Guidance on consideration of soil in Strategic Environmental Assessment

CONTENTS

1. Consideration of soil in Strategic Environmental Assessment (SEA)

1.1 Soil is a key part of our environment and soil degradation can have major implications for air and water quality as well as our climate, biodiversity and economy. Sustainable management and protection of soils is key to ensuring that soils can deliver essential functions vital for the sustainability of Scotland's environment and economy including:

- storing carbon and maintaining the balance of gases in the air;
- biomass production (including agriculture and forestry);
- filtering and buffering pollutants;
- regulating the flow of and providing storage for water;
- providing a physical environment for human activity (including built development);
- providing habitats and supporting biodiversity;
- a source of raw materials;
- preserving cultural and archaeological heritage.

2. Existing environmental problems and potential significant effects

2.1 Climate change and changes in land use and land management practices, including built development, are the most significant pressures on Scottish soils. These overarching pressures result in a range of processes that damage soil quality such as loss of organic matter, soil sealing and soil loss, soil contamination, changes in soil biodiversity, erosion and landslides, and compaction and structural degradation. These can in turn result in damage to the wider environment, society and the economy.

2.2 Identifying and understanding the processes that damage soils will help the Responsible Authority assess whether a plan, programme or strategy (PPS) is likely to have significant effects on soil. Table 1 below sets out examples of current environmental problems in relation to soil, their potential causes, and the likely significant effects which a PPS could have on these existing problems.

2.3 In general a PPS which proposes physical development is likely to have a negative effect on soils. Positive effects could be expected if development is located on contaminated areas and remediation is proposed. Changes in land use or land management which affect soil present a potential threat to the functions which soils fulfil and therefore have potential consequences for not only our soils but also for the wider environment, our society and the economy.

Table 1 – Existing environmental problems relating to soil, their potential causes and examples of likely significant effects	
Existing problems relating to loss of organic matter Soil organic matter underpins many soil functions. It is particularly important as a carbon store and this has implications for climate change.	**Causes of existing problems** Losses can be caused by erosion and built development activity including; land use change; forestry and agricultural soil preparation techniques; intensive agriculture with removal of most biomass from the field, arable cultivation in general, devegetation through overstocking; soil stripping and / or drainage for infrastructure development (e.g. windfarms in upland areas); built development resulting in soil stripping; agricultural and forestry work leading to drainage of carbon rich soils e.g. peatlands; soil erosion.
Example of typical effects of a PPS relating to loss of organic matter *Major positive* ++ Action very likely to lead to full conservation of soil organic matter plus an overall large reduction, or a series of smaller reductions, to rates of soil organic matter loss in most areas at risk of depletion, especially productive soils and sensitive or designated areas. *Minor positive* + Action very likely to lead to some conservation of soil organic matter plus an overall moderate reduction, or a series of smaller reductions, to rates of soil organic matter loss in some areas affected by soil organic matter depletion. *Minor negative* – Action very likely to lead to an overall moderate increase, or a series of smaller increases, to rates of loss of soil organic matter in some areas. *Major negative* - - Action very likely to lead to an overall large increase, or a series of smaller increases, to rates of soil organic matter loss in large areas and is likely to affect highly productive land and / or sensitive or designated areas.	
Existing problems relating to soil sealing There is no systematic data collection to capture the extent and quality of land being sealed.	**Causes of existing problems** Sealing / loss results from activities which include; built development which involves soil stripping and replacing soil with impermeable surfaces including roads, car parks and buildings; and removal of soil for mining and quarrying operations.

Example of typical effects of a PPS on soil sealing

Major positive ++ Action very likely to lead to an overall large reduction / halt, or a series of smaller reductions, in extent of soil sealing and rates of soil loss. Development activities where soil losses are inevitable are required to restore previously sealed soils to open land with productive soils where practicable, especially in sensitive and designated areas.

Minor positive + Action very likely to lead to an overall moderate reduction, or a series of smaller reductions, in extent of soil sealing and rates of soil loss in some areas. Development activities take a more sensitive approach to soil sealing e.g. development is mostly on brownfield sites.

