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Ecosystem specific dose conversion factors for Aberg, Beberg and Ceberg

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Abstract

The aim of this study was to calculate ecosystem specific dose conversion factors (EDFs) for three hypothetical sites, Aberg, Beberg and Ceberg, used in the safety analysis SR 97. The EDFs can, in combination with calculated releases of radionuclides from the geosphere, be used to illustrate relative differences in doses to the most exposed individual due to accidental leakage of radionuclides from a deep repository for spent nuclear fuel. Maps of the three sites were studied and subdivided into areas, which were characterised according to an earlier developed module system. For each of the identified modules, ecosystem transport and exposure model calculations were performed for release of 1 Bq per year during 10 000 years. 44 radionuclides contained within a deep repository for spent nuclear fuel were considered. A preliminary comparison of the EDFs for the three sites showed that the highest relative doses can be expected in Ceberg due to the high frequency of peat bog modules.

Summary

The aim of this study is to calculate ecosystem specific dose conversion factors (EDFs) for three sites; Aberg, Beberg and Ceberg. The EDFs can, in combination with calculated release data from the geosphere, be used to illustrate relative differences in doses to the most exposed individual due to accidental leakage of radionuclides from a deep repository for radioactive waste. The sizes of the three areas were 12, 15 and 28 km^2 respectively. Maps of the sites were studied and divided into uniformly sized squares (250 m·250 m) by a grid net. In each square, the biosphere types were identified and allocated to one of the available modules: well, lake, running waters, coast, agricultural land or peat bog. Models for such modules have been developed earlier (Bergström et al., 1999). The peat bog module was used for forest areas due to the present lack of a forest module. When several biosphere types were present in one square, the one causing the highest EDF was usually used to describe that square. The only exception was when a square included both water and land areas. The area was then transformed into the appropriate surface water module (lake, running water or coast). This was done because it is more probable that a discharge of groundwater occurs within the water body than in the surrounding land area. For each of the identified modules, ecosystem transport and exposure model calculations were performed for release of 1 Bq per year during 10 000 years. In total, 44 radionuclides contained within a deep repository for high level radioactive waste were considered.

Aberg is the most southerly site, situated on the coast while the others are situated inland. Modules for peat bogs were frequently used at all the sites, especially at the inland ones. Modules for coast and lakes were only applied for Aberg and Beberg respectively. Well modules were applied at all sites.

The exposure would, in reality, vary between locations, due to different biospheric conditions. A rough comparison between the calculated EDFs for each site shows that the highest relative doses would be expected in Ceberg. That is due to the high frequency of peat bog modules, which gives the highest EDFs. A comparison of the results from the peat bog and agricultural land modules between the sites shows that Aberg yields the highest EDFs due to lower water runoff causing a larger retention of radionuclides in soils and peats.

The method could be further improved by considering real discharge areas at the studied sites instead of the rather coarse division into squares. In addition, intensified studies at the sites should give possibilities to use additional site specific data concerning e.g. pootential affected areas, soil composition and land use. A forest module should also be developed.

Sammanfattning

Syftet med denna studie är att beräkna ekosystemspecifika dosomvandlingsfaktorer (EDF) för tre områden; Aberg, Beberg och Ceberg. Faktorerna kan användas tillsammans med beräknade utsläppsdata från geosfären för att illustrera relativa skillnader i doser till den mest exponerade individen till följd av ett oavsiktligt radionuklidutsläpp från ett djupförvar för använt kärnbränsle. Storleken på de tre områdena var 12, 15 respektive 28 km^2. Kartor över områdena studerades och delades med hjälp av ett rutnät in i lika stora rutor (250 m·250 m). Biosfärstyperna i varje ruta identifierades via ytterligare indelning och en av de tillgängliga modulerna (brunn, sjö, rinnande vatten, kust, jordbruksmark eller torvmosse) tilldelades. Modeller för dessa moduler har utvecklats tidigare (Bergström et al., 1999). Torvmossemodulen användes för rutor med skogsområden eftersom en modul för denna biosfärstyp saknas för tillfället. När flera olika biosfärstyper fanns inom samma ruta valdes vanligen den typ som gav högst EDF. Det enda undantaget var när rutor innehöll både vatten- och landområden. Området överfördes då till passande ytvattenmodul (sjö, rinnande vatten eller kust). Detta gjordes eftersom det är mer sannolikt att grundvattenutflöde sker i ytvatten än i omgivande mark. Ekosystemtransport- och exponeringsberäkningar gjordes för ett utsläpp av 1 Bq per år under 10 000 år för varje identifierad modul. Totalt beaktades 44 radionuklider från ett djupförvar för högaktivt avfall.

Aberg är det sydligaste området och ligger vid kusten medan de andra områdena ligger i inlandet. Torvmossemoduler användes frekvent framförallt i inlandsområdena. Kust- och sjömoduler användes enbart i Aberg respektive Beberg. Brunnmoduler användes i alla områden.

I realiteten skulle exponeringen variera mellan områdena på grund av olika biosfärsförhållanden. En grov jämförelse mellan framräknade EDF-värden för de olika områdena visar att de högsta relativa doserna kan förväntas i Ceberg. Detta beror på det stora antalet torvmossemoduler vilka ger de högsta EDF-värdena. En jämförelse av resultaten från torvmosse- och jordbruksmarksmodulerna mellan de olika områdena visar att högre EDF-värden genereras vid Aberg på grund av den lägre vattenomsättningen som skapar större retention av radionuklider i jord och torv.

Metoden kunde förbättras ytterligare genom att verkliga utströmningsområden vid de olika områdena användes istället för den rätt grova indelningen i rutor. Dessutom skulle intensifierade studier vid områdena ge möjlighet att använda ytterligare områdesspecifika data när det gäller t ex storleken på berörda utströmningsområden, jordsammansättning och områdesanvändning. En skogsmodul borde också utvecklas.

Contents

1 Introduction

The area around a potential site for a high-level waste repository consists of various types of ecosystems such as lakes, coastal areas, running waters, forests, agricultural soils and wetlands. Models for the turnover of radionuclides can be set up for each ecosystem. Such models (called modules in this report) can be applied to actual sites by the use of site specific information. Ecosystem and site specific dose conversion factors (EDFs) for the exposure from unit releases of radionuclides may then be obtained from such model calculations.

Six modules are currently available, well, lake, running waters, coast, agricultural land and peat bog, respectively. A detailed description of these is given in Bergström et al. (1999). The modules consider only stationary biosphere conditions and EDFs are calculated for a unit release during 10 000 years. Thus the EDFs represent in general steady state concentrations of the radionuclides in the compartments included in the modules for most radionuclides and modules. These steady-state conditions are obtained within a time period of some years or up to thousands of years depending on module and radionuclide properties. However, for immobile radionuclides in the agricultural land module steady state may not be obtained within the calculated 10 000 years (Bergström et al., 1999).

This report describes the selection of modules for three hypothetical sites, Aberg, Beberg and Ceberg, used in the safety assessment SR 97 (SKB, 1999). The site-specific information for these hypothetical sites is obtained from three real sites described in Lindborg & Schüldt (1998). The three sites are subdivided into a number of squares of equal sizes. A module is selected for each one of these squares, and EDFs are calculated based on conditions specific for that area. Combined with calculated release data from the geosphere, the sum EDFs of all nuclides can be used to compare the relative dose to the most exposed individual between sites. The final step was performed, and is presented in the main report (SR 97, 1999). The different steps in the procedure are shown in Figure 1 while Figure 2 gives an overview graph of the used concept.

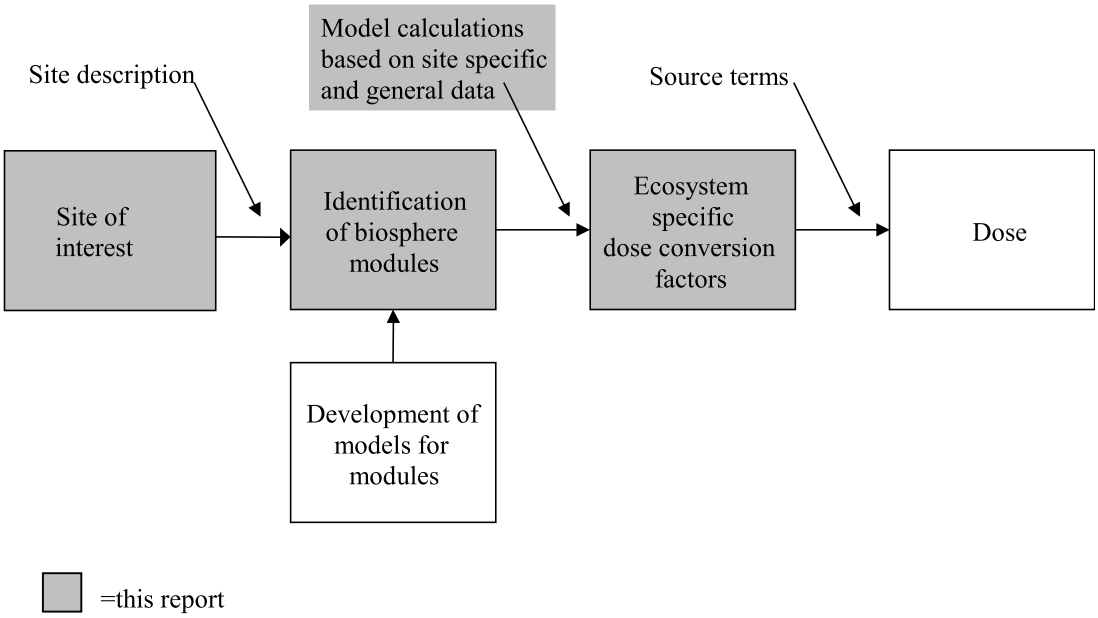

Figure 1 *The different steps in the process which result in the calculation of relative dose to the most exposed individual at the three hypothetical sites Aberg, Beberg and Ceberg. The shaded boxes show the parts of the process treated in this report.*

An outline of the module concept is shown Figure 2.

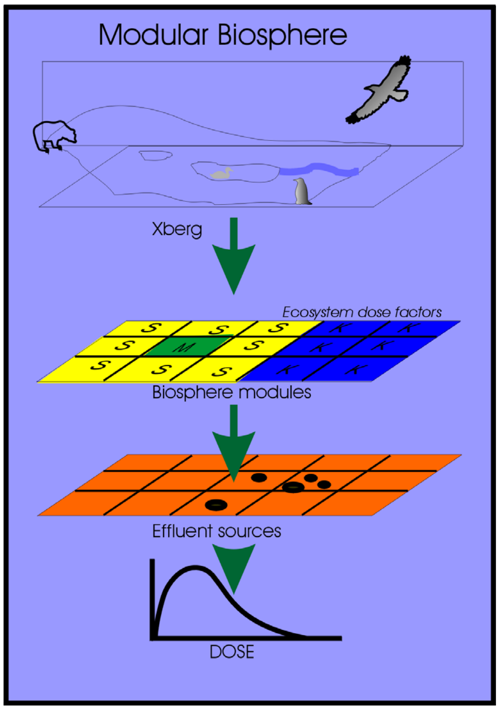

Figure 2 *The module concept used when calculating relative dose to most exposed individual. The modular biospheres at Aberg, Beberg and Ceberg, respectively, are used to calculate ecosystem dose factors (EDFs) which combined with data about the effluent sources gives the relative dose.*

The criteria used for selection of modules for each site are described in Chapter 2. Chapter 3 gives brief site descriptions of Aberg, Beberg and Ceberg, and shows the modules which were applied for each site and the resulting EDFs. A general discussion about the module concept is performed in Chapter 5 while Chapter 6 gives some conclusions. Illustrations of biosphere types and selected modules as well as EDF values for Aberg, Beberg and Ceberg are presented in Appendix A, B and C, respectively.

2 Methods

2.1 Classification of biosphere types

One of the three sites (Aberg) included in the study is situated on the coast while Beberg and Ceberg are inland sites. Ceberg is the most northerly located site, whereas Aberg is most southerly situated.

The sizes of the sites were selected to cover the hydrological model area (Walker et al., 1998, Hartley et al., 1998, Walker & Gylling, 1999). These areas are about 12 km^2 for Aberg, 15 km^2 for Beberg and 28 km^2 for Ceberg. Each site was subdivided by a 250 m·250 m grid. Depending on the ecosystems present in the square a specific module was assigned to each square. Although some of the squares may be considered as recharge areas without any outflow of groundwater all squares were attributed to specific modules.

The classification of the squares was based on environmental information on studies of maps (”Gröna kartan” 1:50 000, ”Ekonomiska kartan” 1:10 000 or ”Gula kartan” 1:20 000). The maps show where there are open water, open land, forests, and bogs. In addition the Swedish archive for wells was used to locate drilled wells in the areas (SGU, 1997).

The transformation of a square into a module needed a judgement for selection of module. This was easy when the entire square was covered by one of the types of ecosystems for which a module was designed. When several types of ecosystems were included in one square or when no module was designed for the ecosystem (e.g. forest), modules were conservatively selected in order to not underestimate the potential exposures. The generic calculations performed in Bergström et al. (1999) showed that the peat bog module gave the highest EDFs. This module was therefore applied for squares covered with forests. Squares including a well were represented by the well module. When a well was located on or close to the line between two squares, the well module was used for both squares. Wells influence the water table at various distances depending on the withdrawal of water from them. It is therefore reasonable to assume that the outflow of groundwater to such a square reaches the water in the well. Furthermore, the results in Bergström et al. (1999) showed that EDFs for the well module were higher than those for most other modules.

When a square was covered by more than one type of ecosystem, several considerations were made. A conservative selection was made when e.g. small streams appeared in combination with peat bogs or agricultural land. The module representing peat bogs was selected, due to the higher EDF for such a module. Small streams and ditches are usually symbolised similarly on maps and probably water from such small reservoirs will not cover the water demand for all the exposure pathways considered in the running water module. For larger running waters such as rivers and streams, the module for running waters was suggested. Many rivers are discharge areas for groundwater, which justified that assumption.

As the borders of lakes or the coastline, for natural reasons, do not follow the square borders, squares including both water and land areas were transformed into the appropriate surface water module (lake or coast). This was done because it is more probable that a discharge of groundwater occurs within the water body than in the surrounding land area.

2.2 Determination of site specific data

As far as possible site specific data were used for each type of module. The capacities of the wells were obtained from drilling protocols from the Swedish Archives on Wells, "Brunnsarkivet" (SGU, 1997). These protocols report the capacity of the newly drilled well in litres per hour. These data were used because information on the present capacities was lacking. Hydrological and morphometric data for lakes were, as far as possible, site specific and taken from the literature (Lindborg & Schüldt, 1998). The agricultural land and peat bog modules do not contain site specific data except for runoff. Data on annual amounts of water used for irrigation and size of irrigated areas were set to the same values for all the three sites.

The exposure pathways included in each module, e.g. intake of water and food, external exposure from agricultural soil and inhalation of resuspended particles from contaminated soils (Table 2.1), are independent of local conditions, c.f. Bergström et al. (1999).

Table 2.1 Exposure pathways included in each module (Bergström et al., 1999).

