March 6, 2013

Mr. Albert Sweetnam
Executive Vice President
Deep Geologic Repository Project
Ontario Power Generation
700 University Avenue
Toronto, ON M5G 1X6

Subject: Information Request Package #10 from the Deep Geologic Repository Joint Review Panel

Dear Mr. Sweetnam,

In the attached document, please find information requests (IRs) from the Deep Geologic Repository Joint Review Panel (the Panel). The Panel has determined that responses to these information requests are required to ensure that the available information adequately responds to the Environmental Impact Statement (EIS) Guidelines issued for the project. As always, the Panel requests that the responses be provided in a complete and timely manner and follow the numbering system and framework as set out in the attached document.

In the IR Package #9 cover letter, the Panel indicated that it was approaching the end of its own review of the EIS, documents in support of the licence application as well as the supplementary information received during the review and comment period. Note that the Panel expects that IR Package #10 will be the last package provided to Ontario Power Generation that includes information requests from the Panel's own review. The Panel will continue to submit additional information requests to you, as necessary, in its consideration of the submissions received in relation to the review.

As you know, the Panel will schedule and announce the start of the public hearing once it is satisfied that the EIS and the additional information has adequately responded to the EIS Guidelines. At or before that announcement, the Panel expects that it will provide direction to Ontario Power Generation regarding the documentation that will be required for the public hearing portion of the review.

If you require clarification with regard to the information requests, do not hesitate to contact either of the Panel's Co-Managers. The Panel would appreciate receiving confirmation with respect to the anticipated date of your responses as soon as possible.

Sincerely,

<original signed by>

Dr. Stella Swanson
Chair, Joint Review Panel

c.c.: James F. Archibald, Joint Review Panel Member
Gunter Muecke, Joint Review Panel Member
Frank King, Nuclear Waste Management Organization
Allan Webster, Ontario Power Generation

/Attachment

Attachment 1
Deep Geological Repository Project
Joint Review Panel EIS Information Requests
Package 10 – March 6, 2013

IR #	EIS Guidelines Section	EIS Section or other technical document	Information Request	Context
EIS 10-478	• Section 10.1.6, Ambient Radioactivity	• *EIS:* Section 12.0, Follow-up Monitoring • Section 10.0, Cumulative Effects • Section 10.5.3.6 Radiation and Radioactivity	Explain how OPG proposes to differentiate radioactivity from the DGR and radioactivity resulting from the remaining operations at the Bruce Nuclear site, when confirming the incremental effects of the DGR project in follow-up monitoring.	Context not required.
EIS 10-479	• Section 11.4.8 Noise and Vibration	• Section 11.4.8 Noise and Vibration	State which North American noise modelling standard was used, in order to provide a basis for comparison of modelled predictions with future environmental noise monitoring results.	There are two very different standard approaches used to model atmospheric sound propagation – worst case (downwind in all directions) vs. more realistic
EIS 10-480	• Section 10.1.2, Surface Water • Section 10.1.6, Ambient Radioactivity	• *EIS:* Section 6.6.6 Radioactivity in Surface Water, pages 6-146 and 6-147 • *Radiation and Radioactivity TSD:* Section 5.6.1 Radioactivity in Surface Water, pages 73-81 • *Hydrology and Surface Water Quality TSD:* Appendix E, 2007 and	Provide standard deviation or standard error for the data on tritium and gross beta provided in the response to IR EIS 03-78.	Follow-up to IR EIS 03-78.