Minor negative – Action very likely to lead to an overall moderate increase, or a series of smaller increases, in extent of soil sealing and levels of soil loss in some areas. Development sometimes takes place on sensitive greenfield sites as well as less sensitive sites.

Major negative - - Action very likely to lead to an overall large increase, or a series of smaller increases, in extent of soil sealing and levels of soil loss e.g. development on greenfield sites is likely to be commonplace and the most productive soils are routinely sealed or excavated and sent to landfill or not adequately re-used at different sites.

Existing problems relating to soil contamination	**Causes of existing problems**
Data on the extent and nature of contamination is limited. There is some evidence that some contaminating imports and their impacts are reducing, for example atmospheric acid deposition. However, many other potential soil contaminants such as organic chemicals (including agricultural pesticides) are not routinely measured.	Soil contamination has a variety of causes including; atmospheric deposition; agriculture and forestry operations including the use and / or disposal of chemicals; waste management and recycling, including sewage sludge; industry, mining and historic land contamination; use and / or disposal of chemicals (e.g. cosmetic / domestic).

Example of typical effects of a PPS on soil contamination

Major positive ++ Action very likely to lead to an overall large reduction, or a series of smaller reductions, to sources / levels of soil contamination, all or most sites on the contaminated land register will be remediated where practicable. Measures will be put in place to prevent future contamination of soils, especially in sensitive and designated areas.

Minor positive + Action very likely to lead to an overall moderate reduction, or a series of smaller reductions, to sources / levels of soil contamination through restoration and remediation of some sites on the contaminated land register. Some measures will be put in place to prevent future contamination of soils.

Minor negative – Action very likely to lead to an overall moderate increase, or a series of smaller increases, to sources / levels of soil contamination in some areas. Preventative measures are unlikely to reduce the number of future sites added to the contaminated land register.

Major negative - - Action very likely to lead to an overall large increase, or a series of smaller increases, to sources / levels of soil contamination. Preventative measures are likely to be removed to an extent that large increases in soil contamination incidents occur in the future / contamination is likely to become a major issue in sensitive areas.

Existing problems relating to erosion and landslides	**Causes of existing problems**
Soil erosion is one of the most visible of the threats to soil. Impacts include loss of soil carbon, loss of fertility and off-site effects such as impacts on the water environment.	Causes of soil erosion and landslides include; extreme rainfall and wind events; stripping of soils for construction and development; infrastructure development (e.g. road and railway cuttings); flood events; removal of vegetation cover for agricultural crops or through excessive grazing; tourism / recreation e.g. trampling; soil compaction caused by heavy machinery or cattle trampling.

Example of typical effects of a PPS on soil erosion and landslides

Major positive ++ Action very likely to lead to an overall large reduction, or a series of smaller reductions, to levels of soil erosion in most of the areas under risk of erosion in the area, particularly productive soils and sensitive and designated areas.

Minor positive + Action very likely to lead to an overall moderate reduction, or a series of smaller reductions, to rates of soil erosion in some of the areas at risk. Some management measures will be put in place to partially reduce soil erosion.

Minor negative – Action very likely to lead to an overall moderate increase, or a series of smaller increases, to rates of soil erosion in some areas.

Major negative - - Action very likely to lead to an overall large increase, or a series of smaller increases, to rates of soil erosion in large areas and is likely to affect highly productive land and / or sensitive and designated areas.

