0.13
石梨貝 Shek Lei Pui	0.20	0.01	0.18 – 0.21
大欖涌 Tai Lam Chung	0.18	0.01	0.18 – 0.20
大美督 Tai Mei Tuk	0.14	0.01	0.13 – 0.15
大埔 Tai Po	0.10	0.01	0.09 – 0.11
塔門 Tap Mun	0.09	0.01	0.09 – 0.10
尖鼻咀 Tsim Bei Tsui	0.13	0.01	0.13 – 0.14
荃灣 Tsuen Wan	0.14	0.01	0.13 – 0.15
屯門 Tuen Mun #	0.15	0.02	0.13 – 0.17
烏溪沙 Wu Kai Sha	0.13	0.01	0.13 – 0.15
元朗 Yuen Long	0.11	0.01	0.09 – 0.12
元五墳 Yuen Ng Fan	0.12	0.01	0.11 – 0.14

註:

由於屯門的熱釋光劑量計遺失，在二零一一年十月十九日至二零一一年十二月三十一日期間沒有數據。

Note:

Data for Tuen Mun was not available for the period between 19 Oct 2011 and 31 December 2011 due to the loss of TLDs.

表 5. 平洲自動伽馬譜法系統在二零一一年的輻射測量結果

Table 5. Results of measurement by the Automatic Gamma Spectrometry System at Ping Chau in 2011

	年平均值 * Annual Average *	**標準差 Standard Deviation**	**日平均值範圍 Range of Daily Average**	**首五年(一九九七至二零零一年)參考範圍 * Reference range from first 5 years of operation (1997 - 2001) ***
阿爾法粒子 Alpha (每立方米貝可 Bq m^{-3})	1.2	0.2	1.0 – 2.1	1.0 – 5.8
貝他粒子 Beta (每立方米貝可 Bq m^{-3})	1.6	0.5	1.0 – 3.7	1.0 – 10.1
碘-131 I-131 (每立方米毫貝可 mBq m^{-3})	< 4	N/A	N/A	< 4
銫-137 Cs-137 (每立方米毫貝可 mBq m^{-3})	< 4	N/A	N/A	< 4
氣態碘-131 Gaseous I-131 (每立方米貝可 Bq m^{-3})	< 1	N/A	N/A	< 1

註:

* 測量結果低於探測下限以“< xx”表示，xx 是該類測量的典型探測下限值。

N/A 表示不適用。

Note:

* Results below the minimum detectable activity (MDA) are reported as “< xx” where xx is the typical MDA value for that type of measurement.

N/A Not applicable.

表6. 二零一一年宇宙輻射引致的伽馬劑量率測量結果 (測量地點: 船灣淡水湖)

Table 6. Measurement results of gamma dose rates due to cosmic radiation in 2011 (measurement site: Plover Cove)

測量日期 Date of measurement	**平均伽馬劑量率(每小時微戈) Average gamma dose rate (μGy h^{-1})**
二零一一年二月二十三日 23 Feb 2011	0.035
二零一一年五月九日 9 May 2011	0.034
二零一一年八月十七日 17 Aug 2011	0.032
二零一一年十一月二十三日 23 Nov 2011	0.034

表7. 二零一一年常規食物及環境樣本中之人工伽馬放射性核素的可測量伽馬活度測量結果

Table 7. Measurement results of measurable gamma activities of artificial gamma-emitting radionuclides in routine food and environmental samples in 2011

放射性核素: 碘-131 Radionuclide: I-131

京士柏常規大氣飄塵及氣態碘樣本中的可測量碘-131 活度

Measurable activity of I-131 in routine King's Park Airborne Particulate and Gaseous Iodine Samples

京士柏每週大氣飄塵樣本採樣日期 Sampling Period of King's Park Weekly Airborne Particulate Samples	碘-131 活度 Activity of I-131 (每立方米微貝可μBq m^{-3})	BRMP 範圍 # BRMP range # (每立方米微貝可μBq m^{-3})
2011 年 4 月 4 日至 4 月 11 日 4 April to 11 April 2011	74	<50*
2011 年 4 月 11 日至 4 月 18 日 11 April to 18 April 2011	26	

京士柏每週氣態碘樣本採樣日期 Sampling Period of King's Park Weekly Gaseous Iodine Samples	碘-131 活度 Activity of I-131 (每立方米微貝可μBq m^{-3})	BRMP 範圍 # BRMP range # (每立方米微貝可μBq m^{-3})
2011 年 3 月 23 日至 3 月 28 日 23 March to 28 March 2011	205	<600*
2011 年 3 月 28 日至 4 月 4 日 28 March to 4 April 2011	619	
2011 年 4 月 4 日至 4 月 11 日 4 April to 11 April 2011	947	
2011 年 4 月 11 日至 4 月 18 日 11 April to 18 April 2011	303	
2011 年 4 月 18 日至 4 月 26 日 18 April to 26 April 2011	91	
2011 年 8 月 16 日至 8 月 23 日 16 August to 23 August 2011	116	

表 7. (續)

Table 7. (cont'd)

沙頭角常規大氣飄塵樣本中的可測量碘-131 活度

Measurable activity of Iodine-131 in routine Sha Tau Kok Airborne Particulate Samples