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		2009 Surface Water Sampling Results		
EIS 10-481	• Section 10.1.3, Groundwater • Section 10.1.6, Ambient Radioactivity	• *EIS:* Section 6.6.9, Radioactivity in Groundwater, pages 6-154 to 6-157 • *Radiation and Radioactivity TSD:* Section 5.9, Radioactivity in Groundwater, pages 102-109	Provide the standard deviation or standard error for the annual average tritium and gross beta activity in shallow well water provided in the response to IR EIS 03-81.	Follow-up to IR EIS 03-81.
EIS 10-482	• Section 10.1.4, Terrestrial Environment • Section 10.1.6, Ambient Radioactivity	• EIS: Section 6.6.8.4, Radioactivity in Soil • EIS: Section 6.6.7.1. Radioactivity in Sediments	Provide supporting mineralogy data for sediment and soil samples referenced in the responses to IRs EIS 03-82 and EIS 03-83.	Follow-up to IRs EIS 03-82 and EIS 03-83.
EIS 10-483	• Section 8.1, General Information and Design Description • Section 11.2, Mitigation Measures • Section 11.4.2, Surface Water • Section 11.4.3, Groundwater	• EIS: Section 4.4.1.5: Stormwater Management System • OPG DGR: Analysis of the Impact on the WWMF of Groundwater Withdrawal Associated with the Construction of the DGR Shafts DGR-TM-03400 (P)	Provide estimates of tritium concentrations in the stormwater management pond from all sources (e.g., DGR, Bruce Power, WWMF) that could contribute tritium via surface water, groundwater, and air emissions. These estimates are to be specific to the site preparation and construction, and operation phases. Provide relative loadings of tritium from each major source for each of the three DGR Project phases. Provide a map illustrating all tritium sources relative to the DGR site. The map is to include, but not be limited to, Bruce Power and WWMF sources.	Follow-up to IR EIS 08-391.

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EIS 10-484	• Section 10, Existing Environment • Section 11, Effects Prediction, Mitigation Measures, and significance of Residual Effects • Section 13, Long-Term Safety of the DGR	• Geosynthesis Report (NWMO DGR-TR-2011-11)	a) Provide the rationale for not considering unloading due to uplift and erosion as a mechanism of joint formation at the DGR site. Explain the apparent absence of systematic neotectonic/glacio-tectonic fractures at the DGR site. Provide the evidence used to distinguish between joints/fractures generated by unloading, tectonic stresses or hydro-fracturing. b) Since the neotectonic/glacio-tectonic fractures of Southern Ontario share the same orientations with older fractures, provide the rationale for rejecting the hypothesis that "barren" fractures at the DGR site originated due to later stress fields (post-brine) of similar orientation resulting from glacial unloading. c) Provide a quantitative evaluation of fracture formation and propagation resulting from loading/unloading by multiple future glacial cycles involving a thinned cover over the DGR.	Follow-up to IR EIS-06-259. a) The response to IR EIS-06-259 does not adequately address the impact of future glacial isostatic adjustment on the current and future behaviour of fractures and joint sets at the DGR site. A commonly invoked mechanism to explain joint formation involves unloading. Joints are thought to be formed when uplift and erosion removes the overlying rocks (as during a glacial cycle) thereby reducing the compressive load and allowing the rock to expand laterally. Joints related to uplift and erosional unloading have orientations reflecting the principal stresses during the uplift. In the response to IR EIS-06-259 (and in NWMO DGR-TR-2011-43 R000) it is stated that "Mechanisms thought to have led to fracture development include: 1) Devonian sediment compaction, 2) dewatering and diagenesis, 3) Devonian or Carboniferous lateral flow of brines driven by distal orogenic processes, or 4) Late Paleozoic orogenic fold-related jointing." No consideration is given to unloading. b) Fractures without infilling dominate over those that are infilled, or veins, in the areas surveyed for report NWMO DGR-TR-2011-43 R000. The presence of carbonate infills is explained by "joints and veins were formed contemporaneously under conditions of elevated pore fluid pressure and an abundant source of carbonate-rich brines (Cruden 2011, Sections 3.2.2 and 4.1)" The absence of infilling in most fractures strongly suggests that such “barren” fractures they post-date

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				the presence of brines. Cases where only some of the fractures of a set are infilled may indicate reactivation of the same fracture directions at a later time (post-brine). The response to IR EIS-05-167 states that "Throughout southern Ontario, ENE-oriented fractures, which are oriented sub-parallel to the maximum horizontal strain (SHmax) of the contemporary tectonic stress field, have been attributed to aneotectonic/glacio-tectonic origin" and that " an early (Paleozoic) set of joints occupies the same orientation as these neotectonic structures." The response to IR EIS-02-38 states that "Non-systematic fracture sets were not investigated in detail and it is possible that some of these near-surface brittle fractures (evidenced by the fracture frequency plot; INTERA 2011, Figure 3.4) may be young (Quaternary) in age," and that "These results are inconsistent with Quaternary-aged transmissive fractures extending into the deep Ordovician formations." No explanation is provided as to what constitutes non-systematic fracture sets (a set usually implies a common range of orientation). c) While neotectonic/glacio-tectonic fractures are not thought to extend into the Ordovician formations, the future removal of 100 m (and possibly up to 300 m) of the stratigraphic column by glacial cycles increases the uncertainty of this assumption.