Existing problems of compaction / structural degradation	**Causes of existing problems**
There is no systematic assessment of the extent and wider implications of soil compaction in Scotland. Consequences include possible reduction in water holding capacity leading to higher levels	Causes of structural degradation include; agricultural / forestry activity – arable cultivation, heavy machinery, working on wet soils, grazing animals; built development – use of heavy machinery, working on wet soils, stripping

of run-off, possible reduction in filtering capacity leading to water pollution and potentially changes in greenhouse gas emissions.	and storing soils, reinstatement; loss of soil organic matter.
Example of typical effects of a PPS on compaction / structural degradation *Major positive* ++ Action very likely to lead to an overall large reduction, or a series of smaller reductions, in extent of structural degradation and compaction of soils in most affected / vulnerable areas, particularly productive soils and / or sensitive and designated areas. *Minor positive* + Action very likely to lead to an overall moderate reduction, or a series of smaller reductions, in extent of structural degradation and compaction of soils in some of the affected areas. Some management measures will be put in place to partially reduce soil compaction. *Minor negative* – Action very likely to lead to an overall moderate increase, or a series of smaller increases, in extent of structural degradation and compaction of soils in some of the area. *Major negative* - - Action very likely to lead to an overall large increase, or a series of smaller increases, in extent of structural degradation and compaction of soils in large areas and is likely to affect highly productive land and / or sensitive and designated areas.	
Existing problems relating to changes in soil biodiversity Soil biodiversity is essential to most soil functions e.g. soil biodiversity affects the sustainability of species and habitats which rely on soil and soil organisms play a vital role in soil carbon and nitrogen turnover and thus in the exchange of greenhouse gases. They also break down potential contaminants thereby cleaning the soil. Relatively little is known about the state and trend of Scotland's soil biodiversity except for a few protected soil-dwelling species.	**Causes of existing problems** Causes of changes in soil biodiversity include changes in land management practices affecting the structure, stability, biological, physical and chemical characteristics of soil.
Example of typical effects of a PPS on soil biodiversity *Major positive* ++ action very likely to lead to full conservation of current biodiversity status in most affected / vulnerable areas, particularly sensitive and designated areas; measures put in place to promote enhancement of soil biodiversity, especially in sensitive / designated areas. *Minor positive* + action very likely to lead to some conservation of current biodiversity status in some areas.	

Minor negative – action very likely to lead to an overall moderate increase, or a series of smaller increases, to rates of loss of soil biodiversity in some areas.

Major negative - - action very likely to lead to an overall large increase, or a series of smaller increases, to rates of loss of soil biodiversity in large areas and is likely to affect sensitive and designated areas.

2.4 Significance of effects is set out using a scoring system ranging from a "major positive" effect to a "major negative" effect. As an example, using these significance criteria if the magnitude of the effect is large, but the receptor that experiences the effect is not particularly sensitive, then the significance of the effect is likely to be less. Responsible Authorities may wish to use these criteria as the basis of developing a method that suits the PPS being assessed.

2.5 Neutral, mixed and uncertain effects of a PPS on soil

- Neutral effects - an action which is unlikely to have any beneficial or negative effects on any existing soil problem. Neutral scoring should only be used where it is very likely that the effect on the current environmental baseline or trends will be neither positive nor negative. It is possible that a neutral effect may be enhanced through mitigation measures such as policy or project intervention.

- Mixed effects – an action which is likely to result in a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criterion. Such mixed effects will be hard to predict, but could be significant in the long-term, or when taken with other effects e.g. cumulative or synergistic.

- Uncertain effects - the effect of an action on soil is not known, or is too unpredictable to assign a conclusive score. Uncertainty may arise where an action covers a range of issues, or where the manner in which the action is implemented is a material factor in the nature of the effects it may have.

2.6 Where a PPS has the potential to have significant environmental effects on another EU Member State these effects are known as Transboundary effects. Pollutants affecting soil may be generated in one Member State and lead to contamination of soil in another Member State, for example, air pollution such as particulate matter or sulphur dioxide generated in one Member State could be transported across Member States and result in soil contamination or acidification in other Member States.

3. SEA objectives

3.1 SEA objectives can be used to develop a systematic, rigorous and consistent framework with which to assess environmental impacts. The level of detail appropriate for the SEA objectives will depend on the characteristics of the PPS being assessed and the potential significance of its environmental effects. Where appropriate, "headline" SEA objectives can be broken down into sub-objectives or assessment criteria – examples of SEA soil objectives are set out in Table 2 below.