Module	Consumption of								Exposure	Inhalation of	
	water	milk/meat	root crops/ vegetables	soil	cereals	fish	crustacean	algae	from ground	dust from soil	gases from peat combustion
Well	Yes	Yes[1]	Yes[i]	Yes[4]	No				Yes	Yes	
Peat bog		Yes	Yes	Yes[4]	Yes				Yes	Yes	Yes[5]
Lake	Yes	Yes[2]	Yes[i]	Yes[4]	Yes[i]	Yes	Yes		Yes	Yes	
Running water	Yes	Yes[2]	Yes[i]	Yes[4]	Yes[i]	Yes	Yes		Yes	Yes	
Agricult. land		Yes	Yes	Yes[4]	Yes				Yes	Yes	
Coast		Yes[3]				Yes		Yes			

1 Contaminated by cattle's intake of water
2 Contaminated by cattle's intake of water, irrigated pasturage and water plants.
3 Contaminated by cattle's intake of water and water plants.
4 Intake of soil via for example insufficiently washed vegetables was assumed.
5 No filter equipment (filter efficiency factor = 1).
i Irrigation.
Yes = Considered in present EDFs.
No = Can be considered in the module but not included in present EDFs.
Blank = The exposure pathway is not included in the module.

3 Ecosystem specific dose conversion factors (EDFs)

Ecosystem specific dose conversion factors were calculated for the three sites Aberg, Beberg and Ceberg. The results are presented in Appendices A – C. A general discussion regarding EDFs for the modules is presented in Bergström et al. (1999), where also all generic and nuclide specific data are given.

3.1 Aberg

Aberg is situated on the Swedish Baltic coast. An archipelago with bays and islands, and also areas with open coast dominate the landscape. The bedrock consists mainly of granite, the soil layer is thin and outcrops are frequently present. Pine forests dominate the vegetation. The average precipitation is relatively low, about 675 mm per year. For a detailed description of the area, see Lindborg & Schüldt (1998).

A schematic map of the ecosystem types in the area is shown in Appendix A, Figure A.1, while the modules applied for the site are shown in Appendix A, Figure A.2. The most frequent modules are peat bogs and coastal areas. The large number of peat bog modules is due to the appearance of forests in the area, for which modules of peat bogs were used according to the methods described above. The coast module was also commonly used since Aberg is situated along the coast. This module described bays in acrhipelagos as well as open coasts by applying data relevant for these two types of ecosystem, see Table 3.2. The agricultural land module was applicable for a small area, and the well module was applied for three squares. The different modules used for Aberg are shown in Table 3.1. The table also shows where the results from the different modules can be found.

Table 3.1 An overview of where the results for the different modules used at Aberg can be found.

Type of module	Results in Appendix A, Table
Well	A.1 – A.3
Peat bog	A.4
Agricultural land	A.5
Coast (archipelago)	A.6
Coast (open)	A.7

General data

Data for the peat bog and agricultural land modules were taken from Bergström et al. (1999). Site-specific runoff values, varied between 0.15 and 0.20 m^3/m^2, were used for Aberg. The mean value was taken from Lindborg & Schüldt (1998) and the ranges were estimated from 30 years statistics of average precipitation in the area.

Coast module data

The same site-specific data were used for bays in the archipelago and open coast scenarios respectively (see Table 3.2). According to Engqvist (1997) bays with small water volumes have shorter water retention times than larger once leading to higher annual volumes for dispersion of the radionuclides. Because of this, data used for all the bays represent one of the largest bays in the area ("Borholmsfjärden") in order not to underestimate the EDFs.

Table 3.2 Site specific data for the coast at Aberg.

	Unit	Mean	Min (Triangularly distributed)	Max	Reference
Archipelago					
Surface area	m^2	1.4E6	1.3E6	1.5E6	Sundblad & Mathiasson, 1994
Mean depth	m	2.3	2.1	2.5	Sundblad & Mathiasson, 1994
Max depth	m	8	7.5	8.5	Sundblad & Mathiasson, 1994
Mean residence time of water in bay	days	45	42	48	Engqvist, 1997
Open coast					
Volume	m^3	1.7E8	1.4E8	2.0E8	Nordlinder & Bergström, 1992
Mean depth	m	7	6	8	Nordlinder & Bergström, 1992
Outflow from open coast (TC)	$year^{-1}$	44	30	57	Nordlinder & Bergström, 1992

Well module data

The exact location of the wells and their capacities according to “Brunnsarkivet” (SGU, 1997) are shown in Table 3.3. It was assumed that the measured capacity was the same during a year. The radionuclides were assumed to be mixed in a volume equal to the annual capacity. The ranges were estimated to be 10 % of the average values. Due to lack of information of the true distribution of the values, a triangular distribution was assumed.

Table 3.3 Capacity and location of wells in Aberg (SGU, 1997).

Number	Capacity (l/hour)	Min (Triangularly distributed)	Max	Co-ordinates RT 90[1]	
1	200	180	220	636621	155023
2	300	270	330	636621	155029
3	400	360	440	636753	155224

[1] RT 90 2.5 V is the Swedish national grid system, “Rikets koordinatsystem 1990”, National Land Survey of Sweden, “Lantmäteriverket”

3.2 Beberg

Beberg is a relatively flat inland area. It is dominated by moraine, peat bogs and outcropping rocks (Gustafsson et al., 1987). The vegetation consists mainly of forest with some cultivated areas in lower parts (Gustafsson et al., 1987). Wetlands are frequent due to the flatness. Forests, as well as cultivated areas have been extensively ditched (Sundblad & Bergström, 1983). There is one lake in Beberg, which drains the area (Wallsten & Blomqvist, 1982). The average precipitation is relatively low in Beberg too, about 670 mm per year. About 30 % of the site consist of groundwater discharge areas according to field mapping and calculations (Carlsson & Gidlund, 1983). For a more detailed description of the area, see Lindborg & Schüldt (1998).

A schematic picture of the ecosystem types in the area, according to information from maps, is shown in Appendix B, Figure B.1, while the modules applied are shown in Appendix B, Figure B.2. Peat bog is the most frequently used module, followed by the agricultural land and lake modules. A few modules for running waters were identified. According to the discussion above, running water modules were not applied for the small streams and ditches identified from the inspection of maps. Six wells were reported in the area with three different capacities. In two cases two wells with the same capacities were situated so close to each other that they was included in the same square and therefore only four well modules were used for the Beberg area. The different modules used for Beberg are shown in Table 3.4 with reference to where the results are presented.

Table 3.4 An overview of where the results for the different modules used at Beberg can be found.

Type of module	Results in Appendix B, Table
Well	B.1 – B.4
Peat bog	B.5
Agricultural land	B.6
Lake	B.7
Running water	B.8

General data

General data according to Bergström et al. (1999) were applied for the peat bog and agricultural land modules. An annual site-specific runoff value of 0.240 m^3/m^2 was used at Beberg, ranging from 0.20 m^3/m^2 up to 0.28 m^3/m^2. The mean value was taken from Lindborg & Schüldt (1998) and the ranges were estimated from 30 years statistics of average precipitation in the area.

Lake module data

The site-specific data used for the lake module is shown in Table 3.5. The ranges used were estimated to be 10 % of the mean values.

Table 3.5 Site specific data used in the lake module calculations.

	Unit	Mean	Min (Triangularly distributed)	Max	Reference
Area	km^2	4.3	3.9	4.7	Wallsten & Blomqvist, 1982
Max depth	m	4.1	3.7	4.5	Carlsson & Gidlund, 1983
Catchment area	km^2	117	105	129	Wallsten & Blomqvist, 1982

Well module data

The exact location of the wells and their capacities according to “Brunnsarkivet” are shown in Table 3.6. It was assumed that the measured capacity was the same during a year. The radionuclides were assumed to be mixed in a volume equal to the annual capacity. The ranges were estimated to be 10 % of the average values. Due to lack of information of the true distribution of the values a triangular distribution was assumed.

Table 3.6 Capacity and location of wells in Beberg (SGU, 1997).

Number	Capacity (l/hour)	Min (Triangularly distributed)	Max	Co-ordinates RT 90[1]	
1	400	360	440	669606	161810
				669600	161800
2	700	630	770	669644	161805
				669645	161817
3	900	810	990	669501	161723
4	3000	2700	3300	669940	161522

[1] RT 90 2.5 V is the Swedish national grid system, “Rikets koordinatsystem 1990”, National Land Survey of Sweden, “Lantmäteriverket”

Running waters module data

The stream in the area constitutes of the outflow from the lake. Therefore flow in the stream is set equal to the outflow of the lake by using the site specific runoff value for Beberg and the same catchment area as for the lake (see above).

3.3 Ceberg

Ceberg is located in the northern part of Sweden about 20 km inland from the Gulf of Bothnia within a mountainous area. The area of interest is a plateau about 100 to 150 m above the sea level. The average precipitation is about 765 mm per year. The dominating vegetation is pine tree forest. Areas of peat bog as well as outcrops of rock are present (Sundblad & Bergström, 1983). The Ceberg site belongs to the Southern boreal zone (Sjörs, 1967). Two rivers drain the area, see Appendix C, Figure C.1. Along one of the rivers, there are small-cultivated areas. For a detailed description of the area, see Lindborg & Schüldt (1998).

The module describing peat bog areas is the most frequently used for the site, see Appendix C, Figure C.2. The rest of the area is described by modules representing running waters and agricultural land. Two wells were identified within the area both situated at boarder lines of the grid net, resulting in four squares represented by the well module. The modules used for Ceberg are shown in Table 3.7 with references to where the results are presented.

Table 3.7 An overview of where the results for the different modules used at Ceberg can be found.

Type of module	Results in Appendix C, Table
Well	C.1 – C.2
Peat bog	C.3
Agricultural land	C.4
Running water	C.5 – C.6

General data

A site-specific runoff value of 0.345 m^3/m^2 was used, ranging from 0.29 m^3/m^2 up to 0.45 m^3/m^2. The mean value was taken from Lindborg & Schüldt (1998) and the ranges were estimated from 30 years statistics of average precipitation in the area.

Well module data

The exact location of the wells and their capacities according to "Brunnsarkivet" are shown in Table 3.8. It was assumed that the measured capacity was the same during a year. The radionuclides were assumed to be mixed in a volume equal to the annual capacity. The ranges were estimated to be 10 % of the average values. Due to lack of information of the true distribution of the values a triangular distribution was assumed.

Table 3.8 Capacity and location of wells in Ceberg (SGU, 1997).

Number	Capacity (l/hour)	Min (Triangularly distributed)	Max	Co-ordinates RT 90[1]	
1	400	360	440	704414	166120
2	600	540	660	704398	166062

[1] RT 90 2.5 V is the Swedish national grid system, "Rikets koordinatsystem 1990", National Land Survey of Sweden, "Lantmäteriverket"

Running waters module data

The site specific runoff values for Ceberg were used as input data for the running waters modules. Data on catchment areas for the stream and river, respectively, are shown in Table 3.9.

Table 3.9 Catchment area of the river and the stream in Ceberg (km^2)

	Area	Min	Max	References
		(Triangularly distributed)		
Stream	580	570	590	Sundblad & Bergström, 1983
River	3430	3420	3440	Melin, 1970 Sundblad & Bergström, 1983

4 Discussion

This discussion focuses on the module concept and on how uncertainties due to selection of module and used assumption will affect the results. Uncertainties in results due to conceptual modelling and input parameter values are handled in Bergström et al. (1999).

4.1 Source terms

The calculations were performed for a constant release rate into the biosphere of 1 Bq per year during 10 000 years for each of the radionuclides included in the study. The most appropriate method to use the modules for dose assessments to man would be to use the calculated release rates as input to the module. This would be a simple modification of the present module system. To use EDF on release rates must be done with precaution if e.g. the release rates are much shorter than the times to reach steady-state conditions. EDFs represent constant conditions both regarding releases and biosphere conditions. For radionuclides with short ecological half-lives, i.e. where steady state is reached within thousands of years, the release rate and EDF values are more certain to use for dose illustrations than for long-lived radionuclides having a high variation in release rates during the 10 000 years.

4.2 Geosphere – biosphere interface

The groundwater flow in the underlying geosphere is calculated to a level of approximately 30 m below the rock surface, leading to a gap between end points in the geosphere and the entrance to biosphere recipients (SKB, 1995). The horizontal transport of radionuclides with superficial groundwater flow is not considered and hence the inflow of radionuclides is assumed to occur into the type of biospheres (described as modules) above the end points (Bergström et al., 1999). This aspect needs to be evaluated when entrance points are calculated, because radionuclides may e.g. be transported to another ecosystem (described as module) than the one directly above.

Another aspect of this is that it is possible that radionuclides entered from several stream tubes may reach the same module. If a peat would receive radionuclides from several stream tubes the doses would increase. If the module is a surface water module instead, the high dispersion volume may lead to lower exposure than e.g. the entrance of one stream tube to a peat module. The results from the geosphere calculations and how they are applied need to be further analysed to quantify the importance of this.

4.3 Selection of modules

Previous studies have emphasised models for wells, lakes and coastal areas whereas the module system developed by Bergström et al. (1999), which was used in this study, also includes modules for groundwater discharge into agricultural land and peat bogs. Each site in the study was divided into uniformly sized squares to be handled in future calculations as a simple matrix. A more careful study of the topography at the site of interest would give the natural borders for drainage areas, lakes etc so that a more correct division into modules could be done. Moreover, the age of the map material used may lead to deviations from the real situation. Expected major changes in land use are e.g. decreased areas used for agricultural purposes as well as decreasing areas of wetlands due to ditching.

There are many sources to variation in results due to how the selection of modules was performed. One source is the use of a grid net with squares of 250x250 m. This was considered to be an appropriate scale for studies of maps and also manageable sizes to handle by the current methods. The location of the borderlines may also play a role for the selection of module types. Small changes of the grid could cause a change in the selection of modules. The importance for the results of how the border lines were set may vary considerably, depending on whether the studied site consists of large homogeneous areas or if several ecosystem types are present. One example of this is the case where a square includes a small part of a lake which would not be inside the square if the grid net was moved for example 150 m to the left or right. If the lake is included in the square the lake module, which give comparatively low EDFs will be used whereas for example the agricultural land module, which gives higher EDFs, is used if the lake is outside the square. To reduce uncertainties due to the division into modules the use of real discharge areas, instead of the rather crude use of grid nets, would be helpful.

In general, when several ecosystems were present within a square, the module giving the highest EDFs was selected. One example of this was when running water occurred in combination with peat bogs or agricultural land in a square. The size of the watercourse is of importance because groundwater outflow will probably take place in large streams and rivers to a larger amount than to small streams and ditches. One solution in these cases would be to choose the peat bog or agricultural land module when the watercourse was small and the running water module in cases with larger watercourses. Anyway, the EDFs could be more than two orders of magnitude lower for the running water module, compared to the EDFs from a peat bog or agricultural land module and therefore the later modules were chosen instead of the running water module in order not to underestimate the EDFs.

At present, no module is available for forest ecosystems. In this study, the peat bog module was used for these types of area. The influence of this on the results is unknown. It is reasonable to assume that EDFs for forest ecosystem could not be higher than those for agricultural land and peat bog.