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EIS 10-485	• Section 8.7, Malfunctions, Accidents and Malevolent Acts • Class1 Nuclear Facilities Regulations, 5(i)	• Preliminary Safety Report • Section 9.4.7.1 - Excavation Methods and Installing Rock Support	Provide an assessment of non-radiologic hazard scenarios that addresses worker safety related to rock falls and rockbursts. Use information relating to published underground mine worker safety statistics to validate the frequency of injury occurrence due to such scenarios.	Follow-up to IR EIS-07-304. Both rock falls and rockbursts represent common underground worker hazards that are possible or likely. Dynamic ejections (rockbursts) or gravity falls of rock (rock falls) can occur between ground support elements such as rock bolts and result in worker hazards. The response given in IR EIS 07-304 primarily identifies rock falls and rockbursts as events capable of crushing containers and allowing release of radiologic contaminants (" ... rock fall leading to a radiological accident ..."). These events are classified as unlikely because they are not severe enough to cause container damage on large scale. However, likely events at frequencies > 10^{-2} that can cause worker hazard and injury would be due to such identified gravity falls or rockburst movements of small rock elements. Conventional worker safety hazard potential and occurrence has been discussed in the Preliminary Safety Report (Section 9.4.7.1 - Excavation Methods and Installing Rock Support) but only in a very superficial manner. The installation of support material between rock bolts to "protect against spalling in between the bolts" is a principal technique used to reduce worker hazard from falls of ground. Such techniques are, however, less effective at restricting rockburst damage.
EIS 10-486	• Section 11.4.9 Effects of the Environment on the Project	• Glacial Erosion Assessment (NWMO DGR-TR-2011-18)	Provide modelling results for the evolution of the DGR site using the more conservative estimate of 300 m of bedrock removal during a glacial cycle.	Post-closure modelling of the DGR incorporates future glacial cycles. Maximum rock removal through erosion by the ice sheets is estimated at 100 m for 1 Myr. (NWMO DGR-TR-2011-18, p. v) using geologic data, reconstructions of the Laurentide ice sheet, and results from the University of Toronto Glacial Systems Model (UofT GSM). Estimates of maximum bedrock erosion by future glacial

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				cycles are associated with major uncertainties due to the possibility of tunnel valley formation under continental ice sheets. These uncertainties arise from the currently poor understanding of tunnel valley formation as well as uncertainties due to progressive non-linear site changes with each glacial cycle. The precautionary approach dictates that, given these major uncertainties, the most conservative estimates of glacial erosion (i.e., ~300 m) for the DGR site should also be modelled. Tunnel valleys are a common, but poorly understood, phenomenon associated with erosional processes initiated by subglacial meltwater under continental ice sheets. Tunnel valley morphology is highly variable and their depths range from tens of metres to 400 m. The origin of tunnel valleys is still controversial and may be attributed to either catastrophic meltwater discharge or steady-state drainage near the terminus or under the ice sheet. Each glacial cycle may be expected to alter the topography, drainage, bedrock fracturing etc. of the DGR site. Use of the current topography of the site (largely determined by the Laurentide ice sheet) may therefore be a very uncertain basis for evaluating the effects of five future glacial cycles. In NWMO DGR-TR-2011-18 Sec. 5.2 it is noted that "the models are not well suited for calculating absolute values of erosion rates. A further limitation of these studies is that they do not address all principal aspects of glacial erosion. Notably, erosion by subglacial meltwater under normal conditions of high discharge during the melt season, as well as during extreme outburst floods, has not been examined quantitatively and simulated numerically. " NWMO DGR-TR-2011-18 p.v states that "The data and model results summarized in this report collectively point to a broad range of values for erosion at the Bruce nuclear site