Table 2 - Examples of SEA soil objectives and assessment questions

Headline objective	Sub-objectives	Example assessment questions
To maintain or improve soil quality and prevent any further degradation of soils.	• To minimise disturbance to carbon rich soils, in particular peat. • To conserve, or reduce loss of, organic matter. • To reduce soil sealing and soil loss. • To reduce levels of soil contamination. • To reduce soil erosion and landslides. • To reduce soil structural degradation and compaction of soils	• Will the PPS contribute to conserving, or reducing loss of, soil organic matter? • Will the PPS contribute to reducing levels of soil contamination?

3.2 Additional details of this approach and how it can be combined with site assessments for local development planning can be found in the Local Development Plan Site Assessment and SEA checklist which has been produced by the Consultation Authorities.

4. Baseline information

4.1 Sufficient data about the current and likely future state of the environment should be collected to allow the Responsible Authority to predict and evaluate the potential effects of the PPS. However, where such information is not available, any data gaps and difficulties

should be listed in the Environmental Report. The gathering of new data may be appropriate to include as recommendations in the Environmental Report, Post Adoption Statement or Monitoring proposals.

4.2 The sources of baseline information and trends set out in Table 3 below cover the soil issues which we would typically expect to see presented (depending on the scope and purpose of the PPS) at the Scoping or Environmental Report stage. These include:

- spatial data on carbon rich soils including peat;
- information on contaminated land;
- information on vacant and derelict land;
- spatial data on prime agricultural land.

Table 3 – Sources of baseline information and trends	
State of Scotland's Soil Report - the most comprehensive source of information on Scottish soils setting out the current state of Scotland's soils and exploring the pressures on soils and their consequences.	www.sepa.org.uk/media/138741/state-of-soil-report-final.pdf
Scotland's Soils Website – provides data and information on Scotland's soils. Includes a range of maps and links for downloading associated data, also points to other useful sources of data and information.	http://soils.environment.gov.scot/
State and trend information and key messages.	www.environment.scotland.gov.uk/get-informed/land/
Socio-economic data on Scottish soils - provides a comprehensive overview of the socio-economic impacts associated with each soil degradation process.	www.sepa.org.uk/media/138663/socio-economic_data_soils.pdf
Scottish vacant and derelict land survey - annual survey of all vacant and derelict land across all of Scotland's local authorities. It provides details of the levels and locations of vacant and derelict land as well as wider information such as previous	www.gov.scot/Topics/Statistics/Browse/Planning/Publications

uses, proximity to people and location relative to deprivation.	
List of identified **special sites in Scotland**.	www.sepa.org.uk/regulations/land/contaminated-land/special-sites-in-scotland/
Dealing with contamination in Scotland – a review of progress 2000-08 SEPA statutory report on sites that are known or suspected to be affected by contamination. The information gathered covers topics such as: the number of sites inspected, determined and remediated via Part IIA; the number of sites considered and remediated through the planning system or through voluntary remediation; and SEPA's information on special sites which we regulate under Part llA.	www.sepa.org.uk/media/28314/dealing-with-land-contamination-in-scotland.pdf
Carbon and peatland 2016 map - shows the distribution of carbon and peatland classes across the whole of Scotland. It gives a value to indicate the likely presence of carbon-rich soils, deep peat and priority peatland habitat for each individually-mapped area, at a coarse scale.	Access the map here: http://map.environment.gov.scot/Soil_maps/?layer=10 Access information about the map here: http://soils.environment.gov.scot/maps/carbon-and-peatland-2016-map/
Soil Information For Scottish Soils (SIFSS) webpage - James Hutton Institute information on **soil types** by postcode or National Grid Reference, **characteristics of different soils**, differences between cultivated and uncultivated soils, key **indicators of soil quality** – also available as **Soil Information for Scottish Soils (SIFSS) app** - link from webpage.	http://sifss.hutton.ac.uk/
UK Soil Observatory maps - includes Forestry Commission soil information. Various apps linked from this webpage including **MySoil app.**	www.ukso.org/