4.4 Site-specific data

Site-specific data for this study were focused on runoff values and surface water volumes. For other conditions such as soil types, rate of irrigation, location of water tables, length of growing seasons, crop species, yield values etc general data were used. This was done because it was beyond the scope of this study to perform the detailed site-specific studies necessary for determination of such data. All element specific data used in the calculations were therefore the same for all sites, due to the limited information about e.g. soil compositions. Wide ranges were used for the element specific parameter values in the modelling (Bergström et al., 1999), which give major contributions to the uncertainties in calculated EDFs. The uncertainties could therefore be reduced if e.g. soil conditions are known.

The assumed consumption patterns or living habits for the most exposed individual were also general. It could be expected that e.g. people in the coastal areas consume considerably larger amounts of fish than inland people do. The species of cultivated crops may also vary from south to north.

4.5 Comparison between sites

The frequency of the various types of modules differs between the three areas. In Aberg the peat bog and coast modules dominate totally. Areas represented by the peat bog module are dominant in Beberg, followed by agricultural land and lake modules, while the running water module is sparsely represented. In Ceberg areas the peat bog module dominates totally, with some smaller areas represented by agricultural land and running waters modules. All three sites include wells with various capacities, from the lowest of 200 l/h at Aberg to the highest 3 000 l/h at Beberg.

Without data on the amounts of radionuclides and entrance points to the biosphere only some general comparisons can be made between the sites. The assumption is that an equal amount of radionuclides enter the biosphere at all three sites.

The peat bog module gives the highest EDFs and therefore the highest doses can be expected at Ceberg. The lowest doses are expected at Aberg due to its location at the coast, with a high frequency of coastal modules having lower EDFs than the other modules.

For the well module the EDFs are inversely proportional to the well capacity due to the diluting effect that the inflowing water has on the radionuclide concentration in the well water. Because of this, the well at Aberg, which has the lowest capacity, gives the highest EDFs when the results for the well modules are compared. Furthermore, Aberg has the lowest runoff values of the three sites. This results in higher EDFs for peat bog and agricultural land modules compared to results from the same modules at the other sites.

5 Conclusions

This approach to use EDFs with site specific parameter values reduces the width of the ranges in resulting doses due to variation in environmental parameters. It also points out the differences in how various ecosystems may expose man. It can be used for comparison of exposure due to the location of a repository at different sites. If assuming the same calculated releases, the relative doses can be expected to be highest at sites with a high frequency of peat bogs.

Most Swedish ecosystems are represented, except for forest and high mountains. The latter is not relevant in this aspect whereas a forest module should be developed. The method could be further improved by considering real discharge areas at the studied sites instead of the rather crude division into squares. In addition, intensified studies at the sites should give possibilities to use more site-specific data concerning e.g. soil composition and land use.

Furthermore, when applying EDFs to calculated time dependent releases the resulting doses will probably be an upper estimate of the exposure.

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Aberg

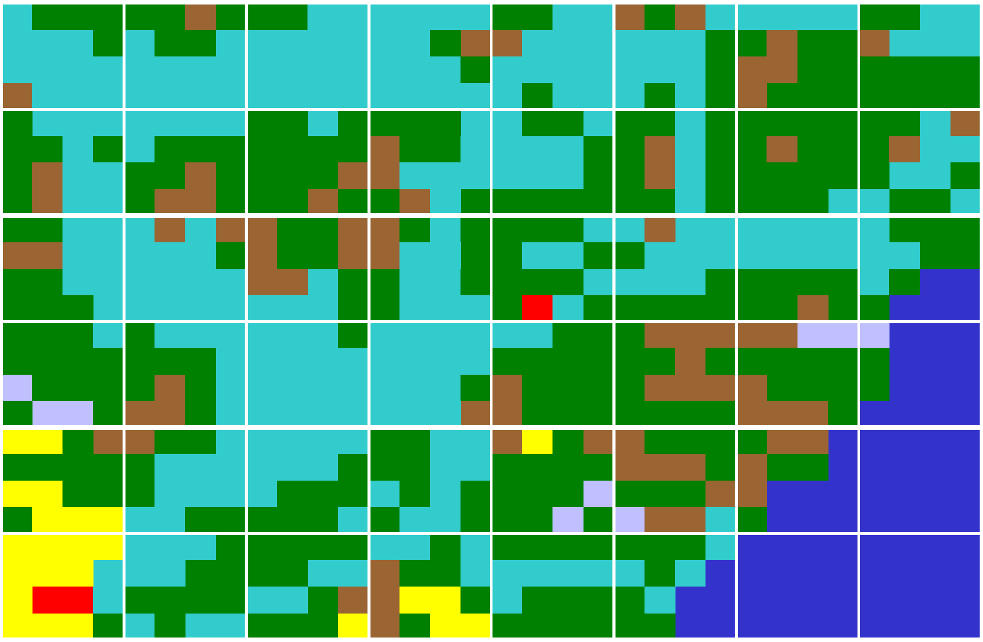

Figure A.1 The Aberg study site. Gridnet (125x125 m) with an illustration of the biosphere types. Lower left corner is positioned at 636600, 155000 RT 90.

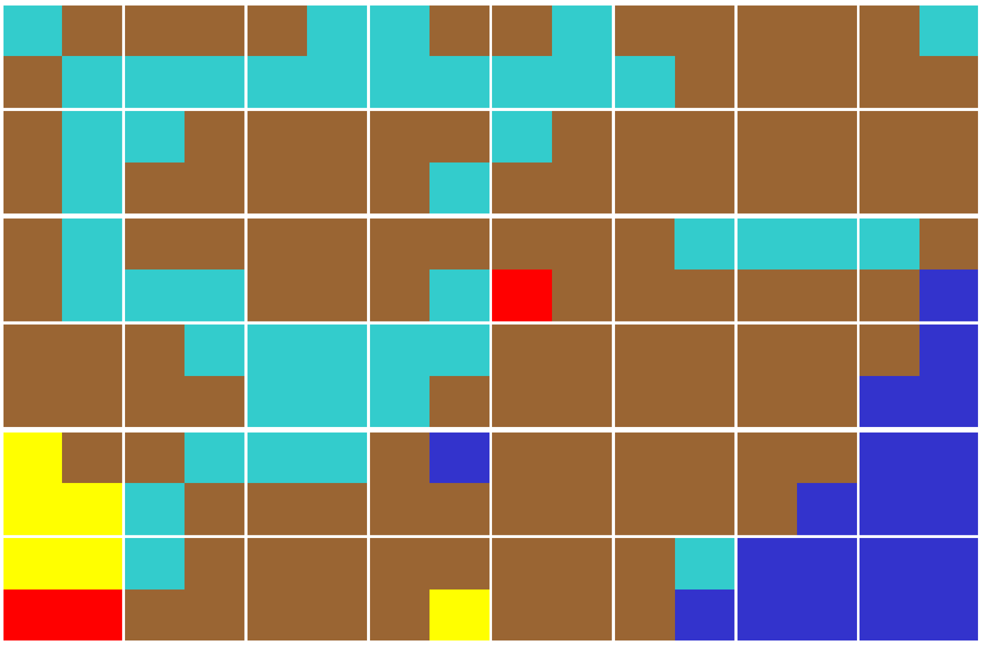

Figure A.2 The Aberg study site. Illustration of selected module types in squares of 250x250 m.

Table A.1 EDFs, Aberg well 1, 200 litre/hour.

Nuclide	Mean	Std	Low	High
H-3	1.4E-14	2.0E-15	1.0E-14	2.0E-14
Be-10	7.0E-13	1.4E-13	4.3E-13	1.2E-12
C-14	3.7E-13	5.5E-14	2.6E-13	5.4E-13
Cl-36	1.1E-12	3.5E-13	6.5E-13	2.9E-12
Co-60	1.6E-12	2.4E-13	1.1E-12	2.3E-12
Ni-59	9.1E-14	4.8E-14	3.7E-14	3.1E-13
Ni-63	9.4E-14	1.9E-14	6.0E-14	1.5E-13
Se-79	4.2E-12	2.3E-12	1.6E-12	1.7E-11
Sr-90	1.9E-11	3.9E-12	1.2E-11	3.3E-11
Zr-93	5.6E-13	7.5E-14	4.0E-13	7.7E-13
Nb-94	5.2E-12	2.5E-12	1.4E-12	1.3E-11
Mo-93	3.9E-12	2.1E-12	1.6E-12	1.4E-11
Tc-99	8.6E-13	4.1E-13	3.4E-13	2.4E-12
Pd-107	3.5E-14	1.5E-14	1.7E-14	1.1E-13
Ag-108m	2.0E-12	4.9E-13	1.2E-12	3.8E-12
Sn-126	6.0E-12	2.9E-12	2.7E-12	1.8E-11
I-129	1.4E-10	8.9E-11	6.2E-11	5.7E-10
Cs-135	3.0E-12	1.4E-12	1.4E-12	9.6E-12
Cs-137	8.4E-12	1.2E-12	5.9E-12	1.2E-11
Sm-151	4.7E-14	6.9E-15	3.3E-14	7.0E-14
Ho-166m	3.1E-12	7.1E-13	1.6E-12	5.1E-12
Pb-210	2.8E-10	3.2E-11	2.0E-10	3.9E-10
Ra-226	1.8E-10	3.8E-11	1.2E-10	3.3E-10
Ac-227	5.1E-10	7.4E-11	3.5E-10	7.4E-10
Th-229	6.3E-10	2.4E-10	2.9E-10	1.5E-09
Th-230	3.1E-10	1.3E-10	1.3E-10	7.9E-10
Th-232	3.4E-10	1.4E-10	1.5E-10	8.6E-10
Pa-231	1.0E-09	3.9E-10	4.6E-10	2.6E-09
U-233	2.9E-11	5.2E-12	2.0E-11	4.6E-11
U-234	2.8E-11	5.0E-12	1.9E-11	4.5E-11
U-235	2.7E-11	4.8E-12	1.8E-11	4.3E-11
U-236	2.7E-11	4.7E-12	1.8E-11	4.2E-11
U-238	2.5E-11	4.5E-12	1.7E-11	4.0E-11
Np-237	7.2E-11	2.3E-11	4.3E-11	2.0E-10
Pu-238	9.9E-11	1.2E-11	7.4E-11	1.4E-10
Pu-239	3.4E-10	1.4E-10	1.4E-10	9.0E-10
Pu-240	2.8E-10	1.1E-10	1.3E-10	7.0E-10
Pu-242	3.5E-10	1.5E-10	1.5E-10	9.6E-10
Am-241	1.0E-10	1.6E-11	6.8E-11	1.6E-10
Am-242m	8.4E-11	1.0E-11	6.1E-11	1.1E-10
Am-243	2.0E-10	7.8E-11	9.4E-11	5.1E-10
Cm-244	4.7E-11	5.1E-12	3.5E-11	6.1E-11
Cm-245	2.4E-10	9.3E-11	1.1E-10	6.1E-10
Cm-246	2.1E-10	7.4E-11	1.0E-10	5.0E-10

Table A.2 EDFs, Aberg well 2, 300 litre/hour.

Nuclide	Mean	Std	Low	High
H-3	9.4E-15	1.3E-15	6.7E-15	1.3E-14
Be-10	4.6E-13	9.2E-14	2.8E-13	8.0E-13
C-14	2.4E-13	3.6E-14	1.7E-13	3.5E-13
Cl-36	7.3E-13	2.2E-13	4.2E-13	1.9E-12
Co-60	1.1E-12	1.6E-13	7.5E-13	1.6E-12
Ni-59	5.9E-14	3.2E-14	2.4E-14	2.0E-13
Ni-63	6.2E-14	1.3E-14	4.0E-14	1.0E-13
Se-79	2.7E-12	1.5E-12	1.1E-12	1.1E-11
Sr-90	1.3E-11	2.6E-12	7.9E-12	2.2E-11
Zr-93	3.7E-13	4.9E-14	2.6E-13	5.0E-13
Nb-94	3.4E-12	1.7E-12	9.1E-13	8.3E-12
Mo-93	2.5E-12	1.4E-12	1.1E-12	9.3E-12
Tc-99	5.5E-13	2.7E-13	2.2E-13	1.6E-12
Pd-107	2.3E-14	9.9E-15	1.1E-14	6.8E-14
Ag-108m	1.3E-12	3.2E-13	7.9E-13	2.6E-12
Sn-126	3.9E-12	1.9E-12	1.8E-12	1.2E-11
I-129	9.2E-11	5.8E-11	4.0E-11	3.7E-10
Cs-135	1.9E-12	9.1E-13	9.1E-13	6.3E-12
Cs-137	5.6E-12	8.3E-13	3.9E-12	8.4E-12
Sm-151	3.2E-14	4.7E-15	2.2E-14	4.7E-14
Ho-166m	2.0E-12	4.8E-13	1.1E-12	3.4E-12
Pb-210	1.9E-10	2.1E-11	1.4E-10	2.6E-10
Ra-226	1.2E-10	2.5E-11	7.5E-11	2.2E-10
Ac-227	3.4E-10	5.0E-11	2.3E-10	5.0E-10
Th-229	4.2E-10	1.6E-10	1.9E-10	1.0E-09
Th-230	2.1E-10	8.6E-11	8.7E-11	5.3E-10
Th-232	2.3E-10	9.3E-11	9.5E-11	5.7E-10
Pa-231	6.8E-10	2.6E-10	3.1E-10	1.7E-09
U-233	1.9E-11	3.4E-12	1.3E-11	3.0E-11
U-234	1.8E-11	3.3E-12	1.2E-11	2.9E-11
U-235	1.7E-11	3.1E-12	1.2E-11	2.8E-11
U-236	1.7E-11	3.1E-12	1.2E-11	2.8E-11
U-238	1.6E-11	2.9E-12	1.1E-11	2.6E-11
Np-237	4.7E-11	1.5E-11	2.8E-11	1.3E-10
Pu-238	6.6E-11	7.8E-12	4.9E-11	9.1E-11
Pu-239	2.2E-10	9.4E-11	9.6E-11	6.0E-10
Pu-240	1.8E-10	7.0E-11	8.7E-11	4.7E-10
Pu-242	2.3E-10	1.0E-10	9.7E-11	6.4E-10
Am-241	6.8E-11	1.1E-11	4.6E-11	1.1E-10
Am-242m	5.6E-11	7.0E-12	4.1E-11	7.7E-11
Am-243	1.3E-10	5.2E-11	6.2E-11	3.4E-10
Cm-244	3.2E-11	3.4E-12	2.3E-11	4.1E-11
Cm-245	1.6E-10	6.2E-11	7.4E-11	4.1E-10
Cm-246	1.4E-10	5.0E-11	6.8E-11	3.4E-10

Table A.3 EDFs, Aberg well 3, 400 litre/hour.