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				on a one million year (1 Myr) time scale. They range from ~300 m, the largest, most conservative amount to a few metres" and "a more realistic but still quite conservative site-specific estimate is 100 m for 1 Myr." Given the high degree of uncertainty associated with glacial erosion estimates, the proponent should follow the directives in the EIS guidelines which state that: “The Precautionary Principle informs the decision-maker to take a cautionary approach, or to err on the side of caution, especially where there is a large degree of uncertainty or high risk.”
EIS 10-487	• Section 11.4.9 Effects of the Environment on the Project	• NWMO DGR-TR-2011-25 Postclosure Safety Assessment Section 5.1.1 External FEPs • NWMO DGR-TR-2011-28 Postclosure Safety Assessment: System and Its Evolution, Section 6.3.4.3 Glacial	Provide a copy of the sections of the research proposal for the Greenland Analogue Project (GAP) that set out the rationale, methods, and objectives of the study. Provide any available interim reports for the project.	A publication by SKB (Swedish Nuclear Fuel and Waste Management Company) states that the company, in conjunction with NWMO, is conducting the Greenland Analogue Project (GAP) [SKB Nuclear R&D, Overview Report 2012]. The research project is designed to study the effects of water flows on geological repositories during an ice age, in particular what could happen under the ice sheet where it borders the bedrock. The project is due to be completed in 2013. This research will have provided insights on the long-term evolution of the DGR involving several glacial cycles.
EIS 10-488	• Section 8.1, General Information and Design Description	• EIS: Section 4.5, Waste to be placed in the DGR	Provide the rationale for the belief that aging waste containers, which have been in storage for 35 years or more, will remain intact for the additional operational period of the DGR (~50 years). Explain how corrosive degradation of containers due to container material-waste interactions can be detected by visual inspection. Provide an overview of non-invasive inspection methods that could be used to supplement visual inspection.	Follow-up to IRs EIS 08-342 and 08-343. In its responses to IRs EIS-08-342 and EIS-08-343 (and other IRs), OPG emphasizes that each package will be visually inspected prior to transfer into the DGR. OPG also maintains that 35 years of safe operation at the Western Waste Management Facility, where these wastes are currently stored in the container types that will be transferred to the DGR, provides certainty of their future stability. Since the containers have not been tested for periods that span their current age plus the operational phase of the

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				DGR, it is questionable that past performance is a good predictor of future performance. Corrosive interactions between container material and waste may not be detectable by visual inspection until containment is breached.
EIS 10-489	• Section 8.3, Operation • Section11.4.1, Geology and Geomorphology	• EIS: Table 3.4.3-1, Comparison of Repository Horizon Alternatives; • Section 7.2, Geology, page 7- 6; • Section 7.3, Hydrology and Surface Water, pages	Discuss whether waste rock from carbonate rock strata (e.g., Salina Group, Guelph Formation, etc.) may also require special management due to salinity, and possibly associated metals, that may be released from these rocks.	Follow-up to IR EIS 04-159. In EIS 04-159, the Panel requested kinetic tests on ground core samples. OPG's response downplayed the potential for water quality problems and made no commitment to undertake kinetic tests. Environment Canada recommends that, should the project move forward, field tests on blasted rock should be undertaken during construction as waste rock is removed to surface, in order to inform the need for and extent of treatment that may be required. Environment Canada noted the merit in the waste rock monitoring program approach outlined in IR EIS 04-160 (the approach outlined in the IR, not OPG's response to that IR). Environment Canada explained that the improbable or low risk of acid rock drainage due to excess neutralization potential does not preclude that risks may exist for metal leaching under conditions at or near neutral pH due to the weathering or oxidation of other minerals not reflected in the small sample size and short-term nature of the testing program.
EIS 10-490	• 10 Existing Environment • 10.1.4 Terrestrial Environment	• Terrestrial Environment TSD, Section 5.8, Significant Species (and subsections) • OPG response to IR EIS	Provide Best Management Practices (BMPs)/mitigation measures for potential impacts on snakes, particularly for those species, including Eastern Ribbonsnake, that have been confirmed on site.	Preventative BMPs to keep various species out of the work area should be implemented, especially since OPG could be creating snake habitat during construction. For example, Eastern Ribbonsnake (SARA Special Concern) was found at the Bruce Nuclear site but not at the proposed DGR site. These species are mobile and could wander into the DGR