5. Other plans, programmes and strategies

5.1 Comprehensive links to other plans, programmes and strategies relevant to the topic of soil can be found at:

- http://soils.environment.gov.scot/
- www.environment.scotland.gov.uk/get-informed/land/soils/
- www.sepa.org.uk/environment/land/soil/
- www.snh.gov.uk/land-and-sea/managing-the-land/soils/
- http://soils.environment.gov.scot/resources/soil-protection/

Table 4 – Key PPS and their associated provisions relevant to soil

PPS title	Key provisions	Relevant SEA soil objectives
Scottish Soil Framework (2009)	Promotes the sustainable management and protection of soils consistent with the economic, social and environmental needs of Scotland; sets out the Scottish Government's vision for soil protection; formally acknowledges the important services soils provide to society; recognises that climate change and loss of organic matter are the most significant threats to Scottish soils.	All
Thematic Strategy for Soil Protection (COM(2006)231)	Overall objective is protection and sustainable use of soil.	All
Getting the best from our land: A Land Use Strategy for Scotland 2016 – 2021	The second Land Use Strategy, published in 2016, retains the long term vision and objectives relating to the economy, environment and communities, and the principles for sustainable land use set out in the first strategy to guide policy and decision making. Where land is highly suitable for a primary use (for example food production, flood management, water catchment	All

	management and carbon storage) this value should be recognised in decision making.	
The Pollution Prevention and Control (Scotland) Regulations 2012	Provisions to ensure permits contain appropriate emission limits / conditions to ensure appropriate soil protection and that no significant pollution is caused.	Contamination
The Waste Management Licensing (Scotland) Regulations 2011	Provisions to authorise the treatment, keeping or disposal of waste in or on land – also relates to closed landfills.	Contamination
The Sludge (Use in Agriculture) Regulations (1989)	Provision to protect the environment, and in particular soil, in relation to spreading sewage sludge on agricultural land.	Contamination
Climate Change (Scotland) Act 2009	Introduces the public body duty to contribute towards Scotland's climate change targets and the adaptation framework.	All
Water Environment and Water Services (Scotland) Act 2003	Provisions to protect and prevent deterioration of the status of water bodies; protect, enhance and restore all water bodies with the aim of achieving good water status by 2015; prevent or limit the input of pollutants to water and reverse any significant and sustainable upward trends in the concentration of pollutants in water, and; achieve compliance with relevant standards and objectives for protected areas.	Loss of organic matter, contamination, erosion and landslides
Scotland River Basin Management Plan and Solway Tweed River Basin Management Plan	Requirement of the Water Framework Directive, setting out the actions required within each river basin to achieve set environmental quality objectives.	Loss of organic matter, contamination, erosion and landslides
The Water Environment (Controlled Activities) (Scotland) Regulations 2011	Applies regulatory controls over activities which may affect Scotland's water environment including rivers, lochs, transitional waters (estuaries), coastal waters, groundwater and groundwater dependent wetlands.	Loss of organic matter, contamination, erosion and landslides

Flood Risk Management (Scotland) Act 2009	Provisions to manage sources and pathways of floodwaters by restoring and enhancing wetlands, rivers, peatlands and other natural features and characteristics to ensure a sustainable approach to flood risk management.	Loss of organic matter, contamination, erosion and landslides
Flood Risk Management Strategies (2015)	14 Flood Risk Management Strategies explain the causes and consequences of flooding in high risk areas, and set objectives and identify actions to manage this risk. Required by the Flood Risk Management (Scotland) Act 2009,	Loss of organic matter, contamination, erosion and landslides
Local Flood Risk Management Plans (2016)	Implementation plans for the Flood Risk Management Strategies. Provides more information on how and when the actions identified in each Strategy will be delivered. Required by the Flood Risk Management (Scotland) Act 2009,	Loss of organic matter, contamination, erosion and landslides
SEPA's Position Statement on Planning and Soils	Clarifies interface between SEPA regulatory and advisory functions in relation to soil.	All
Scottish Planning Policy (2014)	Contains a presumption in favour of development that contributes to sustainable development, protection of soils from damage such as erosion or compaction and consideration of the implications of development for soil quality and effects on carbon dioxide emissions.	All
National Planning Framework 3 (2014)	Takes forward the spatial aspects of the Scottish Government's Economic Strategy with a focus on supporting sustainable economic growth and the transition to a low carbon economy.	All
The Radioactive Contaminated Land (Scotland) Regulations 2007 The Radioactive Contaminated Land (Scotland) (Amendment)	Provides a process for the identification of land in its current use that may be contaminated by radioactivity. The regime allows for remediation of that land under circumstances where intervention is liable to be justified. SEPA are the lead authority.	Contamination