Nuclide	Mean	Std	Low	High
H-3	6.9E-15	9.6E-16	5.0E-15	9.8E-15
Be-10	3.4E-13	6.8E-14	2.1E-13	6.0E-13
C-14	1.8E-13	2.6E-14	1.3E-13	2.6E-13
Cl-36	5.4E-13	1.6E-13	3.1E-13	1.4E-12
Co-60	8.2E-13	1.2E-13	5.6E-13	1.2E-12
Ni-59	4.4E-14	2.3E-14	1.8E-14	1.5E-13
Ni-63	4.7E-14	9.4E-15	3.0E-14	7.5E-14
Se-79	2.0E-12	1.1E-12	7.9E-13	8.1E-12
Sr-90	9.4E-12	1.9E-12	5.9E-12	1.6E-11
Zr-93	2.7E-13	3.7E-14	1.9E-13	3.7E-13
Nb-94	2.5E-12	1.3E-12	6.7E-13	6.2E-12
Mo-93	1.9E-12	1.0E-12	7.8E-13	6.9E-12
Tc-99	4.1E-13	2.0E-13	1.7E-13	1.2E-12
Pd-107	1.7E-14	7.3E-15	8.0E-15	5.1E-14
Ag-108m	1.0E-12	2.4E-13	5.9E-13	1.9E-12
Sn-126	2.9E-12	1.4E-12	1.3E-12	8.8E-12
I-129	6.8E-11	4.3E-11	3.0E-11	2.7E-10
Cs-135	1.4E-12	6.8E-13	6.8E-13	4.7E-12
Cs-137	4.2E-12	6.2E-13	2.9E-12	6.3E-12
Sm-151	2.4E-14	3.5E-15	1.6E-14	3.5E-14
Ho-166m	1.5E-12	3.6E-13	7.9E-13	2.5E-12
Pb-210	1.4E-10	1.6E-11	1.0E-10	1.9E-10
Ra-226	8.6E-11	1.8E-11	5.6E-11	1.6E-10
Ac-227	2.5E-10	3.7E-11	1.7E-10	3.7E-10
Th-229	3.1E-10	1.2E-10	1.4E-10	7.5E-10
Th-230	1.6E-10	6.4E-11	6.5E-11	3.9E-10
Th-232	1.7E-10	7.0E-11	7.1E-11	4.3E-10
Pa-231	5.1E-10	2.0E-10	2.3E-10	1.3E-09
U-233	1.4E-11	2.5E-12	9.4E-12	2.3E-11
U-234	1.3E-11	2.4E-12	9.0E-12	2.2E-11
U-235	1.3E-11	2.3E-12	8.6E-12	2.1E-11
U-236	1.3E-11	2.3E-12	8.6E-12	2.1E-11
U-238	1.2E-11	2.1E-12	8.3E-12	1.9E-11
Np-237	3.5E-11	1.1E-11	2.1E-11	9.8E-11
Pu-238	5.0E-11	5.9E-12	3.7E-11	6.8E-11
Pu-239	1.7E-10	7.0E-11	7.2E-11	4.5E-10
Pu-240	1.4E-10	5.3E-11	6.5E-11	3.5E-10
Pu-242	1.8E-10	7.6E-11	7.3E-11	4.8E-10
Am-241	5.1E-11	8.3E-12	3.4E-11	8.1E-11
Am-242m	4.2E-11	5.2E-12	3.1E-11	5.7E-11
Am-243	9.9E-11	3.9E-11	4.6E-11	2.5E-10
Cm-244	2.4E-11	2.6E-12	1.7E-11	3.1E-11
Cm-245	1.2E-10	4.6E-11	5.5E-11	3.1E-10
Cm-246	1.1E-10	3.7E-11	5.1E-11	2.5E-10

Table A.4 EDFs, Aberg, peat bog.

Nuclide	Mean	Std	Low	High
H-3	5.3E-16	6.3E-16	8.9E-17	4.2E-15
Be-10	1.3E-12	2.4E-12	1.3E-13	1.6E-11
C-14	1.1E-14	2.1E-14	2.9E-16	1.6E-13
Cl-36	3.6E-11	5.0E-11	2.8E-12	3.3E-10
Co-60	2.8E-13	4.6E-13	1.0E-14	2.8E-12
Ni-59	4.5E-13	6.4E-13	6.6E-14	4.1E-12
Ni-63	1.8E-13	2.8E-13	8.1E-15	2.0E-12
Se-79	2.7E-09	3.8E-09	2.9E-10	2.6E-08
Sr-90	2.1E-11	3.1E-11	1.7E-12	2.2E-10
Zr-93	6.1E-13	7.7E-13	6.2E-14	4.8E-12
Nb-94	3.0E-12	4.6E-12	2.3E-13	3.3E-11
Mo-93	4.1E-12	5.9E-12	4.2E-13	4.4E-11
Tc-99	7.0E-13	2.5E-12	1.6E-15	1.8E-11
Pd-107	1.0E-13	1.5E-13	1.3E-14	1.1E-12
Ag-108m	1.9E-11	3.0E-11	8.8E-13	2.3E-10
Sn-126	1.4E-10	2.0E-10	1.4E-11	1.4E-09
I-129	5.0E-11	6.7E-11	5.4E-12	4.7E-10
Cs-135	4.4E-12	5.5E-12	6.1E-13	3.7E-11
Cs-137	4.0E-12	7.8E-12	1.9E-13	3.6E-11
Sm-151	6.4E-15	1.1E-14	4.5E-16	8.4E-14
Ho-166m	2.3E-12	3.3E-12	1.8E-13	2.3E-11
Pb-210	1.6E-11	3.0E-11	5.7E-13	2.3E-10
Ra-226	1.7E-09	2.7E-09	1.5E-10	1.9E-08
Ac-227	6.3E-11	9.3E-11	3.5E-12	6.6E-10
Th-229	7.5E-09	1.2E-08	5.2E-10	9.9E-08
Th-230	4.4E-09	7.1E-09	3.1E-10	5.7E-08
Th-232	4.9E-09	7.8E-09	3.4E-10	6.3E-08
Pa-231	4.7E-09	7.2E-09	3.3E-10	5.2E-08
U-233	1.0E-11	2.1E-11	9.4E-14	1.4E-10
U-234	9.8E-12	2.0E-11	9.1E-14	1.4E-10
U-235	8.9E-12	1.8E-11	8.5E-14	1.3E-10
U-236	9.1E-12	1.9E-11	8.6E-14	1.3E-10
U-238	8.3E-12	1.7E-11	8.0E-14	1.2E-10
Np-237	1.8E-10	2.5E-10	2.0E-11	1.7E-09
Pu-238	3.9E-11	5.8E-11	1.8E-12	4.0E-10
Pu-239	6.2E-10	1.2E-09	1.4E-11	7.7E-09
Pu-240	5.2E-10	9.4E-10	1.4E-11	6.4E-09
Pu-242	6.3E-10	1.2E-09	1.3E-11	8.3E-09
Am-241	2.0E-10	3.3E-10	1.3E-11	2.6E-09
Am-242m	6.3E-11	1.0E-10	4.1E-12	8.1E-10
Am-243	1.9E-09	2.9E-09	1.1E-10	2.7E-08
Cm-244	5.6E-12	8.3E-12	3.7E-13	6.3E-11
Cm-245	1.2E-09	2.0E-09	6.3E-11	1.4E-08
Cm-246	9.9E-10	1.6E-09	5.8E-11	1.1E-08

Table A.5 EDFs, Aberg, agricultural land.

Nuclide	Mean	Std	Low	High
H-3	3.1E-15	4.2E-15	4.4E-16	3.3E-14
Be-10	1.7E-14	3.1E-14	3.4E-16	2.5E-13
C-14	5.7E-17	8.3E-17	4.3E-18	5.9E-16
Cl-36	1.1E-12	1.6E-12	1.3E-13	1.2E-11
Co-60	5.3E-18	2.8E-17	2.7E-21	2.4E-16
Ni-59	1.7E-14	2.6E-14	3.3E-16	1.9E-13
Ni-63	8.8E-17	3.0E-16	2.9E-19	1.4E-15
Se-79	4.3E-12	6.2E-12	4.2E-13	3.7E-11
Sr-90	4.5E-14	8.3E-14	5.9E-16	5.8E-13
Zr-93	4.0E-15	6.0E-15	7.9E-17	3.6E-14
Nb-94	3.3E-13	4.0E-13	3.0E-14	2.7E-12
Mo-93	1.7E-12	2.3E-12	8.6E-14	1.6E-11
Tc-99	1.7E-13	3.8E-13	3.9E-15	1.8E-12
Pd-107	4.8E-15	6.8E-15	2.8E-16	4.3E-14
Ag-108m	2.5E-14	4.7E-14	3.5E-16	3.1E-13
Sn-126	2.3E-12	3.3E-12	1.5E-13	2.3E-11
I-129	7.9E-11	1.3E-10	2.8E-12	8.2E-10
Cs-135	4.2E-13	7.8E-13	5.6E-15	5.4E-12
Cs-137	1.8E-16	5.3E-16	6.5E-19	4.0E-15
Sm-151	7.5E-19	1.5E-18	9.7E-21	1.1E-17
Ho-166m	4.0E-14	6.3E-14	2.1E-15	4.4E-13
Pb-210	4.2E-15	1.5E-14	9.7E-18	9.4E-14
Ra-226	1.1E-11	1.8E-11	5.0E-13	1.1E-10
Ac-227	7.6E-16	2.0E-15	1.1E-17	1.3E-14
Th-229	4.9E-12	1.3E-11	6.4E-14	8.8E-11
Th-230	3.2E-12	8.3E-12	4.2E-14	5.9E-11
Th-232	3.6E-12	9.4E-12	4.7E-14	6.7E-11
Pa-231	6.5E-12	1.3E-11	9.8E-14	7.6E-11
U-233	6.9E-13	9.3E-13	6.0E-14	6.7E-12
U-234	6.7E-13	9.1E-13	5.8E-14	6.5E-12
U-235	6.4E-13	8.6E-13	5.5E-14	6.2E-12
U-236	6.3E-13	8.5E-13	5.5E-14	6.1E-12
U-238	5.9E-13	7.8E-13	5.2E-14	5.7E-12
Np-237	3.8E-12	5.4E-12	2.2E-13	3.7E-11
Pu-238	3.6E-16	1.0E-15	5.8E-18	6.2E-15
Pu-239	1.2E-12	3.0E-12	2.6E-14	2.0E-11
Pu-240	8.1E-13	2.0E-12	1.7E-14	1.3E-11
Pu-242	1.4E-12	3.4E-12	2.9E-14	2.2E-11
Am-241	7.4E-14	1.4E-13	1.3E-15	1.2E-12
Am-242m	6.9E-15	1.4E-14	1.1E-16	1.2E-13
Am-243	3.0E-12	4.9E-12	7.5E-14	3.6E-11
Cm-244	4.1E-18	8.1E-18	4.9E-20	4.8E-17
Cm-245	1.1E-12	1.8E-12	1.7E-14	1.1E-11
Cm-246	7.4E-13	1.3E-12	1.2E-14	8.0E-12

Table A.6 EDFs, Aberg, coast (archipelago).

Nuclide	Mean	Std	Low	High
H-3	3.2E-18	1.5E-18	9.9E-19	9.0E-18
Be-10	3.9E-16	3.9E-16	3.3E-17	2.1E-15
C-14	1.7E-15	2.4E-16	1.2E-15	2.4E-15
Cl-36	1.6E-16	6.4E-17	6.3E-17	3.9E-16
Co-60	5.1E-16	2.5E-16	1.1E-16	1.3E-15
Ni-59	2.2E-17	9.6E-18	4.7E-18	5.0E-17
Ni-63	5.2E-17	2.2E-17	1.1E-17	1.1E-16
Se-79	1.4E-14	4.3E-15	6.8E-15	2.6E-14
Sr-90	1.3E-15	6.7E-16	3.2E-16	3.6E-15
Zr-93	9.0E-17	5.3E-17	1.6E-17	2.5E-16
Nb-94	2.1E-16	1.7E-16	2.1E-17	8.9E-16
Mo-93	9.2E-17	5.4E-17	1.5E-17	3.1E-16
Tc-99	1.7E-17	1.4E-17	1.4E-18	6.9E-17
Pd-107	1.2E-18	8.4E-19	2.0E-19	4.4E-18
Ag-108m	1.1E-15	5.0E-16	2.9E-16	2.6E-15
Sn-126	9.9E-16	8.3E-16	1.4E-16	4.4E-15
I-129	1.8E-14	8.8E-15	6.0E-15	5.6E-14
Cs-135	7.8E-16	2.4E-16	3.6E-16	1.5E-15
Cs-137	4.8E-15	1.4E-15	2.3E-15	9.2E-15
Sm-151	5.9E-18	4.5E-18	7.3E-19	2.4E-17
Ho-166m	1.3E-16	1.1E-16	1.4E-17	6.0E-16
Pb-210	8.5E-14	2.6E-14	4.0E-14	1.7E-13
Ra-226	1.6E-14	6.4E-15	4.9E-15	3.6E-14
Ac-227	1.8E-13	1.7E-13	1.5E-14	9.1E-13
Th-229	1.3E-14	1.1E-14	8.4E-16	4.9E-14
Th-230	5.4E-15	4.5E-15	3.6E-16	2.1E-14
Th-232	5.9E-15	5.0E-15	3.9E-16	2.3E-14
Pa-231	1.3E-14	1.2E-14	1.1E-15	6.8E-14
U-233	2.6E-15	1.1E-15	7.5E-16	5.9E-15
U-234	2.5E-15	1.1E-15	7.2E-16	5.7E-15
U-235	2.4E-15	1.0E-15	6.9E-16	5.4E-15
U-236	2.4E-15	1.0E-15	6.9E-16	5.4E-15
U-238	2.3E-15	1.0E-15	6.6E-16	5.2E-15
Np-237	2.0E-15	2.0E-15	1.8E-16	1.1E-14
Pu-238	5.1E-15	2.2E-15	1.4E-15	1.1E-14
Pu-239	6.4E-15	2.9E-15	1.5E-15	1.5E-14
Pu-240	6.3E-15	2.9E-15	1.5E-15	1.5E-14
Pu-242	6.1E-15	2.8E-15	1.4E-15	1.4E-14
Am-241	1.6E-14	9.4E-15	2.6E-15	4.6E-14
Am-242m	1.5E-14	8.8E-15	2.5E-15	4.3E-14
Am-243	1.6E-14	9.5E-15	2.6E-15	4.6E-14
Cm-244	4.0E-15	2.7E-15	7.5E-16	1.5E-14
Cm-245	1.6E-14	1.2E-14	2.7E-15	6.5E-14
Cm-246	1.6E-14	1.2E-14	2.7E-15	6.4E-14

Table A.7 EDFs, Aberg, coast (open).