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		01-15		site even though they have not been observed there. Also, since there are records of Eastern Ribbonsnake occurring at the Bruce Nuclear Site in 1999, and the species has been incidentally observed by Golder Associates and the Ontario Ministry of Natural Resources staff more recently, OPG should assume that the species does occur within the Site Study Area, contrary to the statement that the species "likely occurs within the Site Study Area." (OPG response to IR EIS 01-15)
EIS 10-491	• 10 Existing Environment • 10.1.4 Terrestrial Environment	• Figure 1 from OPG response to IR EIS 05-168 • Enclosure 6, Figure 1, associated with the response to EIS IR 03-85.	Confirm whether or not the proposed location of the stormwater management pond (SWMP) will result in a loss of wetland habitat from Wetland #4. If a portion of the wetland will be removed, identify: • the implications upon water levels (and the viability of the wetland) within Wetland #4; and • options to change the alignment of the SWMP to avoid intersecting the wetland.	Follow-up to IR EIS 05-168. Figure 1, which was attached to the OPG response to EIS 05-168, delineates Wetland #4, and it appears that the western "finger" of this wetland lies within the footprint of the SWMP. If this is the case, it implies that the excavation of the SWMP will likely intersect the water table, which could reduce water levels within Wetland #4 and thereby affect the size and viability of the remaining wetland. There appears to be a discrepancy between Figure 1, referenced above, and the map of vegetation communities provided as Enclosure 6, Figure 1, associated with the response to EIS IR 03-85 (CEAR# 614).
EIS 10-492	• Section 8.5, Decommissioning • Section 8.6, Abandonment	• EIS: Section 4.11.4.2, Construction of Shaft Seal, page 4-77. • Postclosure Safety Assessment: Section 4.2.4, Safety Relevant Features, page 43 Section 4.2.5, Uncertainties, page 43.	Provide additional information relating to the long term, postclosure interval durability of natural analogs similar in physical character to proposed shaft seal materials that will be influenced by subsurface environmental conditions, in terms of chemical and water quality exposure characteristics, that currently are known to exist at the DGR. Assess analog performance in terms of postclosure time intervals and environmental exposure conditions that more closely relate to expected DGR conditions than previously	Follow-up to IR EIS 03-64. IR EIS 03-64 requested an evaluation of the durability of concrete bulkheads, asphalt seals and bentonite sand seals for the operational phase and extending into the postclosure phase. OPG was requested to provide experience in other relevant settings and explain how assumptions with respect to the life-span of these materials contribute to confidence in the post-closure assessment. Examples of relevant settings based on other existing repository experience have been identified, though only on thousand, and potentially ten

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		• Section 3.6, Treatment of Uncertainties. • Table 3.5, Confidence Building Measures and Attributes,	presented.	thousand, year short-term timescales. Natural analogs for concrete, bentonite and asphalt-based materials were presented to characterize the durability of shaft seal materials over million year timescales, as would be displayed through the long-term postclosure period. However, each described analog material, though partially similar in physical character is (a) not identical to proposed shaft seal materials that will be used in the DGR; and (b) has not been subjected to subsurface chemical and water environment conditions similar to those to which seal materials will be exposed at the DGR.
EIS 10-493	• Section 10, Aquatic Environment • Section 11, Effects Prediction, Mitigation Measures and Significance of Residual Effects	• Hydrology and Surface Water Quality TSD: Section 5, Existing Environment	Provide the baseline surface water and sediment quality data specifically requested in IR EIS 07-299 for the Un-named Ditch, immediately downstream of Interconnecting Road, for the spring 2013 season. More than one location must be sampled downstream of the proposed stormwater management pond. The number of samples should be sufficient to be statistically representative of baseline conditions.	Follow-up to IR EIS 07-299. Environment Canada noted that: “This baseline is important since it would be used to compare to the data collected from a Follow-up and Monitoring Program that we expect would be established for verifying effects from the effluent released from the Stormwater Management Pond” (CEARIS # 901)
EIS 10-494	• Section 8.1, General Information and Design Description	• EIS: Section 4.5, Waste to be Placed in the DGR	Confirm that the maximum factor of expansion for the repository volume is 2. Provide the primary technical constraints that limit expansion capacity.	Follow-up to IR EIS 08-341. The response to IR EIS 04-145, referred to in IR EIS 08-341, stipulates a factor of 2, but it is not clear if this is a maximum.
EIS 10-495	• Section 8.1, General Information and Design Description	• EIS: Table 4.5.1-3, Summary of Waste Acceptance Criteria	Provide the waste package Design Requirements and Technical Specifications referenced in the response to IR EIS 08-343.	Follow-up to IR EIS 08-343.