沙頭角每週大氣飄塵樣本採樣日期 Sampling Period of Sha Tau Kok Weekly Airborne Particulate Samples	碘-131 活度 Activity of I-131 (每立方米微貝可 μBq m^{-3})	BRMP 範圍 # BRMP range # (每立方米微貝可 μBq m^{-3})
2011 年 3 月 22 日至 3 月 29 日 22 March to 29 March 2011	132	<50*
2011 年 3 月 29 日至 4 月 5 日 29 March to 5 April 2011	97	
2011 年 4 月 5 日至 4 月 12 日 5 April to 12 April 2011	90	
2011 年 4 月 12 日至 4 月 19 日 12 April to 19 April 2011	33	

註: # BRMP 測量結果低於探測下限以 "< xx" 表示，xx 是該類測量的典型探測下限值。

* 在 BRMP 期間分析的大氣飄塵及氣態碘樣本中，只有京士柏兩個每週大氣飄塵及一個氣態碘樣本中測量出碘-131(大氣飄塵 - 活度每立方米 328 及 38 微貝可；氣態碘 - 活度每立方米 2000 微貝可)，但經調查後相信碘-131 是來自附近伊利沙伯醫院的小量低放射性醫療廢物排放。因此並不應將這些樣本在 BRMP 期間測量出的碘-131 活度視爲大氣飄塵及氣態碘的本底活度範圍。大氣飄塵及氣態碘的 BRMP 碘-131 本底範圍應爲低於探測下限。

Note: # BRMP results that are below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement.

* During the BRMP period, among the airborne particulate and gaseous iodine samples analysed, I-131 was detected only in two weekly airborne particulate samples (activity 328 μBqm^{-3} and 38 μBq m^{-3}) and one gaseous iodine sample (activity 2000 μBqm^{-3}) at King's Park. Subsequent investigation suggested that a possible source of I-131 could be the release of small amount of low-level radioactive medical waste from Queen Elizabeth Hospital nearby. Hence the I-131 activities detected in these samples during BRMP should not be interpreted as baseline activity for airborne particulate and gaseous iodine. The baseline BRMP range of I-131 in airborne particulate and gaseous iodine should be below MDA.

表 7. (續)
Table 7. (cont'd)

放射性核素: 銫-134 Radionuclide: Cs-134

京士柏常規大氣飄塵樣本中的可測量銫-134 活度
Measurable activity of Cs-134 in routine King's Park Airborne Particulate Samples

京士柏累積每月大氣飄塵樣本採樣日期 Sampling Period of King's Park Bulked Monthly Airborne Particulate Samples	銫-134 活度 Activity of Cs-134 (每立方米微貝可μBq m^{-3})	BRMP 範圍 # BRMP range # (每立方米微貝可μBq m^{-3})
2011 年 4 月 April 2011	12	<10

元五墳常規大氣飄塵樣本中的可測量銫-134 活度
Measurable activity of Cs-134 in routine Yuen Ng Fan Airborne Particulate Samples

元五墳累積每月大氣飄塵樣本採樣日期 Sampling Period of Yuen Ng Fan Bulked Monthly Airborne Particulate Samples	銫-134 活度 Activity of Cs-134 (每立方米微貝可μBq m^{-3})	BRMP 範圍 # BRMP range # (每立方米微貝可μBq m^{-3})
2011 年 4 月 April 2011	35	<10

沙頭角常規大氣飄塵樣本中的可測量銫-134 活度
Measurable activity of Cs-134 in routine Sha Tau Kok Airborne Particulate Samples

沙頭角累積每月大氣飄塵樣本採樣日期 Sampling Period of Sha Tau Kok Bulked Monthly Airborne Particulate Samples	銫-134 活度 Activity of Cs-134 (每立方米微貝可μBq m^{-3})	BRMP 範圍 # BRMP range # (每立方米微貝可μBq m^{-3})
2011 年 4 月 April 2011	28	<10

註: # BRMP 測量結果低於探測下限以 "< xx" 表示，xx 是該類測量的典型探測下限值。

Note: # BRMP results that are below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement.

表 7. (續)

Table 7. (cont'd)

放射性核素: 銫-137 Radionuclide: Cs-137

京士柏常規大氣飄塵樣本中的可測量銫-137 活度

Measurable activity of Cs-137 in routine King's Park Airborne Particulate Samples

京士柏每週大氣飄塵樣本採樣日期 Sampling Period of King's Park Weekly Airborne Particulate Samples	銫-137 活度 Activity of Cs-137 (每立方米微貝可μBq m^{-3})	BRMP 範圍 # BRMP range # (每立方米微貝可μBq m^{-3})
2011 年 4 月 4 日至 4 月 11 日 4 April to 11 April 2011	37	<50
2011 年 4 月 11 日至 4 月 18 日 11 April to 18 April 2011	27	

京士柏累積每月大氣飄塵樣本採樣日期 Sampling Period of King's Park Bulked Monthly Airborne Particulate Samples	銫-137 活度 Activity of Cs-137 (每立方米微貝可μBq m^{-3})	BRMP 範圍 # BRMP range # (每立方米微貝可μBq m^{-3})
2011 年 4 月 April 2011	24	<10

元五墳常規大氣飄塵樣本中的可測量銫-137 活度

Measurable activity of Cs-137 in routine Yuen Ng Fan Airborne Particulate Samples

元五墳每週大氣飄塵樣本採樣日期 Sampling Period of Yuen Ng Fan Weekly Airborne Particulate Samples	銫-137 活度 Activity of Cs-137 (每立方米微貝可μBq m^{-3})	BRMP 範圍 # BRMP range # (每立方米微貝可μBq m^{-3})
2011 年 4 月 4 日至 4 月 11 日 4 April to 11 April 2011	104	<50