Nuclide	Mean	Std	Low	High
H-3	1.2E-20	2E-19	3.6E-21	3.2E-20
Be-10	1.9E-18	1.9E-18	1.8E-19	1.1E-17
C-14	6.7E-18	1.4E-18	4E-18	1.1E-17
Cl-36	5.7E-19	2.5E-19	2.1E-19	1.6E-18
Co-60	3.3E-18	2E-18	6.4E-19	1.1E-17
Ni-59	9E-20	2E-19	1.9E-20	2.2E-19
Ni-63	2.1E-19	2E-19	4.6E-20	5.2E-19
Se-79	5.3E-17	1.8E-17	2.2E-17	1.2E-16
Sr-90	5E-18	2.6E-18	1E-18	1.5E-17
Zr-93	9.8E-19	6.9E-19	1.3E-19	3.8E-18
Nb-94	1.5E-18	1.3E-18	1.4E-19	6.5E-18
Mo-93	3.5E-19	2.1E-19	4.7E-20	1.3E-18
Tc-99	6.1E-19	4E-19	7.8E-20	2E-18
Pd-107	2.6E-20	2E-19	3.4E-21	1.1E-19
Ag-108m	4.3E-18	2.1E-18	1.1E-18	1.1E-17
Sn-126	3.8E-18	3.2E-18	4.6E-19	1.7E-17
I-129	1.1E-16	6.4E-17	2.9E-17	3.7E-16
Cs-135	2.9E-18	9.8E-19	1.2E-18	6.4E-18
Cs-137	1.8E-17	5.8E-18	7.7E-18	3.7E-17
Sm-151	9.1E-20	2E-19	6.8E-21	3.4E-19
Ho-166m	1.9E-18	1.5E-18	1.4E-19	7.1E-18
Pb-210	6E-16	3.7E-16	1.7E-16	2.3E-15
Ra-226	7E-17	3.5E-17	1.7E-17	2E-16
Ac-227	1.4E-15	1.2E-15	9.8E-17	5.5E-15
Th-229	4E-16	2.8E-16	5.1E-17	1.3E-15
Th-230	1.7E-16	1.2E-16	2.2E-17	5.7E-16
Th-232	1.9E-16	1.3E-16	2.4E-17	6.2E-16
Pa-231	4.8E-17	4.7E-17	3.8E-18	2.6E-16
U-233	1.1E-17	5.6E-18	2.7E-18	3.1E-17
U-234	1.1E-17	5.4E-18	2.6E-18	3E-17
U-235	1E-17	5.1E-18	2.5E-18	2.9E-17
U-236	1E-17	5.1E-18	2.5E-18	2.9E-17
U-238	9.7E-18	4.9E-18	2.4E-18	2.8E-17
Np-237	7.6E-18	7.6E-18	6.5E-19	4.1E-17
Pu-238	4.8E-17	3.6E-17	6.8E-18	2E-16
Pu-239	5.5E-17	4.2E-17	7.5E-18	2.4E-16
Pu-240	5.5E-17	4.2E-17	7.4E-18	2.4E-16
Pu-242	5.3E-17	4E-17	7.2E-18	2.3E-16
Am-241	2E-16	1.5E-16	1.9E-17	7.1E-16
Am-242m	1.9E-16	1.4E-16	1.8E-17	6.7E-16
Am-243	2E-16	1.5E-16	1.9E-17	7.1E-16
Cm-244	9.7E-17	7.4E-17	9.5E-18	3.6E-16
Cm-245	2.1E-16	1.6E-16	2E-17	7.6E-16
Cm-246	2.1E-16	1.6E-16	2E-17	7.6E-16

Beberg

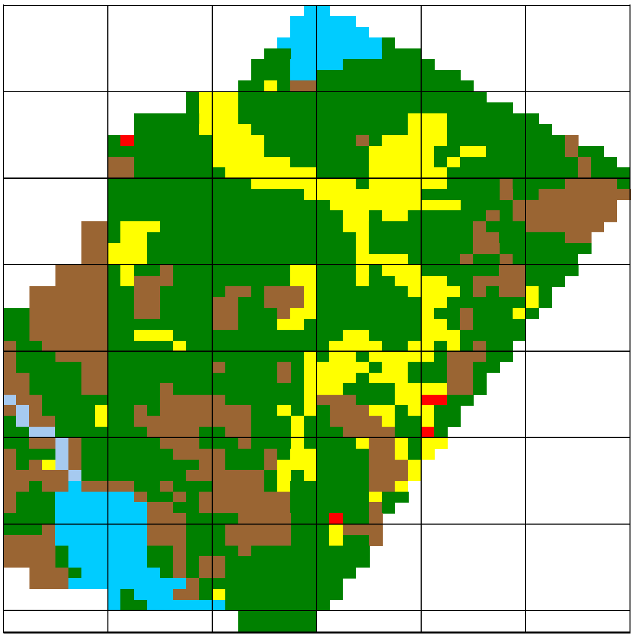

Figure B.1 The Beberg study site. Gridnet (125x125 m) with an illustration of the biosphere types.The southern boarder of the area is at 669375 and the eastern boarder at 1614000 in RT 90 co-ordinates.

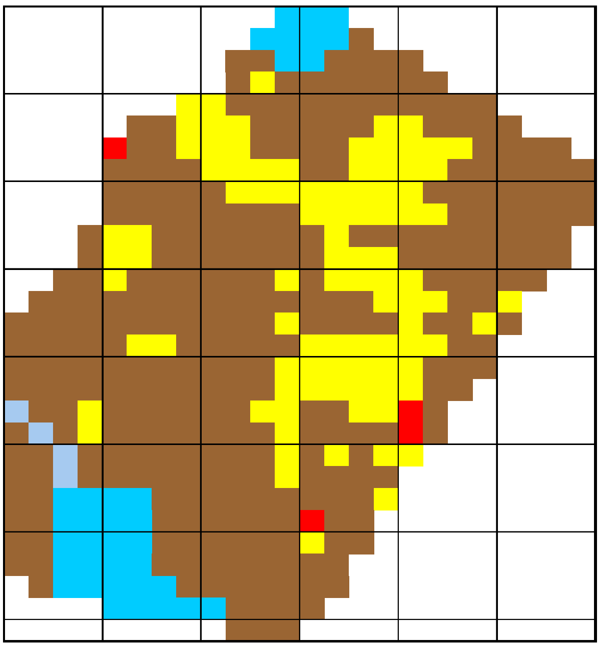

Figure B.2 The Beberg study site. Illustration of selected module types in squares of 250x250 m.

Table B.1 EDFs Beberg, well 1, 400 litre/hour.

Nuclide	Mean	Std	Low	High
H-3	6.9E-15	9.6E-16	5.0E-15	9.8E-15
Be-10	3.4E-13	6.8E-14	2.1E-13	6.0E-13
C-14	1.8E-13	2.6E-14	1.3E-13	2.6E-13
Cl-36	5.4E-13	1.6E-13	3.1E-13	1.4E-12
Co-60	8.2E-13	1.2E-13	5.6E-13	1.2E-12
Ni-59	4.4E-14	2.3E-14	1.8E-14	1.5E-13
Ni-63	4.7E-14	9.4E-15	3.0E-14	7.5E-14
Se-79	2.0E-12	1.1E-12	7.9E-13	8.1E-12
Sr-90	9.4E-12	1.9E-12	5.9E-12	1.6E-11
Zr-93	2.7E-13	3.7E-14	1.9E-13	3.7E-13
Nb-94	2.5E-12	1.3E-12	6.7E-13	6.2E-12
Mo-93	1.9E-12	1.0E-12	7.8E-13	6.9E-12
Tc-99	4.1E-13	2.0E-13	1.7E-13	1.2E-12
Pd-107	1.7E-14	7.3E-15	8.0E-15	5.1E-14
Ag-108m	1.0E-12	2.4E-13	5.9E-13	1.9E-12
Sn-126	2.9E-12	1.4E-12	1.3E-12	8.8E-12
I-129	6.8E-11	4.3E-11	3.0E-11	2.7E-10
Cs-135	1.4E-12	6.8E-13	6.8E-13	4.7E-12
Cs-137	4.2E-12	6.2E-13	2.9E-12	6.3E-12
Sm-151	2.4E-14	3.5E-15	1.6E-14	3.5E-14
Ho-166m	1.5E-12	3.6E-13	7.9E-13	2.5E-12
Pb-210	1.4E-10	1.6E-11	1.0E-10	1.9E-10
Ra-226	8.6E-11	1.8E-11	5.6E-11	1.6E-10
Ac-227	2.5E-10	3.7E-11	1.7E-10	3.7E-10
Th-229	3.1E-10	1.2E-10	1.4E-10	7.5E-10
Th-230	1.6E-10	6.4E-11	6.5E-11	3.9E-10
Th-232	1.7E-10	7.0E-11	7.1E-11	4.3E-10
Pa-231	5.1E-10	2.0E-10	2.3E-10	1.3E-09
U-233	1.4E-11	2.5E-12	9.4E-12	2.3E-11
U-234	1.3E-11	2.4E-12	9.0E-12	2.2E-11
U-235	1.3E-11	2.3E-12	8.6E-12	2.1E-11
U-236	1.3E-11	2.3E-12	8.6E-12	2.1E-11
U-238	1.2E-11	2.1E-12	8.3E-12	1.9E-11
Np-237	3.5E-11	1.1E-11	2.1E-11	9.8E-11
Pu-238	5.0E-11	5.9E-12	3.7E-11	6.8E-11
Pu-239	1.7E-10	7.0E-11	7.2E-11	4.5E-10
Pu-240	1.4E-10	5.3E-11	6.5E-11	3.5E-10
Pu-242	1.8E-10	7.6E-11	7.3E-11	4.8E-10
Am-241	5.1E-11	8.3E-12	3.4E-11	8.1E-11
Am-242m	4.2E-11	5.2E-12	3.1E-11	5.7E-11
Am-243	9.9E-11	3.9E-11	4.6E-11	2.5E-10
Cm-244	2.4E-11	2.6E-12	1.7E-11	3.1E-11
Cm-245	1.2E-10	4.6E-11	5.5E-11	3.1E-10
Cm-246	1.1E-10	3.7E-11	5.1E-11	2.5E-10

Table B.2 EDFs Beberg, well 2, 700 litre/hour.

Nuclide	Mean	Std	Low	High
H-3	3.9E-15	5.3E-16	2.8E-15	5.5E-15
Be-10	1.9E-13	3.9E-14	1.2E-13	3.4E-13
C-14	1.0E-13	1.5E-14	7.0E-14	1.5E-13
Cl-36	3.0E-13	9.2E-14	1.8E-13	7.7E-13
Co-60	4.7E-13	6.9E-14	3.2E-13	6.7E-13
Ni-59	2.5E-14	1.3E-14	1.0E-14	8.3E-14
Ni-63	2.7E-14	5.4E-15	1.7E-14	4.3E-14
Se-79	1.1E-12	6.3E-13	4.4E-13	4.6E-12
Sr-90	5.3E-12	1.1E-12	3.4E-12	9.3E-12
Zr-93	1.5E-13	2.1E-14	1.1E-13	2.1E-13
Nb-94	1.4E-12	7.1E-13	3.8E-13	3.5E-12
Mo-93	1.1E-12	5.7E-13	4.4E-13	3.9E-12
Tc-99	2.3E-13	1.1E-13	9.3E-14	6.5E-13
Pd-107	9.4E-15	4.1E-15	4.5E-15	2.8E-14
Ag-108m	5.7E-13	1.4E-13	3.3E-13	1.1E-12
Sn-126	1.6E-12	7.7E-13	7.3E-13	4.9E-12
I-129	3.8E-11	2.4E-11	1.7E-11	1.5E-10
Cs-135	8.2E-13	3.8E-13	3.8E-13	2.7E-12
Cs-137	2.4E-12	3.6E-13	1.7E-12	3.6E-12
Sm-151	1.4E-14	2.0E-15	9.3E-15	2.0E-14
Ho-166m	8.7E-13	2.1E-13	4.5E-13	1.4E-12
Pb-210	8.0E-11	9.2E-12	5.8E-11	1.1E-10
Ra-226	4.9E-11	1.0E-11	3.1E-11	9.2E-11
Ac-227	1.4E-10	2.1E-11	9.8E-11	2.1E-10
Th-229	1.8E-10	6.8E-11	8.1E-11	4.3E-10
Th-230	8.9E-11	3.7E-11	3.7E-11	2.2E-10
Th-232	9.7E-11	4.0E-11	4.0E-11	2.4E-10
Pa-231	2.9E-10	1.1E-10	1.3E-10	7.2E-10
U-233	7.8E-12	1.4E-12	5.2E-12	1.3E-11
U-234	7.5E-12	1.3E-12	5.0E-12	1.2E-11
U-235	7.2E-12	1.3E-12	4.8E-12	1.2E-11
U-236	7.2E-12	1.3E-12	4.8E-12	1.2E-11
U-238	6.8E-12	1.2E-12	4.6E-12	1.1E-11
Np-237	1.9E-11	6.3E-12	1.2E-11	5.5E-11
Pu-238	2.8E-11	3.4E-12	2.1E-11	3.9E-11
Pu-239	9.6E-11	4.0E-11	4.1E-11	2.6E-10
Pu-240	7.9E-11	3.0E-11	3.7E-11	2.0E-10
Pu-242	1.0E-10	4.3E-11	4.2E-11	2.8E-10
Am-241	2.9E-11	4.7E-12	2.0E-11	4.6E-11
Am-242m	2.4E-11	3.0E-12	1.7E-11	3.3E-11
Am-243	5.6E-11	2.2E-11	2.6E-11	1.4E-10
Cm-244	1.4E-11	1.5E-12	9.9E-12	1.8E-11
Cm-245	6.9E-11	2.6E-11	3.2E-11	1.8E-10
Cm-246	6.0E-11	2.1E-11	2.9E-11	1.4E-10

Table B.3 EDFs Beberg, well 3, 900 litre/hour.

Nuclide	Mean	Std	Low	High
H-3	3.0E-15	4.1E-16	2.2E-15	4.2E-15
Be-10	1.5E-13	3.0E-14	9.2E-14	2.6E-13
C-14	7.7E-14	1.1E-14	5.4E-14	1.1E-13
Cl-36	2.3E-13	7.1E-14	1.4E-13	5.9E-13
Co-60	3.6E-13	5.4E-14	2.5E-13	5.2E-13
Ni-59	1.9E-14	1.0E-14	7.7E-15	6.4E-14
Ni-63	2.1E-14	4.2E-15	1.3E-14	3.3E-14
Se-79	8.6E-13	4.8E-13	3.4E-13	3.5E-12
Sr-90	4.1E-12	8.4E-13	2.6E-12	7.2E-12
Zr-93	1.2E-13	1.6E-14	8.4E-14	1.6E-13
Nb-94	1.1E-12	5.5E-13	2.9E-13	2.7E-12
Mo-93	8.2E-13	4.4E-13	3.4E-13	3.0E-12
Tc-99	1.8E-13	8.5E-14	7.2E-14	5.0E-13
Pd-107	7.3E-15	3.2E-15	3.5E-15	2.2E-14
Ag-108m	4.4E-13	1.1E-13	2.6E-13	8.5E-13
Sn-126	1.2E-12	5.9E-13	5.7E-13	3.8E-12
I-129	3.0E-11	1.8E-11	1.3E-11	1.2E-10
Cs-135	6.3E-13	3.0E-13	2.9E-13	2.1E-12
Cs-137	1.9E-12	2.8E-13	1.3E-12	2.8E-12
Sm-151	1.1E-14	1.6E-15	7.2E-15	1.6E-14
Ho-166m	6.8E-13	1.6E-13	3.5E-13	1.1E-12
Pb-210	6.2E-11	7.1E-12	4.5E-11	8.5E-11
Ra-226	3.8E-11	8.0E-12	2.4E-11	7.1E-11
Ac-227	1.1E-10	1.7E-11	7.6E-11	1.7E-10
Th-229	1.4E-10	5.3E-11	6.2E-11	3.3E-10
Th-230	6.9E-11	2.8E-11	2.9E-11	1.7E-10
Th-232	7.5E-11	3.1E-11	3.1E-11	1.9E-10
Pa-231	2.3E-10	8.7E-11	1.0E-10	5.6E-10
U-233	6.0E-12	1.1E-12	4.0E-12	9.8E-12
U-234	5.8E-12	1.0E-12	3.9E-12	9.5E-12
U-235	5.5E-12	9.8E-13	3.7E-12	9.0E-12
U-236	5.5E-12	9.8E-13	3.7E-12	9.0E-12
U-238	5.3E-12	9.2E-13	3.6E-12	8.5E-12
Np-237	1.5E-11	4.8E-12	8.9E-12	4.3E-11
Pu-238	2.2E-11	2.6E-12	1.6E-11	3.0E-11
Pu-239	7.4E-11	3.1E-11	3.2E-11	2.0E-10
Pu-240	6.1E-11	2.3E-11	2.9E-11	1.5E-10
Pu-242	7.7E-11	3.4E-11	3.2E-11	2.1E-10
Am-241	2.2E-11	3.7E-12	1.5E-11	3.6E-11
Am-242m	1.9E-11	2.3E-12	1.4E-11	2.5E-11
Am-243	4.4E-11	1.7E-11	2.0E-11	1.1E-10
Cm-244	1.0E-11	1.1E-12	7.7E-12	1.4E-11
Cm-245	5.4E-11	2.1E-11	2.4E-11	1.4E-10
Cm-246	4.7E-11	1.6E-11	2.3E-11	1.1E-10

Table B.4 EDFs Beberg, well 4, 3000 litre/hour.