Regulations 2007		
The Contaminated Land (Scotland) Regulations 2000 The Contaminated Land (Scotland) Regulations 2005	Provides a system for the identification and remediation of land where historical contamination is causing unacceptable risks to human health or the wider environment assessed in the context of the current use and circumstances of the land. The local authority is the lead authority except where the site is designated a special site where SEPA are the lead authority.	Contamination
Scotland's National Peatland Plan	Highlights the importance of Scotland's peatlands. It draws attention to the poor state of large areas, and proposes building on existing initiatives to secure their sustainable use, management and restoration.	Minimise disturbance to carbon rich soils, in particular peat

6. Mitigation and enhancement

6.1 Mitigation involves the identification of measures which are envisaged to prevent, reduce and as far as possible offset any adverse environmental effects identified by the assessment. The best form of mitigation, especially in relation to minimising disturbance to carbon rich soils is avoidance. For any plan which includes physical disturbance mitigation should therefore start with avoidance of carbon rich soils as a first choice in the decision-making process.

6.2 Other examples of mitigation include setting a requirement for additional surveys and assessments at the next level of planning or project management e.g.

- setting a requirement for a peat survey and management plan;
- requiring that any disturbance or excavation should be minimised through avoidance of sensitive sites through micro-siting and sensitive site design;
- requiring that processes to ensure that suitable mitigation measures to reduce soil carbon loss either through gaseous emissions or through particulate and dissolved carbon in watercourses are established and implemented.

6.3 Opportunities for enhancement should be explored for any neutral, uncertain and minimal effects identified. Such measures should aim to

result in restoration of soil quality and thus soil function. This is particularly important for developments such as quarries and windfarms. PPS which relate to areas which include contaminated land or brownfield sites will also provide opportunities for enhancement.

7. Monitoring

7.1 The information gathered as a result of monitoring the environmental effects of the PPS enables the Responsible Authority to track the environmental effects of the PPS, gauge the effectiveness of any mitigation measures employed, identify unforeseen effects and manage any uncertainty encountered in the assessment process.

7.2 Table 3 below provides some examples of indicators relevant to monitoring significant effects of a PPS on soil. Other more contextual indicators should be identified by the Responsible Authority to monitor for unexpected effects and consider the effectiveness of mitigation and enhancement measures.

Table 3 – Examples of SEA indicators

SEA soil objective	Example of monitoring indicators
To minimise disturbance to carbon rich soils, in particular peat.	• Surface area affected by loss of carbon rich soils / peat within Plan area (e.g. hectares) • Rate of loss of carbon rich soils / peat within Plan area (e.g. tonnes/ year) • Area of carbon rich soils / peat within Plan area (e.g. hectares)
To conserve or reduce loss of organic matter.	• Surface area affected by loss of soil organic matter within Plan area (e.g. hectares) • Area of peat / organic rich soils within Plan area (e.g. hectares) • Surface area of habitat removed from carbon rich / peat soils within Plan area (e.g. hectares per year)
To reduce soil sealing and soil loss.	• Surface area of land sealed within Plan area (e.g. hectares per year)