元五墳累積每月大氣飄塵樣本採樣日期 Sampling Period of Yuen Ng Fan Bulked Monthly Airborne Particulate Samples	銫-137 活度 Activity of Cs-137 (每立方米微貝可μBq m^{-3})	BRMP 範圍 # BRMP range # (每立方米微貝可μBq m^{-3})
2011 年 4 月 April 2011	41	<10

表 7. (續)

Table 7. (cont'd)

沙頭角常規大氣飄塵樣本中的可測量銫-137 活度

Measurable activity of Cs-137 in routine Sha Tau Kok Airborne Particulate Samples

沙頭角每週大氣飄塵樣本採樣日期 Sampling Period of Sha Tau Kok Weekly Airborne Particulate Samples	銫-137 活度 Activity of Cs-137 (每立方米微貝可μBq m^{-3})	BRMP 範圍 # BRMP range # (每立方米微貝可μBq m^{-3})
2011 年 4 月 5 日至 4 月 12 日 5 April to 12 April 2011	64	<50

沙頭角累積每月大氣飄塵樣本採樣日期 Sampling Period of Sha Tau Kok Bulked Monthly Airborne Particulate Samples	銫-137 活度 Activity of Cs-137 (每立方米微貝可μBq m^{-3})	BRMP 範圍 # BRMP range # (每立方米微貝可μBq m^{-3})
2011 年 4 月 April 2011	35	<10

註: # BRMP 測量結果低於探測下限以 "< xx" 表示，xx 是該類測量的典型探測下限值。

Note: # BRMP results that are below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement.

表 7. (續)
Table 7. (cont'd)

常規食物及環境樣本中的可測量銫-137 活度 (每公斤貝可)
Measurable activity of Cs-137 (Bq kg^{-1}) in routine food and environmental samples

類別 Type	**地點 Location**	**含有可測量活度的樣本總數 Total no. of samples with measurable activity**	**範圍 Range**	**活度 * Activity ***	**BRMP 範圍 # BRMP range #**	**單位 Unit**
牙帶 *Trichiurus haumela* (Hair tail)	香港水域 Hong Kong Waters	2	0.03	0.03	≤ 0.2	Bq kg^{-1}
土壤(上層) Land soil (upper)	見表 1 See Table 1	3	0.8 – 1.3	1.1	≤ 10.0	Bq kg^{-1}
土壤(下層) Land soil (lower)	見表 1 See Table 1	2	0.4	0.4	≤ 4.0	Bq kg^{-1}
潮間帶土(上層) Intertidal sediment (upper)	白沙灣 Pak Sha Wan	3	0.3 – 0.4	0.4	≤ 2.4	Bq kg^{-1}
	尖鼻咀 Tsim Bei Tsui	4	0.5 – 0.7	0.6		
	沙頭角 Sha Tau Kok	4	0.3 – 0.6	0.5		
潮間帶土(下層) Intertidal sediment (lower)	白沙灣 Pak Sha Wan	2	0.2 – 0.3	0.3	≤ 3.1	Bq kg^{-1}
	尖鼻咀 Tsim Bei Tsui	4	0.7 – 0.8	0.7		
	沙頭角 Sha Tau Kok	4	0.3 – 0.7	0.5		
海床沉澱物 Seabed sediment	大灘海 Tai Tan Hoi	1	-	0.5	≤ 1.9	Bq kg^{-1}
	龍蝦灣 Lung Ha Wan	1	-	1.0		
	索罟灣 Picnic Bay	1	-	0.5		
	西區碇泊處 Western Anchorage	1	-	0.4		

註: * 如有多過一個樣本發現可測量活度，此欄則報告平均值。

BRMP 測量結果低於探測下限以 "< xx" 表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告爲 "≤ xx" ，xx 則爲測量到的活度最大值。

Note: * The mean activity is reported if there are more than one sample with measurable activities.

BRMP results that are below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as "≤ xx" where xx is the maximum measured activity value.

表 8. 二零一一年常規食物及環境樣本的可測量氚活度測量結果

Table 8. Measurement results of measurable activities of tritium in routine food and environmental samples in 2011

(每公斤貝可 Bq kg^{-1}; 每公升貝可 Bq L^{-1}; 每平方米貝可 Bq m^{-2}; 每立方米貝可 Bq m^{-3})