Nuclide	Mean	Std	Low	High
H-3	8.9E-16	1.2E-16	6.4E-16	1.3E-15
Be-10	4.4E-14	8.9E-15	2.8E-14	7.7E-14
C-14	2.3E-14	3.3E-15	1.6E-14	3.3E-14
Cl-36	6.9E-14	2.1E-14	4.1E-14	1.8E-13
Co-60	1.1E-13	1.6E-14	7.5E-14	1.6E-13
Ni-59	5.7E-15	3.0E-15	2.3E-15	1.9E-14
Ni-63	6.2E-15	1.2E-15	4.0E-15	1.0E-14
Se-79	2.6E-13	1.4E-13	1.0E-13	1.0E-12
Sr-90	1.2E-12	2.5E-13	7.8E-13	2.1E-12
Zr-93	3.6E-14	4.8E-15	2.5E-14	4.8E-14
Nb-94	3.3E-13	1.7E-13	8.6E-14	8.1E-13
Mo-93	2.4E-13	1.3E-13	1.0E-13	8.8E-13
Tc-99	5.2E-14	2.5E-14	2.1E-14	1.5E-13
Pd-107	2.2E-15	9.5E-16	1.0E-15	6.5E-15
Ag-108m	1.3E-13	3.2E-14	7.7E-14	2.5E-13
Sn-126	3.7E-13	1.7E-13	1.7E-13	1.1E-12
I-129	8.8E-12	5.5E-12	3.9E-12	3.5E-11
Cs-135	1.9E-13	8.8E-14	8.7E-14	6.2E-13
Cs-137	5.6E-13	8.3E-14	3.9E-13	8.4E-13
Sm-151	3.2E-15	4.7E-16	2.2E-15	4.7E-15
Ho-166m	2.0E-13	4.8E-14	1.0E-13	3.4E-13
Pb-210	1.9E-11	2.1E-12	1.4E-11	2.6E-11
Ra-226	1.1E-11	2.4E-12	7.2E-12	2.1E-11
Ac-227	3.4E-11	5.0E-12	2.3E-11	5.0E-11
Th-229	4.1E-11	1.6E-11	1.9E-11	1.0E-10
Th-230	2.1E-11	8.5E-12	8.6E-12	5.2E-11
Th-232	2.3E-11	9.3E-12	9.4E-12	5.7E-11
Pa-231	6.8E-11	2.6E-11	3.1E-11	1.7E-10
U-233	1.8E-12	3.2E-13	1.2E-12	2.9E-12
U-234	1.7E-12	3.1E-13	1.2E-12	2.8E-12
U-235	1.6E-12	2.9E-13	1.1E-12	2.7E-12
U-236	1.6E-12	2.9E-13	1.1E-12	2.7E-12
U-238	1.6E-12	2.7E-13	1.1E-12	2.5E-12
Np-237	4.4E-12	1.4E-12	2.7E-12	1.3E-11
Pu-238	6.6E-12	7.8E-13	4.9E-12	9.1E-12
Pu-239	2.2E-11	9.4E-12	9.6E-12	6.0E-11
Pu-240	1.8E-11	7.0E-12	8.7E-12	4.7E-11
Pu-242	2.3E-11	1.0E-11	9.7E-12	6.4E-11
Am-241	6.7E-12	1.1E-12	4.6E-12	1.1E-11
Am-242m	5.6E-12	7.0E-13	4.1E-12	7.7E-12
Am-243	1.3E-11	5.2E-12	6.0E-12	3.3E-11
Cm-244	3.2E-12	3.4E-13	2.3E-12	4.1E-12
Cm-245	1.6E-11	6.2E-12	7.4E-12	4.1E-11
Cm-246	1.4E-11	4.9E-12	6.8E-12	3.4E-11

Table B.5 EDFs Beberg, peat bog.

Nuclide	Mean	Std	Low	High
H-3	3.6E-16	4.2E-16	6.1E-17	2.7E-15
Be-10	8.6E-13	1.7E-12	7.7E-14	9.8E-12
C-14	6.5E-15	1.3E-14	1.7E-16	9.8E-14
Cl-36	2.2E-11	3.0E-11	1.7E-12	2.0E-10
Co-60	2.8E-13	4.5E-13	1.0E-14	2.7E-12
Ni-59	2.7E-13	3.9E-13	4.1E-14	2.5E-12
Ni-63	1.6E-13	2.4E-13	8.0E-15	1.6E-12
Se-79	1.7E-09	2.4E-09	1.7E-10	1.7E-08
Sr-90	1.8E-11	2.6E-11	1.3E-12	1.8E-10
Zr-93	4.4E-13	5.6E-13	3.8E-14	3.5E-12
Nb-94	2.0E-12	3.3E-12	1.4E-13	2.4E-11
Mo-93	2.5E-12	3.6E-12	2.6E-13	2.6E-11
Tc-99	4.2E-13	1.5E-12	9.4E-16	1.1E-11
Pd-107	6.4E-14	9.0E-14	7.6E-15	7.1E-13
Ag-108m	1.9E-11	2.9E-11	8.8E-13	2.3E-10
Sn-126	8.6E-11	1.3E-10	8.7E-12	9.1E-10
I-129	3.0E-11	4.1E-11	3.3E-12	2.8E-10
Cs-135	2.7E-12	3.3E-12	3.7E-13	2.2E-11
Cs-137	3.5E-12	6.4E-12	1.9E-13	2.9E-11
Sm-151	6.0E-15	1.0E-14	4.4E-16	8.1E-14
Ho-166m	1.9E-12	2.8E-12	1.2E-13	2.0E-11
Pb-210	1.6E-11	3.0E-11	5.7E-13	2.3E-10
Ra-226	1.2E-09	2.1E-09	1.1E-10	1.6E-08
Ac-227	6.2E-11	9.2E-11	3.5E-12	6.5E-10
Th-229	7.0E-09	1.1E-08	5.1E-10	8.6E-08
Th-230	4.0E-09	6.4E-09	3.0E-10	5.0E-08
Th-232	4.4E-09	7.1E-09	3.4E-10	5.5E-08
Pa-231	3.5E-09	5.6E-09	2.0E-10	4.3E-08
U-233	6.1E-12	1.3E-11	5.7E-14	8.7E-11
U-234	5.9E-12	1.2E-11	5.5E-14	8.4E-11
U-235	5.4E-12	1.1E-11	5.1E-14	7.6E-11
U-236	5.5E-12	1.1E-11	5.2E-14	7.8E-11
U-238	5.1E-12	1.0E-11	4.8E-14	7.2E-11
Np-237	1.1E-10	1.5E-10	1.2E-11	1.0E-09
Pu-238	3.7E-11	5.4E-11	1.8E-12	3.6E-10
Pu-239	4.1E-10	8.1E-10	8.4E-12	6.4E-09
Pu-240	3.6E-10	6.7E-10	8.3E-12	4.9E-09
Pu-242	4.1E-10	8.3E-10	8.1E-12	6.8E-09
Am-241	2.0E-10	3.2E-10	1.3E-11	2.6E-09
Am-242m	6.3E-11	1.0E-10	4.1E-12	8.1E-10
Am-243	1.8E-09	2.8E-09	1.1E-10	2.5E-08
Cm-244	5.5E-12	8.3E-12	3.6E-13	6.1E-11
Cm-245	9.8E-10	1.7E-09	4.4E-11	1.2E-08
Cm-246	8.1E-10	1.4E-09	4.0E-11	1.0E-08

Table B.6 EDFs Beberg, agricultural land.

Nuclide	Mean	Std	Low	High
H-3	1.3E-15	1.8E-15	1.8E-16	1.3E-14
Be-10	1.3E-14	2.1E-14	3.3E-16	1.5E-13
C-14	2.0E-17	3.0E-17	1.5E-18	2.2E-16
Cl-36	4.0E-13	5.6E-13	4.0E-14	4.0E-12
Co-60	5.0E-18	2.5E-17	2.7E-21	2.3E-16
Ni-59	1.1E-14	1.6E-14	3.2E-16	8.8E-14
Ni-63	7.6E-17	2.4E-16	2.8E-19	1.3E-15
Se-79	1.6E-12	2.4E-12	1.4E-13	1.5E-11
Sr-90	2.8E-14	4.8E-14	5.2E-16	3.1E-13
Zr-93	3.0E-15	4.2E-15	7.7E-17	2.6E-14
Nb-94	2.4E-13	2.9E-13	2.6E-14	2.2E-12
Mo-93	8.7E-13	1.1E-12	6.7E-14	8.2E-12
Tc-99	5.9E-14	1.4E-13	1.4E-15	6.5E-13
Pd-107	2.7E-15	3.6E-15	2.3E-16	2.5E-14
Ag-108m	1.8E-14	3.2E-14	3.3E-16	1.9E-13
Sn-126	1.2E-12	1.7E-12	1.0E-13	1.2E-11
I-129	5.0E-11	7.9E-11	2.3E-12	4.9E-10
Cs-135	3.1E-13	5.2E-13	5.4E-15	3.5E-12
Cs-137	1.7E-16	5.0E-16	6.5E-19	3.8E-15
Sm-151	7.0E-19	1.3E-18	9.7E-21	9.8E-18
Ho-166m	3.4E-14	5.0E-14	2.1E-15	3.5E-13
Pb-210	3.4E-15	1.1E-14	9.6E-18	7.7E-14
Ra-226	7.2E-12	1.1E-11	4.2E-13	7.4E-11
Ac-227	7.4E-16	1.9E-15	1.1E-17	1.2E-14
Th-229	4.6E-12	1.1E-11	6.4E-14	7.9E-11
Th-230	3.0E-12	7.5E-12	4.2E-14	5.2E-11
Th-232	3.4E-12	8.5E-12	4.7E-14	5.9E-11
Pa-231	6.1E-12	1.2E-11	9.8E-14	6.9E-11
U-233	3.7E-13	5.4E-13	2.2E-14	3.9E-12
U-234	3.6E-13	5.3E-13	2.1E-14	3.8E-12
U-235	3.4E-13	5.0E-13	2.0E-14	3.6E-12
U-236	3.4E-13	4.9E-13	2.0E-14	3.6E-12
U-238	3.1E-13	4.5E-13	1.9E-14	3.3E-12
Np-237	2.1E-12	3.3E-12	7.8E-14	2.2E-11
Pu-238	3.6E-16	1.0E-15	5.8E-18	6.0E-15
Pu-239	1.2E-12	2.8E-12	2.6E-14	1.8E-11
Pu-240	7.7E-13	1.9E-12	1.7E-14	1.2E-11
Pu-242	1.3E-12	3.2E-12	2.9E-14	2.0E-11
Am-241	6.9E-14	1.3E-13	1.2E-15	1.1E-12
Am-242m	6.6E-15	1.3E-14	1.1E-16	1.1E-13
Am-243	2.6E-12	4.0E-12	7.3E-14	2.8E-11
Cm-244	4.1E-18	8.1E-18	4.9E-20	4.8E-17
Cm-245	1.0E-12	1.7E-12	1.7E-14	1.0E-11
Cm-246	7.1E-13	1.2E-12	1.2E-14	7.4E-12

Table B.7 EDFs Beberg, lake.

Nuclide	Mean	Std	Low	High
H-3	5.3E-18	1.9E-18	2.3E-18	1.3E-17
Be-10	2.3E-16	1.8E-16	5.8E-17	1.0E-15
C-14	1.3E-14	9.8E-15	9.5E-16	4.0E-14
Cl-36	4.8E-16	1.4E-16	2.4E-16	1.0E-15
Co-60	6.5E-16	3.0E-16	1.8E-16	1.7E-15
Ni-59	2.8E-17	1.4E-17	8.0E-18	8.4E-17
Ni-63	5.3E-17	2.9E-17	1.4E-17	1.7E-16
Se-79	7.0E-15	3.0E-15	2.4E-15	1.6E-14
Sr-90	5.6E-15	4.2E-15	1.6E-15	2.6E-14
Zr-93	1.4E-16	8.6E-17	3.8E-17	4.0E-16
Nb-94	4.3E-15	6.4E-15	3.6E-16	3.9E-14
Mo-93	7.5E-16	3.2E-16	2.8E-16	2.2E-15
Tc-99	8.9E-17	4.5E-17	3.5E-17	3.0E-16
Pd-107	1.0E-17	7.2E-18	3.0E-18	4.2E-17
Ag-108m	4.3E-16	2.1E-16	1.7E-16	1.3E-15
Sn-126	2.4E-14	2.3E-14	2.6E-15	1.2E-13
I-129	5.7E-14	2.3E-14	1.8E-14	1.4E-13
Cs-135	2.2E-14	5.2E-15	1.2E-14	3.8E-14
Cs-137	1.3E-13	2.9E-14	7.2E-14	2.1E-13
Sm-151	2.0E-17	1.4E-17	4.9E-18	8.3E-17
Ho-166m	5.2E-16	3.0E-16	1.7E-16	1.7E-15
Pb-210	2.0E-13	6.0E-14	9.0E-14	3.6E-13
Ra-226	4.6E-14	2.0E-14	1.8E-14	1.2E-13
Ac-227	2.2E-13	1.3E-13	5.6E-14	7.5E-13
Th-229	1.7E-13	1.0E-13	4.6E-14	6.2E-13
Th-230	7.4E-14	4.5E-14	2.1E-14	2.7E-13
Th-232	8.1E-14	5.0E-14	2.3E-14	2.9E-13
Pa-231	7.4E-14	2.5E-14	3.4E-14	1.6E-13
U-233	3.4E-15	1.1E-15	1.7E-15	8.0E-15
U-234	3.3E-15	1.1E-15	1.6E-15	7.7E-15
U-235	3.1E-15	1.0E-15	1.6E-15	7.4E-15
U-236	3.1E-15	1.0E-15	1.6E-15	7.3E-15
U-238	3.0E-15	9.7E-16	1.5E-15	7.0E-15
Np-237	3.8E-14	4.7E-14	5.8E-15	3.0E-13
Pu-238	1.7E-14	9.9E-15	6.6E-15	5.8E-14
Pu-239	3.1E-14	1.6E-14	1.1E-14	9.6E-14
Pu-240	2.9E-14	1.5E-14	1.0E-14	9.4E-14
Pu-242	3.1E-14	1.5E-14	1.1E-14	9.3E-14
Am-241	4.1E-14	3.0E-14	9.7E-15	1.8E-13
Am-242m	3.8E-14	2.8E-14	8.8E-15	1.6E-13
Am-243	4.4E-14	3.1E-14	1.2E-14	1.8E-13
Cm-244	2.2E-14	1.6E-14	5.6E-15	9.3E-14
Cm-245	4.8E-14	3.3E-14	1.3E-14	2.0E-13
Cm-246	4.7E-14	3.3E-14	1.3E-14	2.0E-13

Table B.8 EDFs Beberg, running water.