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EIS 10-496	• Section 8.1, General Information and Design Description	• EIS: Table 4.5.1-3, Summary of Waste Acceptance Criteria	Provide specific information describing measures to ensure the physical stability of waste packages during transport, especially during underground cage operations, such as, for example, physical clamping of waste packages.	Follow-up to IR EIS 08-344. The response to IR EIS 08-344 was not sufficient.
EIS 10-497	• Section 10.1.6, Ambient Radioactivity	• *Radiation and Radioactivity TSD*: Section 5.9, Radioactivity in Groundwater	Resubmission of IR EIS 07-290. Provide an explanation for the steady increases of tritium detected in well WSH231 since 2002 and the increases of tritium in well WSH243 since 2007. Provide information regarding the radiological groundwater contamination in the existing Western Waste Management Facility (WWMF) area and any influences it may have on the proposed DGR project area.	The original response to IR EIS 07-290 was not sufficient. The reason for the increasing trends of tritium in WSH231 and at WSH243 was not addressed. The reasons for the increasing trends for tritium must be understood in order to determine if the DGR site might similarly be affected.
EIS 10-498	• Section 10, Existing Environment;	• EIS: Section 6.4.6 Wildlife Communities and Species • Terrestrial Environment TSD, Section 5.8, Significant Species (and subsections)	Provide the information below, as was originally requested by Environment Canada in an email to NWMO dated November 16, 2012 (CEARIS #893): a) Confirm whether the Ontario Ministry of Natural Resources (OMNR) has been informed regarding the possible presence of Western Chorus Frog (SARA THR) in the Local Study Area or the DGR Project Area. b) Confirm whether the OMNR has been informed regarding the possible presence of Eastern Milksnake (SARA SC) to be present in the Local Study Area or the DGR Project Area. If milksnakes are present (or have potential to be present), outline mitigation measures for this species.• c) Confirm whether OMNR has been informed regarding the possible presence of the Queen Snake at the DGR site.	Follow-up to IR EIS 01-15. a) Western Chorus Frog was recorded on the Bruce Nuclear Site in 2009 (Attachment 2, IR# EIS-01-15, p. 10, para. 5). b) OPG states ‘there is a possibility that eastern milksnake could be using the cultural habitat found on the DGR Project site…”, but further states that milksnakes have not been found and that there are no adverse effects on population(s) of Eastern Milksnake within the Local Study Area (Attachment 2, IR# EIS-01-15, p. 4, para. 4). If milksnakes ‘could be using’ the site then they ‘could be’ present and there ‘could be’ adverse effects. c) Confirming OMNR’s opinion with respect to the Queen Snake is important; while it may not be considered extant in the COSEWIC status report assessment, a future recovery action might involve verifying species' presence at historic sites (one of

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			d) Provide the survey protocols for Whip-poor-will that have been “established by OMNR” (Attachment 2, IR# EIS-01-15, p. 15, para. 1)	these being the Local Study Area). d) This information was requested by Environment Canada. Environment Canada noted that, for some SAR species, OPG indicated OMNR’s opinion as to whether or not the species is present in the Local Study Area and/or the DGR Project Area. Environment Canada recommends that the same consideration be applied for the other SAR species.