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
食米 Rice	內地 Mainland	3	0.01 – 0.14	0.06	< 1	Bq kg^{-1}
牛奶(經消毒) Pasteurized milk	深圳 Shenzhen	1	–	0.22	< 6	Bq L^{-1}
	沙頭角 Sha Tau Kok	2	0.07 – 0.14	0.11		
菜心 Choi sum	內地 Mainland	4	0.1 – 3.3	1.4	≤ 7.4	Bq kg^{-1}
	本地 Local	3	0.1 – 3.0	1.2		
白菜 Pak choi	內地 Mainland	3	0.2 – 2.6	1.1	< 6	Bq kg^{-1}
	本地 Local	2	1.1 – 1.9	1.5		
荔枝 Lychee	內地 Mainland	1	-	0.2	< 4	Bq kg^{-1}
柑橘 Mandarin	內地 Mainland	2	0.1 – 0.8	0.5	< 4	Bq kg^{-1}
雞 Chicken	內地 Mainland	2	0.3 – 0.5	0.4	≤ 2.2	Bq kg^{-1}
	本地 Local	2	0.2 – 0.5	0.4		
鴨 Duck	內地 Mainland	1	-	0.1	≤ 3.5	Bq kg^{-1}
牛肉 Beef	內地 Mainland	4	0.1 – 1.4	0.8	≤ 5.3	Bq kg^{-1}
豬肝 Pig's liver	內地 Mainland	1	-	0.9	< 4	Bq kg^{-1}
	本地 Local	1	-	0.8		
豬肉 Pork	內地 Mainland	2	0.1 – 1.2	0.7	< 4	Bq kg^{-1}
	本地 Local	1	-	0.5		
瓜三 *Nemipterus japonicus* (Melon coat)	香港以西海域 Seas west of Hong Kong	1	-	0.08	< 2	Bq kg^{-1}
牛鰍 *Platycephalus indicus* (Bartail flathead)	香港以西海域 Seas west of Hong Kong	1	-	0.06	< 2	Bq kg^{-1}
三點蟹 *Portunus sanguinolentus* (Three-spotted crab)	香港水域 Hong Kong Waters	1	-	0.2	< 2	Bq kg^{-1}
	香港以西海域 Seas west of Hong Kong	1	-	0.1		
赤米蝦 *Metapenaeopsis Barbata* (Fire prawn)	香港水域 Hong Kong Waters	2	0.1 – 0.3	0.2	≤ 4.9	Bq kg^{-1}
墨魚 *Sepia spp.* (Cuttlefish)	香港水域 Hong Kong Waters	1	-	1.0	≤ 2.7 @	Bq kg^{-1}
魷魚 *Loligo edulis* (Squid)	香港水域 Hong Kong Waters	1	-	1.3	< 3	Bq kg^{-1}

表 8. (續)

Table 8. (cont'd)

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
青口 *Perna viridis* (Green-lipped mussel)	長洲 Cheung Chau	1	-	0.02	< 2	Bq kg^{-1}
蜆 *Tapes philippinarum* (Clam)	吐露港 Tolo Harbour	1	-	0.2	< 2	Bq kg^{-1}
半葉馬尾藻 *Sargassum hemiphyllum* (Brown algae)	布袋澳 Po Toi O	1	-	0.2	< 2	Bq kg^{-1}
石蒓 *Ulva lactuca* (Sea lettuce)	布袋澳 Po Toi O	1	-	0.5	< 2	Bq kg^{-1}
濕沉積物 (降雨) Wet deposition (precipitation)	京士柏 King's Park	6	0.1 – 1.7	0.7	≤ 12	Bq L^{-1}
	沙頭角 Sha Tau Kok	8	0.1 – 3.0	1.5		
	元五墳 Yuen Ng Fan	6	0.9 – 3.0	1.8		
總沉積物 Total deposition	京士柏 King's Park	5	21.6 – 867.3	283.6	≤ 2210 $	Bq m^{-2}
大氣水蒸氣 Water vapour in air	京士柏 King's Park	7	0.003 – 0.018	0.008	≤ 242	Bq m^{-3}
飲用水(經處理) Drinking water (treated)	九龍配水管 Kowloon distribution tap	3	0.7 – 3.0	2.1	< 6	Bq L^{-1}
	屯門配水管 Tuen Mun distribution tap	2	0.5 – 1.1	0.8		
	油柑頭濾水廠 Yau Kom Tau Treatment Works	2	1.8 – 3.6	2.7		
	屯門濾水廠 Tuen Mun Treatment Works	2	0.1 – 1.7	0.9		
	沙田濾水廠 Shatin Treatment Works	3	1.3 – 3.1	2.3		

表 8. (續)

Table 8. (cont'd)

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
飲用水 (未經處理) Drinking water (untreated)	木湖 B 抽水站 Muk Wu B Pumping Station	3	0.1 – 5.5	2.4	< 6	$Bq\ L^{-1}$
	油柑頭濾水廠 Yau Kom Tau Treatment Works	2	2.0 – 3.9	2.9		
	屯門濾水廠 Tuen Mun Treatment Works	2	0.7 – 3.6	2.1		
	沙田濾水廠 Shatin Treatment Works	3	0.2 – 4.5	1.7		
	萬宜水庫 High Island Reservoir	1	-	4.5		
	船灣淡水湖 Plover Cove Reservoir	2	0.4 – 3.4	1.9		
地下水 Underground water	長康邨 Cheung Hong Estate	1	-	0.2	≤ 2.8	$Bq\ L^{-1}$
	鈞樂新村 Kwan Lok San Tsuen	1	-	0.2		
	環翠邨 Wan Tsui Estate	1	-	0.1		
	華富邨 Wah Fu Estate	1	-	0.2		
	富山邨 Fu Shan Estate	1	-	0.1		
	清涼法苑 Ching Leung Nunnery	1	-	0.3		
海水(上層) Sea water (upper level)	火石洲 Basalt Island	1	-	1.2	< 6	$Bq\ L^{-1}$
	大浪灣 Tai Long Wan	1	-	1.7		
	赤洲 Port Island	1	-	1.7		
	橫瀾島 Waglan Island	1	-	0.4		

表 8. (續)

Table 8. (cont'd)