Nuclide	Mean	Std	Low	High
H-3	5.1E-18	1.8E-18	2.3E-18	1.1E-17
Be-10	2.3E-16	1.8E-16	5.7E-17	1.0E-15
C-14	1.3E-14	9.7E-15	1.1E-15	3.9E-14
Cl-36	4.9E-16	1.4E-16	2.5E-16	9.5E-16
Co-60	7.5E-16	3.4E-16	2.1E-16	1.7E-15
Ni-59	2.8E-17	1.3E-17	8.8E-18	8.5E-17
Ni-63	5.5E-17	3.0E-17	1.3E-17	1.9E-16
Se-79	7.0E-15	2.9E-15	2.4E-15	1.6E-14
Sr-90	5.5E-15	3.9E-15	1.8E-15	2.4E-14
Zr-93	1.4E-16	8.5E-17	3.7E-17	4.0E-16
Nb-94	4.3E-15	6.4E-15	3.9E-16	3.9E-14
Mo-93	7.5E-16	3.1E-16	2.7E-16	2.0E-15
Tc-99	8.9E-17	4.3E-17	3.1E-17	2.8E-16
Pd-107	1.0E-17	6.3E-18	3.2E-18	3.8E-17
Ag-108m	4.3E-16	2.1E-16	1.7E-16	1.3E-15
Sn-126	2.4E-14	2.3E-14	3.0E-15	1.3E-13
I-129	5.7E-14	2.3E-14	1.9E-14	1.4E-13
Cs-135	2.2E-14	5.2E-15	1.1E-14	3.9E-14
Cs-137	1.4E-13	3.3E-14	6.8E-14	2.5E-13
Sm-151	2.0E-17	1.2E-17	5.9E-18	7.1E-17
Ho-166m	5.2E-16	2.5E-16	2.0E-16	1.5E-15
Pb-210	2.0E-13	5.5E-14	9.2E-14	3.4E-13
Ra-226	4.6E-14	1.6E-14	2.0E-14	1.0E-13
Ac-227	2.4E-13	1.3E-13	6.3E-14	7.3E-13
Th-229	1.7E-13	8.8E-14	5.4E-14	5.5E-13
Th-230	7.4E-14	3.8E-14	2.4E-14	2.4E-13
Th-232	8.1E-14	4.2E-14	2.7E-14	2.6E-13
Pa-231	7.4E-14	2.2E-14	3.4E-14	1.5E-13
U-233	3.4E-15	9.0E-16	1.9E-15	6.6E-15
U-234	3.3E-15	8.7E-16	1.8E-15	6.3E-15
U-235	3.1E-15	8.3E-16	1.7E-15	6.0E-15
U-236	3.1E-15	8.3E-16	1.7E-15	6.0E-15
U-238	3.0E-15	8.0E-16	1.6E-15	5.8E-15
Np-237	3.8E-14	4.4E-14	7.0E-15	2.8E-13
Pu-238	2.1E-14	1.2E-14	7.9E-15	7.4E-14
Pu-239	3.1E-14	1.4E-14	1.2E-14	8.7E-14
Pu-240	2.9E-14	1.4E-14	1.1E-14	8.5E-14
Pu-242	3.1E-14	1.4E-14	1.2E-14	8.4E-14
Am-241	4.1E-14	2.5E-14	1.2E-14	1.4E-13
Am-242m	3.8E-14	2.4E-14	1.1E-14	1.3E-13
Am-243	4.4E-14	2.5E-14	1.4E-14	1.5E-13
Cm-244	2.3E-14	1.4E-14	6.1E-15	8.2E-14
Cm-245	4.8E-14	2.6E-14	1.5E-14	1.6E-13
Cm-246	4.7E-14	2.6E-14	1.4E-14	1.5E-13

Ceberg

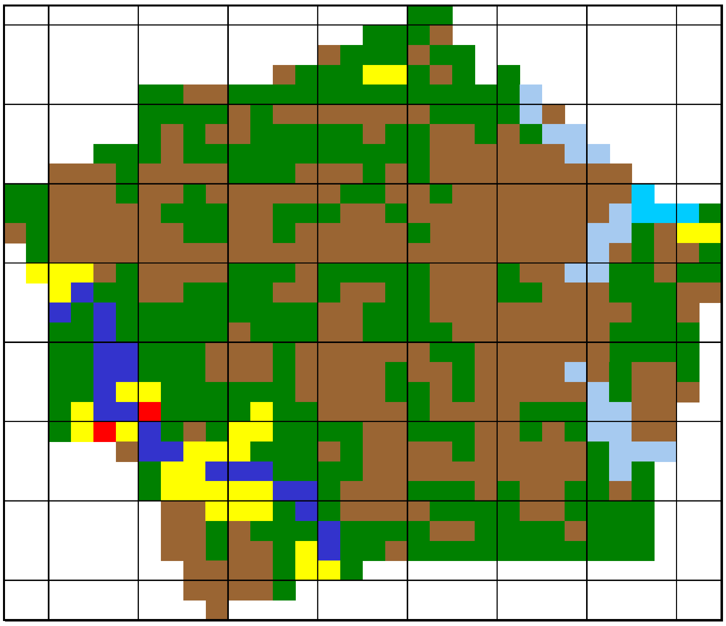

Figure C.1 The Ceberg study site. Gridnet (250x250 m) with an illustration of the biosphere types. The southern boarder of the area is at 704150 and the eastern boarder at 165950 in RT 90 co-ordinates.

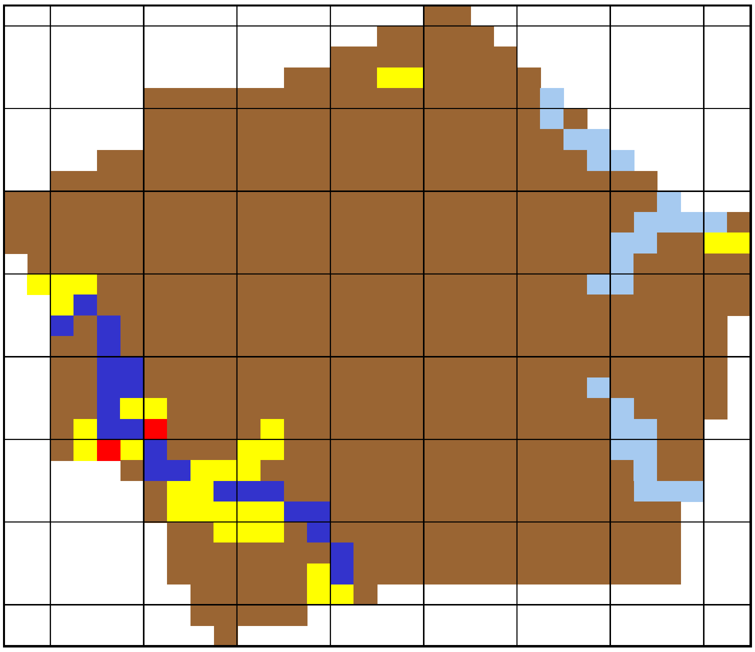

Figure C.2 The Ceberg study site. Illustration of selected module types in squares of 250x250 m.

Table C.1 EDFs Ceberg, well 1, 400 litre/hour.

Nuclide	Mean	Std	Low	High
H-3	6.6E-15	8.9E-16	4.8E-15	9.4E-15
Be-10	3.3E-13	6.1E-14	2.1E-13	5.6E-13
C-14	1.8E-13	2.6E-14	1.3E-13	2.6E-13
Cl-36	4.7E-13	1.2E-13	2.9E-13	1.0E-12
Co-60	8.2E-13	1.2E-13	5.6E-13	1.2E-12
Ni-59	3.8E-14	1.8E-14	1.6E-14	1.2E-13
Ni-63	4.6E-14	9.1E-15	3.0E-14	7.3E-14
Se-79	1.6E-12	7.8E-13	7.2E-13	5.9E-12
Sr-90	9.2E-12	1.9E-12	5.8E-12	1.6E-11
Zr-93	2.7E-13	3.6E-14	1.9E-13	3.7E-13
Nb-94	2.1E-12	1.2E-12	5.9E-13	5.5E-12
Mo-93	1.6E-12	7.6E-13	7.4E-13	5.1E-12
Tc-99	3.5E-13	1.4E-13	1.6E-13	8.8E-13
Pd-107	1.5E-14	5.6E-15	7.7E-15	4.1E-14
Ag-108m	9.4E-13	2.2E-13	5.5E-13	1.8E-12
Sn-126	2.3E-12	9.5E-13	1.2E-12	6.3E-12
I-129	5.8E-11	3.0E-11	2.9E-11	2.0E-10
Cs-135	1.3E-12	5.6E-13	6.2E-13	4.1E-12
Cs-137	4.2E-12	6.2E-13	2.9E-12	6.3E-12
Sm-151	2.4E-14	3.5E-15	1.6E-14	3.5E-14
Ho-166m	1.5E-12	3.6E-13	7.1E-13	2.4E-12
Pb-210	1.4E-10	1.6E-11	1.0E-10	1.9E-10
Ra-226	8.2E-11	1.6E-11	5.4E-11	1.4E-10
Ac-227	2.5E-10	3.7E-11	1.7E-10	3.7E-10
Th-229	3.1E-10	1.2E-10	1.4E-10	7.3E-10
Th-230	1.5E-10	6.3E-11	6.4E-11	3.8E-10
Th-232	1.7E-10	6.8E-11	7.0E-11	4.2E-10
Pa-231	5.0E-10	1.9E-10	2.3E-10	1.2E-09
U-233	1.3E-11	2.2E-12	9.2E-12	2.1E-11
U-234	1.3E-11	2.2E-12	8.9E-12	2.0E-11
U-235	1.2E-11	2.1E-12	8.5E-12	1.9E-11
U-236	1.2E-11	2.0E-12	8.5E-12	1.9E-11
U-238	1.2E-11	1.9E-12	8.1E-12	1.8E-11
Np-237	3.2E-11	8.6E-12	2.0E-11	8.2E-11
Pu-238	5.0E-11	5.9E-12	3.7E-11	6.8E-11
Pu-239	1.7E-10	7.0E-11	7.2E-11	4.5E-10
Pu-240	1.4E-10	5.2E-11	6.5E-11	3.5E-10
Pu-242	1.7E-10	7.5E-11	7.3E-11	4.8E-10
Am-241	5.0E-11	8.2E-12	3.4E-11	8.0E-11
Am-242m	4.2E-11	5.2E-12	3.1E-11	5.7E-11
Am-243	9.4E-11	3.7E-11	4.4E-11	2.4E-10
Cm-244	2.4E-11	2.6E-12	1.7E-11	3.1E-11
Cm-245	1.2E-10	4.5E-11	5.5E-11	3.0E-10
Cm-246	1.0E-10	3.6E-11	5.1E-11	2.5E-10

Table C.2 EDFs Ceberg, well 2, 600 litre/hour.

Nuclide	Mean	Std	Low	High
H-3	4.3E-15	5.8E-16	3.1E-15	6.2E-15
Be-10	2.2E-13	4.0E-14	1.4E-13	3.7E-13
C-14	1.2E-13	1.7E-14	8.2E-14	1.7E-13
Cl-36	3.1E-13	7.7E-14	1.9E-13	6.8E-13
Co-60	5.5E-13	8.1E-14	3.7E-13	7.9E-13
Ni-59	2.5E-14	1.2E-14	1.1E-14	7.7E-14
Ni-63	3.1E-14	6.1E-15	2.0E-14	4.9E-14
Se-79	1.1E-12	5.1E-13	4.8E-13	3.8E-12
Sr-90	6.1E-12	1.3E-12	3.9E-12	1.1E-11
Zr-93	1.8E-13	2.4E-14	1.3E-13	2.4E-13
Nb-94	1.4E-12	7.7E-13	3.9E-13	3.7E-12
Mo-93	1.0E-12	5.0E-13	4.8E-13	3.4E-12
Tc-99	2.3E-13	9.3E-14	1.0E-13	5.8E-13
Pd-107	9.6E-15	3.7E-15	5.0E-15	2.7E-14
Ag-108m	6.2E-13	1.5E-13	3.6E-13	1.2E-12
Sn-126	1.5E-12	6.2E-13	8.0E-13	4.2E-12
I-129	3.8E-11	2.0E-11	1.9E-11	1.3E-10
Cs-135	8.6E-13	3.7E-13	4.1E-13	2.7E-12
Cs-137	2.8E-12	4.2E-13	1.9E-12	4.2E-12
Sm-151	1.6E-14	2.3E-15	1.1E-14	2.3E-14
Ho-166m	9.6E-13	2.4E-13	4.7E-13	1.6E-12
Pb-210	9.3E-11	1.1E-11	6.8E-11	1.3E-10
Ra-226	5.4E-11	1.1E-11	3.5E-11	9.5E-11
Ac-227	1.7E-10	2.5E-11	1.1E-10	2.5E-10
Th-229	2.0E-10	7.7E-11	9.3E-11	4.9E-10
Th-230	1.0E-10	4.2E-11	4.3E-11	2.5E-10
Th-232	1.1E-10	4.5E-11	4.7E-11	2.8E-10
Pa-231	3.3E-10	1.3E-10	1.5E-10	7.9E-10
U-233	8.8E-12	1.5E-12	6.0E-12	1.4E-11
U-234	8.5E-12	1.4E-12	5.8E-12	1.3E-11
U-235	8.1E-12	1.3E-12	5.6E-12	1.3E-11
U-236	8.1E-12	1.3E-12	5.6E-12	1.3E-11
U-238	7.7E-12	1.3E-12	5.3E-12	1.2E-11
Np-237	2.1E-11	5.7E-12	1.3E-11	5.4E-11
Pu-238	3.3E-11	3.9E-12	2.5E-11	4.5E-11
Pu-239	1.1E-10	4.6E-11	4.8E-11	3.0E-10
Pu-240	9.1E-11	3.5E-11	4.3E-11	2.3E-10
Pu-242	1.1E-10	5.0E-11	4.8E-11	3.2E-10
Am-241	3.4E-11	5.5E-12	2.3E-11	5.3E-11
Am-242m	2.8E-11	3.5E-12	2.0E-11	3.8E-11
Am-243	6.2E-11	2.5E-11	2.9E-11	1.6E-10
Cm-244	1.6E-11	1.7E-12	1.2E-11	2.1E-11
Cm-245	8.0E-11	3.0E-11	3.7E-11	2.0E-10
Cm-246	6.9E-11	2.4E-11	3.4E-11	1.7E-10

Table C.3 EDFs Ceberg, peat bog.