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
海水(中層) Sea water (middle level)	火石洲 Basalt Island	1	-	1.1	< 6	Bq L^{-1}
	大浪灣 Tai Long Wan	1	-	1.5		
	赤洲 Port Island	1	-	1.4		
海水(低層) Sea water (lower level)	火石洲 Basalt Island	1	-	0.7	< 6	Bq L^{-1}
	大浪灣 Tai Long Wan	1	-	1.8		
	赤洲 Port Island	1	-	0.3		
	橫瀾島 Waglan Island	1	-	0.7		
樽裝水(蒸餾水) Bottled water (Distilled)	本地 Local	3	1.4 – 1.9	1.6	≤ 4.9 &	Bq L^{-1}
樽裝水(礦泉水) Bottled water (Mineral)	本地 Local	4	1.3 – 2.0	1.6	≤ 5.8 &	Bq L^{-1}

註: * 如有多過一個樣本發現可測量活度，此欄則報告平均值。

\# BRMP 測量結果低於探測下限以"< xx"表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告爲"≤ xx"，xx 則爲測量到的活度最大值。

@ 該樣本沒有在 BRMP 測量。這裡顯示的測量範圍爲該樣本首五年(一九九七年至二零零二年)的測量數值。

$ 該樣本沒有在 BRMP 測量。這裡顯示的測量範圍爲該樣本首五年(一九九六年至二零零零年)的測量數值。

& 該樣本測量始於二零零七年，並沒有在 BRMP 測量。這裡顯示的測量範圍包含二零零七至二零一零年的樣本測量數值。

Note: * The mean activity is reported if there are more than one sample with measurable activities.

\# BRMP results that are below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as "≤ xx" where xx is the maximum measured activity value.

@ The sample was not measured in BRMP. The indicated range refers to results from first 5 years' sample measurement (1997 to 2002).

$ The sample was not measured in BRMP. The indicated range refers to results from first 5 years' sample measurement (1996 to 2000).

& Measurement of this sample started in 2007. The sample was not measured in BRMP. The indicated range refers to results from 2007 to 2010 sample measurement.

表 9. 二零一一年常規食物及環境樣本的可測量鍶-90 活度測量結果

Table 9. Measurement results of measurable activities of strontium-90 in routine food and environmental samples in 2011

(每公斤貝可 Bq kg^{-1}；每公升貝可 Bq L^{-1}；每立方米貝可 Bq m^{-3}；每平方米貝可 Bq m^{-2}；每公斤毫貝可 mBq kg^{-1}；每公升毫貝可 mBq L^{-1}；每立方米微貝可μBq m^{-3})

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
食米 Rice	內地 Mainland	3	3 – 5	4	≤ 56	mBq kg^{-1}
牛奶(經消毒) Pasteurized milk	深圳 Shenzhen	4	8 – 13	11	≤ 81	mBq L^{-1}
	沙頭角 Sha Tau Kok	4	6 – 11	9		
菜心 Choi sum	內地 Mainland	4	34 – 220	108	≤ 266	mBq kg^{-1}
	本地 Local	4	8 – 185	61		
白菜 Pak choi	內地 Mainland	4	19 – 105	50	≤ 570	mBq kg^{-1}
	本地 Local	4	19 – 54	33		
甘蔗 Sugar cane	內地 Mainland	1	-	2	≤ 14	mBq kg^{-1}
荔枝 Lychee	內地 Mainland	1	-	3	≤ 14	mBq kg^{-1}
柑橘 Mandarin	內地 Mainland	2	63 – 81	72	≤ 84	mBq kg^{-1}
雞 Chicken	本地 Local	1	-	2	≤ 37	mBq kg^{-1}
豬肉 Pork	內地 Mainland	1	-	8	≤ 36	mBq kg^{-1}
豬肝 Pig's liver	內地 Mainland	1	-	6	≤ 43	mBq kg^{-1}
大魚 *Aristichthys nobilis* (Big-head carp)	深圳 Shenzhen	2	4 – 8	6	≤ 94	mBq kg^{-1}
	元朗 Yuen Long	3	3 – 5	4		
瓜三 *Nemipterus japonicus* (Melon coat)	香港水域 Hong Kong Waters	1	-	4	≤ 21	mBq kg^{-1}
牛鰍 *Platycephalus indicus* (Bartail flathead)	香港水域 Hong Kong Waters	1	-	4	≤ 25	mBq kg^{-1}
牙帶 *Trichiurus haumela* (Hair tail)	香港水域 Hong Kong Waters	2	5 – 10	8	≤ 49	mBq kg^{-1}
	香港以西海域 Seas west of Hong Kong	1	-	7		
三點蟹 *Portunus sanguinolentus* (Three-spotted crab)	香港水域 Hong Kong Waters	2	4 – 5	4	≤ 105	mBq kg^{-1}
赤米蝦 *Metapenaeopsis barbata* (Fire prawn)	香港水域 Hong Kong Waters	1	-	5	≤ 66	mBq kg^{-1}
魷魚 *Loligo edulis* (Squid)	香港水域 Hong Kong Waters	3	8 – 18	11	≤ 43	mBq kg^{-1}
	香港以西海域 Seas west of Hong Kong	1	-	9		

表 9. (續)

Table 9. (cont'd)

類別 Type	地點 Location	含有可測量活度的樣本總數 Total no. of samples with measurable activity	範圍 Range	活度 * Activity *	BRMP 範圍 # BRMP range #	單位 Unit
東風螺 *Babylonia formosae* (Gastropod)	香港水域 Hong Kong Waters	3	7 – 10	9	≤ 31	mBq kg^{-1}
青口 *Perna viridis* (Green-lipped mussel)	長洲 Cheung Chau	2	10 – 16	13	≤ 47	mBq kg^{-1}
	吐露港 Tolo Harbour	3	12 – 17	15		
	大亞灣 Daya Bay	1	-	10		
蜆 *Tapes philippinarum* (Clam)	吐露港 Tolo Harbour	3	7 – 10	9	≤ 32	mBq kg^{-1}
半葉馬尾藻 *Sargassum hemiphyllum* (Brown algae)	布袋澳 Po Toi O	1	-	605	≤ 1440	mBq kg^{-1}
大氣飄塵 Airborne particulate	京士柏 King's Park	3	0.7 – 4.0	2.2	≤ 5	μBq m^{-3}
	沙頭角 Sha Tau Kok	4	0.8 – 2.2	1.5		
	元五墳 Yuen Ng Fan	5	0.8 – 3.5	1.8		
濕沉積物(降雨) Wet deposition (precipitation)	京士柏 King's Park	2	8.4 – 12.6	10.5	≤ 39	mBq L^{-1}
	沙頭角 Sha Tau Kok	3	4.0 – 18.7	9.1		
	元五墳 Yuen Ng Fan	3	4.8 – 12.1	9.1		
總沉積物 Total deposition	京士柏 King's Park	3	0.8 – 1.3	1.1	≤ 3.9 $	Bq m^{-2}
土壤(上層) Land soil (upper)	見表 1. Please see Table 1.	6	1.3 – 23.9	7.7	≤ 27.3	Bq kg^{-1}
土壤(下層) Land soil (lower)	見表 1. Please see Table 1.	5	1.2 – 15.3	4.9	≤ 19.9	Bq kg^{-1}

註: * 如有多過一個樣本發現可測量活度，此欄則報告平均值。

\# BRMP 測量結果低於探測下限以 "< xx" 表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告爲 "≤ xx" ，xx 則爲測量到的活度最大值。

$ 該樣本沒有在 BRMP 測量。這裡顯示的測量範圍爲該樣本首五年(一九九六年至二零零零年)的測量數值。

Note: * The mean activity is reported if there is more than one sample with measurable activities.

\# BRMP results that are below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as "≤ xx" where xx is the maximum measured activity value.

$ The sample was not measured in BRMP. The indicated range refers to results from first 5 years' measurement (1996 to 2000).

表10. 二零一一年常規食物及環境樣本的可測量鈈-239活度測量結果

Table 10. Measurement results of measurable activities of plutonium-239 in routine food and environmental samples in 2011

類別 Type	**地點 Location**	**含有可測量活度的樣本總數 Total no. of samples with measurable activity**	**範圍 Range**	**活度 * Activity ***	**BRMP 範圍 # BRMP range #**	**單位 Unit** 每公斤貝可 Bq kg^{-1}
潮間帶土(上層) Intertidal sediment (upper)	尖鼻咀 Tsim Bei Tsui	1	-	0.14	≤ 0.19	Bq kg^{-1}
海床沉澱物 Seabed sediment	索罟灣 Picnic Bay	1	-	0.34	≤ 0.57	Bq kg^{-1}
	西區碇泊處 Western Anchorage	1	-	0.26		
	大灘海 Tai Tan Hoi	1	-	0.46		
	龍蝦灣 Lung Ha Wan	1	-	0.56		

註:

* 如有多過一個樣本發現可測量活度，此欄則報告平均值。

\# BRMP 測量結果低於探測下限以“< xx”表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告爲“≤ xx”，xx 則爲測量到的活度最大值。

Note:

* The mean activity is reported if there is more than one sample with measurable activities.

\# BRMP results that are below the minimum detectable activity (MDA) are reported as “< xx” where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as “≤ xx” where xx is the maximum measured activity value.

表 11. 二零一一年常規樣本整體測量結果概要

Table 11. Overall summary of measurement results of routine samples in 2011

(每公斤貝可 Bq kg^{-1}; 每公升貝可 Bq L^{-1}; 每立方米微貝可μBq m^{-3})

途徑 Pathway	樣本類別 Sample Type	測量結果# Measurement results# / 參考數值# Reference values#	碘-131 I-131	銫-137 Cs-137	銫-134 Cs-134	氚 H-3	鍶-90 Sr-90	鈈-239 Pu-239	單位 Unit
大氣 Atmospheric	大氣飄塵 (每月累積樣本) Airborne Particulate (bulked monthly sample)	範圍 Range	**< 10**	**24 | 41**	**12 | 35**	**---**	**0.7 | 4.0**	**< 0.2**	μBq m^{-3}
		BRMP	< 10&	< 10	< 10		≤ 5	< 0.2	
地面Terrestrial	食米 Rice	範圍 Range	**< 0.2**	**< 0.2**	**< 0.1**	**0.01 | 0.14**	**0.003 | 0.005**	---	Bq kg^{-1}
		BRMP	< 0.1	≤ 0.9	< 0.1	< 1	≤ 0.056		
	牛奶 Milk	範圍 Range	**< 0.2**	**< 0.3**	**< 0.3**	**0.07 | 0.22**	**0.006 | 0.013**	---	Bq L^{-1}
		BRMP	< 0.2	≤ 0.3	< 0.3	< 6	≤ 0.081		
	蔬菜Vegetable	範圍 Range	**< 0.3**	**< 0.4**	**< 0.3**	**0.1 | 3.3**	**0.008 | 0.220**	---	Bq kg^{-1}
		BRMP	< 0.3	< 0.4	< 0.3	≤ 7.4	≤ 0.570		
水 Aquatic	魚 Fish	範圍 Range	**< 0.1**	**0.03**	**< 0.1**	**0.06 | 0.08**	**0.003 | 0.010**	**< 0.002**	Bq kg^{-1}
		BRMP	< 0.1	≤ 0.2	< 0.1	< 2	≤ 0.094	< 0.002	
	經處理的飲用水Treated Drinking Water	範圍 Range	**< 0.1**	**< 0.1**	**< 0.1**	**0.1 | 3.6**	---	---	Bq L^{-1}
		BRMP	< 0.1	< 0.1	< 0.1	< 6			