Nuclide	Mean	Std	Low	High
H-3	2.6E-16	3.1E-16	4.4E-17	2.0E-15
Be-10	6.2E-13	1.3E-12	5.3E-14	8.0E-12
C-14	4.6E-15	9.1E-15	1.2E-16	6.8E-14
Cl-36	1.5E-11	2.1E-11	1.2E-12	1.4E-10
Co-60	2.7E-13	4.3E-13	1.0E-14	2.6E-12
Ni-59	1.9E-13	2.7E-13	2.8E-14	1.7E-12
Ni-63	1.4E-13	2.1E-13	7.9E-15	1.4E-12
Se-79	1.2E-09	1.8E-09	1.2E-10	1.2E-08
Sr-90	1.6E-11	2.3E-11	1.0E-12	1.6E-10
Zr-93	3.3E-13	4.3E-13	2.6E-14	2.8E-12
Nb-94	1.5E-12	2.5E-12	9.8E-14	1.9E-11
Mo-93	1.7E-12	2.5E-12	1.8E-13	1.8E-11
Tc-99	2.9E-13	1.0E-12	6.5E-16	7.4E-12
Pd-107	4.4E-14	6.3E-14	5.3E-15	5.0E-13
Ag-108m	1.8E-11	2.8E-11	8.7E-13	2.2E-10
Sn-126	6.1E-11	9.1E-11	6.1E-12	6.3E-10
I-129	2.1E-11	2.8E-11	2.3E-12	2.0E-10
Cs-135	1.8E-12	2.3E-12	2.6E-13	1.5E-11
Cs-137	3.1E-12	5.3E-12	1.8E-13	2.6E-11
Sm-151	5.7E-15	9.9E-15	4.4E-16	7.7E-14
Ho-166m	1.6E-12	2.4E-12	8.8E-14	1.8E-11
Pb-210	1.6E-11	3.0E-11	5.7E-13	2.3E-10
Ra-226	9.4E-10	1.7E-09	8.7E-11	1.2E-08
Ac-227	6.1E-11	9.1E-11	3.5E-12	6.5E-10
Th-229	6.5E-09	1.0E-08	5.1E-10	8.2E-08
Th-230	3.7E-09	5.9E-09	3.0E-10	4.5E-08
Th-232	4.1E-09	6.5E-09	3.3E-10	4.9E-08
Pa-231	2.7E-09	4.6E-09	1.4E-10	3.4E-08
U-233	4.3E-12	8.7E-12	4.0E-14	6.0E-11
U-234	4.1E-12	8.5E-12	3.8E-14	5.9E-11
U-235	3.7E-12	7.7E-12	3.6E-14	5.3E-11
U-236	3.8E-12	7.8E-12	3.6E-14	5.4E-11
U-238	3.5E-12	7.2E-12	3.4E-14	5.0E-11
Np-237	7.5E-11	1.0E-10	8.3E-12	7.0E-10
Pu-238	3.4E-11	5.0E-11	1.8E-12	3.3E-10
Pu-239	3.0E-10	6.0E-10	5.8E-12	5.0E-09
Pu-240	2.7E-10	5.2E-10	5.8E-12	4.1E-09
Pu-242	3.0E-10	6.1E-10	5.6E-12	5.0E-09
Am-241	2.0E-10	3.2E-10	1.3E-11	2.6E-09
Am-242m	6.3E-11	1.0E-10	4.1E-12	8.1E-10
Am-243	1.7E-09	2.6E-09	1.1E-10	2.3E-08
Cm-244	5.5E-12	8.2E-12	3.6E-13	6.0E-11
Cm-245	8.1E-10	1.5E-09	3.1E-11	9.4E-09
Cm-246	6.8E-10	1.2E-09	3.0E-11	8.1E-09

Table C.4 EDFs Ceberg, agricultural land.

Nuclide	Mean	Std	Low	High
H-3	6.2E-16	9.0E-16	8.2E-17	6.4E-15
Be-10	9.4E-15	1.5E-14	3.1E-16	9.8E-14
C-14	8.9E-18	1.3E-17	6.1E-19	9.7E-17
Cl-36	1.7E-13	2.5E-13	1.6E-14	1.8E-12
Co-60	4.6E-18	2.3E-17	2.7E-21	2.1E-16
Ni-59	7.5E-15	1.1E-14	2.9E-16	6.1E-14
Ni-63	6.6E-17	2.0E-16	2.8E-19	1.1E-15
Se-79	7.3E-13	1.1E-12	5.8E-14	6.9E-12
Sr-90	1.9E-14	3.0E-14	4.5E-16	2.0E-13
Zr-93	2.3E-15	3.1E-15	7.5E-17	1.9E-14
Nb-94	1.8E-13	2.2E-13	1.6E-14	1.7E-12
Mo-93	5.0E-13	6.3E-13	5.0E-14	3.9E-12
Tc-99	2.6E-14	6.5E-14	6.0E-16	2.9E-13
Pd-107	1.6E-15	2.1E-15	1.8E-16	1.5E-14
Ag-108m	1.3E-14	2.3E-14	3.1E-16	1.2E-13
Sn-126	6.4E-13	9.3E-13	6.7E-14	6.6E-12
I-129	3.2E-11	4.9E-11	1.6E-12	3.1E-10
Cs-135	2.3E-13	3.5E-13	5.3E-15	2.5E-12
Cs-137	1.6E-16	4.7E-16	6.5E-19	3.6E-15
Sm-151	6.6E-19	1.2E-18	9.6E-21	8.8E-18
Ho-166m	2.8E-14	4.1E-14	2.0E-15	2.7E-13
Pb-210	2.8E-15	8.4E-15	9.5E-18	5.6E-14
Ra-226	4.8E-12	7.8E-12	3.6E-13	5.0E-11
Ac-227	7.2E-16	1.8E-15	1.1E-17	1.2E-14
Th-229	4.3E-12	1.0E-11	6.4E-14	7.0E-11
Th-230	2.8E-12	6.7E-12	4.2E-14	4.6E-11
Th-232	3.1E-12	7.6E-12	4.7E-14	5.2E-11
Pa-231	5.8E-12	1.1E-11	9.8E-14	6.3E-11
U-233	2.2E-13	3.4E-13	9.4E-15	2.3E-12
U-234	2.1E-13	3.3E-13	9.0E-15	2.3E-12
U-235	2.0E-13	3.1E-13	8.6E-15	2.1E-12
U-236	2.0E-13	3.1E-13	8.5E-15	2.1E-12
U-238	1.8E-13	2.8E-13	8.0E-15	2.0E-12
Np-237	1.3E-12	2.2E-12	3.4E-14	1.4E-11
Pu-238	3.6E-16	1.0E-15	5.8E-18	5.9E-15
Pu-239	1.1E-12	2.6E-12	2.6E-14	1.7E-11
Pu-240	7.3E-13	1.7E-12	1.7E-14	1.1E-11
Pu-242	1.3E-12	2.9E-12	2.9E-14	1.9E-11
Am-241	6.4E-14	1.1E-13	1.2E-15	9.4E-13
Am-242m	6.3E-15	1.2E-14	1.1E-16	1.0E-13
Am-243	2.2E-12	3.3E-12	7.2E-14	2.0E-11
Cm-244	4.1E-18	8.0E-18	4.9E-20	4.8E-17
Cm-245	9.5E-13	1.6E-12	1.7E-14	9.5E-12
Cm-246	6.8E-13	1.1E-12	1.2E-14	6.8E-12

Table C.5 EDFs Ceberg, running water, stream.

Nuclide	Mean	Std	Low	High
H-3	6.8E-19	2.4E-19	3.0E-19	1.5E-18
Be-10	3.3E-17	2.6E-17	7.9E-18	1.4E-16
C-14	1.8E-15	1.3E-15	1.5E-16	5.3E-15
Cl-36	5.9E-17	1.6E-17	3.1E-17	1.1E-16
Co-60	1.0E-16	4.7E-17	2.9E-17	2.3E-16
Ni-59	3.8E-18	1.8E-18	1.1E-18	1.1E-17
Ni-63	7.6E-18	4.1E-18	1.9E-18	2.6E-17
Se-79	9.5E-16	4.0E-16	3.3E-16	2.1E-15
Sr-90	7.7E-16	5.5E-16	2.6E-16	3.4E-15
Zr-93	2.0E-17	1.2E-17	5.0E-18	5.3E-17
Nb-94	6.0E-16	9.0E-16	4.9E-17	5.3E-15
Mo-93	8.6E-17	3.4E-17	3.5E-17	2.2E-16
Tc-99	1.1E-17	4.5E-18	4.3E-18	3.0E-17
Pd-107	1.4E-18	8.9E-19	4.3E-19	5.3E-18
Ag-108m	5.8E-17	2.9E-17	2.3E-17	1.8E-16
Sn-126	3.4E-15	3.3E-15	4.0E-16	1.7E-14
I-129	7.3E-15	2.9E-15	2.6E-15	1.8E-14
Cs-135	3.1E-15	7.2E-16	1.5E-15	5.4E-15
Cs-137	2.0E-14	4.6E-15	9.4E-15	3.4E-14
Sm-151	2.8E-18	1.7E-18	8.0E-19	9.8E-18
Ho-166m	7.1E-17	3.4E-17	2.7E-17	2.1E-16
Pb-210	2.8E-14	7.5E-15	1.3E-14	4.7E-14
Ra-226	6.3E-15	2.2E-15	2.7E-15	1.4E-14
Ac-227	3.3E-14	1.8E-14	9.1E-15	1.0E-13
Th-229	2.3E-14	1.2E-14	7.5E-15	7.7E-14
Th-230	1.0E-14	5.3E-15	3.4E-15	3.3E-14
Th-232	1.1E-14	5.8E-15	3.7E-15	3.6E-14
Pa-231	1.0E-14	3.0E-15	4.5E-15	2.0E-14
U-233	4.7E-16	1.2E-16	2.6E-16	9.1E-16
U-234	4.5E-16	1.2E-16	2.5E-16	8.7E-16
U-235	4.3E-16	1.1E-16	2.4E-16	8.4E-16
U-236	4.3E-16	1.1E-16	2.4E-16	8.4E-16
U-238	4.1E-16	1.1E-16	2.3E-16	8.0E-16
Np-237	5.3E-15	6.2E-15	9.7E-16	4.1E-14
Pu-238	2.9E-15	1.6E-15	1.1E-15	1.0E-14
Pu-239	4.3E-15	2.0E-15	1.7E-15	1.3E-14
Pu-240	4.1E-15	1.9E-15	1.6E-15	1.2E-14
Pu-242	4.3E-15	1.9E-15	1.6E-15	1.2E-14
Am-241	5.7E-15	3.5E-15	1.7E-15	2.1E-14
Am-242m	5.3E-15	3.3E-15	1.5E-15	2.0E-14
Am-243	6.1E-15	3.5E-15	1.9E-15	2.2E-14
Cm-244	3.2E-15	2.0E-15	8.4E-16	1.1E-14
Cm-245	6.7E-15	3.6E-15	2.1E-15	2.1E-14
Cm-246	6.5E-15	3.6E-15	2.0E-15	2.1E-14

Table C.6 EDFs Ceberg, running waters, river.

Nuclide	Mean	Std	Low	High
H-3	1.2E-19	2.0E-19	5.1E-20	2.6E-19
Be-10	5.5E-18	4.3E-18	1.3E-18	2.4E-17
C-14	3.1E-16	2.3E-16	2.4E-17	8.9E-16
Cl-36	9.9E-18	2.6E-18	5.2E-18	1.8E-17
Co-60	1.8E-17	8.0E-18	4.9E-18	3.8E-17
Ni-59	6.4E-19	3.1E-19	1.9E-19	1.9E-18
Ni-63	1.3E-18	7.0E-19	3.1E-19	4.4E-18
Se-79	1.6E-16	6.8E-17	5.6E-17	3.6E-16
Sr-90	1.3E-16	9.3E-17	4.3E-17	5.7E-16
Zr-93	3.4E-18	2.0E-18	8.5E-19	9.0E-18
Nb-94	1.0E-16	1.5E-16	8.5E-18	8.9E-16
Mo-93	1.4E-17	5.7E-18	5.9E-18	3.8E-17
Tc-99	1.9E-18	7.6E-19	7.3E-19	5.0E-18
Pd-107	2.4E-19	2.0E-19	7.2E-20	9.0E-19
Ag-108m	9.8E-18	5.0E-18	3.9E-18	3.1E-17
Sn-126	5.8E-16	5.5E-16	6.8E-17	2.9E-15
I-129	1.2E-15	4.9E-16	4.3E-16	3.0E-15
Cs-135	5.2E-16	1.2E-16	2.5E-16	9.1E-16
Cs-137	3.3E-15	7.7E-16	1.6E-15	5.7E-15
Sm-151	4.8E-19	2.9E-19	1.3E-19	1.6E-18
Ho-166m	1.2E-17	5.8E-18	4.6E-18	3.6E-17
Pb-210	4.8E-15	1.3E-15	2.2E-15	7.9E-15
Ra-226	1.1E-15	3.7E-16	4.5E-16	2.3E-15
Ac-227	5.6E-15	3.0E-15	1.5E-15	1.8E-14
Th-229	3.9E-15	2.1E-15	1.3E-15	1.3E-14
Th-230	1.7E-15	9.0E-16	5.7E-16	5.5E-15
Th-232	1.9E-15	9.8E-16	6.3E-16	6.1E-15
Pa-231	1.7E-15	5.1E-16	7.6E-16	3.4E-15
U-233	7.9E-17	2.1E-17	4.4E-17	1.5E-16
U-234	7.6E-17	2.0E-17	4.2E-17	1.5E-16
U-235	7.3E-17	1.9E-17	4.0E-17	1.4E-16
U-236	7.3E-17	1.9E-17	4.0E-17	1.4E-16
U-238	7.0E-17	1.8E-17	3.9E-17	1.4E-16
Np-237	9.0E-16	1.0E-15	1.6E-16	6.9E-15
Pu-238	4.9E-16	2.8E-16	1.8E-16	1.7E-15
Pu-239	7.3E-16	3.3E-16	2.8E-16	2.1E-15
Pu-240	6.9E-16	3.2E-16	2.7E-16	2.1E-15
Pu-242	7.2E-16	3.2E-16	2.7E-16	2.0E-15
Am-241	9.6E-16	5.8E-16	2.8E-16	3.5E-15
Am-242m	9.0E-16	5.5E-16	2.5E-16	3.3E-15
Am-243	1.0E-15	5.9E-16	3.2E-16	3.7E-15
Cm-244	5.5E-16	3.4E-16	1.4E-16	1.9E-15
Cm-245	1.1E-15	6.1E-16	3.5E-16	3.6E-15
Cm-246	1.1E-15	6.1E-16	3.4E-16	3.5E-15