註:

測量結果低於探測下限以 "< xx" 表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，BRMP 結果將報告爲 "≤ xx" ，xx 則爲測量到的活度最大值。

--- 表示沒有在 BRMP 及 ERMP 進行此項測量。

& 在 BRMP 期間分析的大氣飄塵樣本中，只有京士柏兩個樣本測量出碘-131，活度分別是 328 μBq m^{-3} 及 38 μBq m^{-3}，但經調查後相信碘-131 是來自附近伊利沙伯醫院的小量低放射性醫療廢物排放，因此並不應將這些樣本在 BRMP 期間測量出的碘-131 活度視爲大氣飄塵的本底活度範圍。大氣飄塵的 BRMP 碘-131 本底範圍應爲低於探測下限。

Notes:

Results that are below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the BRMP results will be reported as "≤ xx" where xx is the maximum measured activity value.

--- Measurements not included under BRMP and ERMP.

& During the BRMP period, among the airborne particulate samples analysed, I-131 was detected only in two weekly samples at King's Park (activity 328 μBqm^{-3} and 38 μBq m^{-3}), subsequent investigation suggested that a possible source of I-131 could be the release of small amount of low-level radioactive medical waste from Queen Elizabeth Hospital nearby. Hence the I-131 activities detected in these samples during BRMP should not be interpreted as baseline activity for airborne particulate. The baseline BRMP range of I-131 in airborne particulate should be below MDA.

表A1. 二零一一年三月底至五月底加強輻射監測時段中收集的大氣飄塵樣本中之人工伽馬放射性核素的可測量伽馬活度測量結果

Table A1. Measurement results of measurable gamma activities of artificial gamma-emitting radionuclides in airborne particulate samples collected during enhanced radiation monitoring period from late March to late May 2011

放射性核素: 碘-131 Radionuclide: I-131

京士柏每日大氣飄塵樣本中的可測量碘-131 活度

Measurable activity of I-131 in King's Park Daily Airborne Particulate Samples

京士柏每日大氣飄塵樣本採樣日期 Sampling Period of King's Park Daily Airborne Particulate Samples	**碘-131 放射性活度 Activity of I-131 ($\mu Bq\ m^{-3}$)**
2011 年 3 月 26 日中午至 3 月 27 日中午 26 March to 27 March 2011 (noon to noon)	62.5
2011 年 3 月 27 日中午至 3 月 28 日中午 27 March to 28 March 2011 (noon to noon)	186.9
2011 年 3 月 28 日中午至 3 月 29 日中午 28 March to 29 March 2011 (noon to noon)	296
2011 年 3 月 29 日中午至 3 月 30 日中午 29 March to 30 March 2011 (noon to noon)	828**
2011 年 3 月 30 日中午至 3 月 31 日中午 30 March to 31 March 2011 (noon to noon)	647
2011 年 3 月 31 日中午至 4 月 1 日中午 31 March to 1 April 2011 (noon to noon)	359
2011 年 4 月 5 日中午至 4 月 6 日中午 5 April to 6 April 2011 (noon to noon)	264
2011 年 4 月 6 日中午至 4 月 7 日中午 6 April to 7 April 2011 (noon to noon)	320
2011 年 4 月 7 日中午至 4 月 8 日中午 7 April to 8 April 2011 (noon to noon)	60
2011 年 4 月 8 日中午至 4 月 9 日中午 8 April to 9 April 2011 (noon to noon)	187
2011 年 4 月 9 日中午至 4 月 10 日中午 9 April to 10 April 2011 (noon to noon)	136
2011 年 4 月 10 日中午至 4 月 11 日中午 10 April to 11 April 2011 (noon to noon)	172
2011 年 4 月 12 日中午至 4 月 13 日中午 12 April to 13 April 2011 (noon to noon)	148
2011 年 4 月 13 日中午至 4 月 14 日中午 13 April to 14 April 2011 (noon to noon)	71

註:

** 大氣飄塵樣本中測量出最高的碘-131 活度爲 828 $\mu Bq\ m^{-3}$，對應劑量率 6×10^{-6} $\mu Sv\ hr^{-1}$，而根據 1987 年至 2011 年間在香港各地區所錄得的數據顯示，本港的本底環境伽馬輻射劑量率在 0.06 至 0.30 $\mu Sv\ hr^{-1}$ 這範圍內變動。 即大氣飄塵樣本中測量出最高的碘-131 活度約爲香港本底環境伽馬輻射劑量率的一萬至五萬分之一。由於碘-131 活度極低，不會影響公眾健康。劑量率的估計建基於兩個假設: (i) 以一般運動量成年男性的每日呼吸量 22.2 m^3 爲標準; (ii) 採用碘-131 最保守(即最高)的劑量吸入系數 7.4×10^{-9} $Sv\ Bq^{-1}$ (ICRP Publication 7, 1995)。

Note:

** The peak activity of I-131 detected in Airborne Particulate samples, 828 $\mu Bq/m^3$, corresponded to a dose rate of 6×10^{-6} $\mu Sv\ hr^{-1}$. From readings taken at various locations in Hong Kong during the period 1987 to 2011, the background ambient gamma radiation levels vary between 0.06 and 0.30 $\mu Sv\ hr^{-1}$. The peak activity of I-131 in airborne particulate samples were thus about 1/10,000 to 1/50,000 of the background ambient gamma radiation level in Hong Kong. Since the activity of I-131 detected is very low, it will not affect public health. The dose rate is estimated based on the two assumptions: (i) inhalation rate of 22.2 m^3 per day for an adult (male) with average exercise level and (ii) the most conservative (i.e. highest) Inhalation Dose Coefficients are used for I-131 , i.e. 7.4×10^{-9} $Sv\ Bq^{-1}$ (ICRP Publication 7, 1995).

表 A1. (續)
Table A1. (cont'd)

放射性核素: 碘-131 Radionuclide: I-131

元五墳每日大氣飄塵樣本中的可測量碘-131 活度
Measurable activity of Iodine-131 in Yuen Ng Fan Daily Airborne Particulate Samples

元五墳每日大氣飄塵樣本採樣日期 Sampling Period of Yuen Ng Fan Daily Airborne Particulate Samples	**碘-131 活度 Activity of I-131 ($\mu Bq\ m^{-3}$)**
2011 年 3 月 28 日中午至 3 月 29 日中午 28 March to 29 March 2011 (noon to noon)	274
2011 年 3 月 29 日中午至 3 月 30 日中午 29 March to 30 March 2011 (noon to noon)	471
2011 年 3 月 30 日中午至 3 月 31 日中午 30 March to 31 March 2011 (noon to noon)	419
2011 年 3 月 31 日中午至 4 月 1 日中午 31 March to 1 April 2011 (noon to noon)	239
2011 年 4 月 5 日中午至 4 月 6 日中午 5 April to 6 April 2011 (noon to noon)	168
2011 年 4 月 6 日中午至 4 月 7 日中午 6 April to 7 April 2011 (noon to noon)	245
2011 年 4 月 13 日中午至 4 月 14 日中午 13 April to 14 April 2011 (noon to noon)	86

放射性核素: 銫-137 Radionuclide: Cs-137

京士柏每日大氣飄塵樣本中的可測量銫-137 活度
Measurable activity of Cs-137 in King's Park Daily Airborne Particulate Samples

京士柏每日大氣飄塵樣本採樣日期 Sampling Period of King's Park Daily Airborne Particulate Samples	**銫-137 活度 Activity of Cs-137 ($\mu Bq\ m^{-3}$)**
2011 年 4 月 8 日中午至 4 月 9 日中午 8 April to 9 April 2011 (noon to noon)	67
2011 年 4 月 12 日中午至 4 月 13 日中午 12 April to 13 April 2011 (noon to noon)	30

表A2. 二零一一年五月六至十二日加強輻射監測時段中收集之土壤樣本中人工伽馬放射性核素的可測量伽馬活度測量結果

Table A2. Measurement results of measurable gamma activities of artificial gamma-emitting radionuclides in soil samples collected during enhanced radiation monitoring period from 6 to 12 May 2011

土壤樣本收集地點/日期 **Soil Sampling Location/Date**	**銫-137 活度** **Activity of Cs-137** **(每千克貝可 $Bqkg^{-1}$)**	**BRMP 範圍 #** **BRMP range #** **(每千克貝可 $Bqkg^{-1}$)**
萬宜水庫西(土壤上層)/2011 年 5 月 6 日 High Island West (Upper Layer)/6 May 2011	0.6	≤10
平洲(土壤上層)/2011 年 5 月 7 日 Ping Chau (Upper Layer)/7 May 2011	0.8	≤10
平洲(土壤下層)/2011 年 5 月 7 日 Ping Chau (Lower Layer)/7 May 2011	0.6	≤4
京士柏(土壤上層)/2011 年 5 月 11 日 King's Park (Upper Layer)/11 May 2011	2.1	≤10
京士柏(土壤下層) /2011 年 5 月 11 日 King's Park (Lower Layer)/11 May 2011	2.2	≤4
沙頭角(土壤上層)/2011 年 5 月 11 日 Sha Tau Kok (Upper Layer)/11 May 2011	1.2	≤10
沙頭角(土壤下層)/2011 年 5 月 11 日 Sha Tau Kok (Lower Layer)/11 May 2011	0.4	≤4
塔門(土壤上層)/2011 年 5 月 12 日 Tap Mun (Upper Layer)/12 May 2011	2.1	≤10
塔門(土壤下層)/2011 年 5 月 12 日 Tap Mun (Lower Layer)/12 May 2011	2.6	≤4

註: # BRMP 測量結果低於探測下限以 "< xx" 表示，xx 是該類測量的典型探測下限值。如只在部份樣本中探測到該放射性核素，結果將報告爲 "≤ xx" ，xx 則爲測量到的活度最大值。

Note: # BRMP results that are below the minimum detectable activity (MDA) are reported as "< xx" where xx is the typical MDA value for that type of measurement. When a particular radionuclide was detected only in some of the samples in a certain sample type, the results will be reported as "≤ xx" where xx is the maximum measured activity value.