	• Surface area and depth of soils lost to mineral workings within Plan area (e.g. hectares per year)
To reduce levels of soil contamination.	• Area of statutorily contaminated land within Plan area (e.g. hectares) • Surface area (e.g. hectares) of soils affected by contamination e.g. a change in soil chemistry which has a negative effect on soil function and the ecosystem supported by that soil. This might include mine water discharge introducing heavy metals, eutrophication through atmospheric and surface water pathways, acid decomposition associated with deposition of air pollutants • Concentration of organic contaminants in soils within Plan area (e.g. mg kg^{-1}) • Concentration of potentially toxic elements (e.g. heavy metal pollutants) in soils within Plan area (e.g. mg kg^{-1})
To reduce soil erosion and landslides.	• Topsoil losses due to erosion within Plan area (e.g. tonnes per year) • Surface area affected by subsidence/ instability within Plan area • Number of landslides within Plan area (occurrences per year)
To reduce soil structural degradation and compaction of soils.	• Changes in bulk density of soils (particularly agricultural land) within Plan area (e.g. g/cm^3) • Changes in air porosity of soils (particularly agricultural land) within Plan area

8. Interaction with other topics / cumulative effects

Table 4 – Cumulative effects	
Cumulative effect	**Examples**
Time crowding - frequent and repetitive effects	Increased compaction of soils at popular outdoor tourist attractions due to frequent and repetitive footfall impacts or intense farming practices causing decreased organic matter content if all crop residues are removed from the land.
Time lag - long delays between cause and effect	Soil sealing leading to reduced rainwater infiltration and so reduced aquifer recharge - decreases groundwater levels and productivity of the aquifer.
Space crowding - high spatial density of effects	High spatial density of transport infrastructure in urban areas compounds soil sealing effects.
Cross-boundary - effects occur some distance away from the source	Run-off and through flow over and / or through soils which are contaminated affect sediments / surface water / groundwater quality in locations removed from the source. Note - this effect is not limited to land which is classified as “contaminated land”.
Synergistic - effects resulting from multiple sources or combined effects different in nature from the individual effects	Vegetation removal, soil sealing and soil compaction may cause increased surface run-off and erosion of soils that may have a negative synergistic effect on aquatic ecosystems due to increased sediment loading / silting if the sediment rich run-off enters water bodies or pollution by potential contaminants bound to the soil particles, or leaching of dissolved contaminants through the soil and into adjacent watercourses.
Indirect - secondary effects resulting from a primary activity	Deposition of airborne pollutants such as ash causing secondary effects on soil quality such as changes in soil pH or deposition of nutrient nitrogen causing eutrophication of soil.
Nibbling - incremental effects	Incremental soil sealing in urban areas due to development pressures e.g. sealing gardens for driveways.

Table 5 - Interaction of soil with other SEA topics

SEA topic	**Existing soil problems and interactions with other SEA topics**					
	Loss of organic matter	Soil sealing / loss	Contamination	Erosion and landslides	Compaction / structural degradation	Loss of soil biodiversity
Biodiversity, fauna & flora Interactions with soil include biodiversity within the soil habitat and soil as a habitat and as a support to specific habitats e.g. blanket bog, machair, limestone pavements.	Potential for biodiversity loss as most soil organisms require organic matter as a substrate.	Soil no longer available for biomass, food and fibre production and therefore its capacity to support habitats, biodiversity and crops is affected.	Direct contact and uptake through roots may cause various adverse effects on soil organisms, plants, ecosystems and biodiversity. Effects of contaminated run-off e.g. nutritionally rich on aquatic habitat / species. Contamination by invasive alien species.	Loss of fertile topsoil can cause a reduction in biomass production of the soil affecting ecosystems and biodiversity. Large scale erosion of peat represents a major threat to the soil's carbon storage function and also loss of habitat and species.	Physical changes to habitat affecting soil may result in loss of habitat for larger soil fauna e.g. earthworms Reduced / restricted root growth is a key issue for trees / plants in the built environment. Reduced gas exchange / aeration / water exchange in compacted soils affects functioning of the soil ecosystem.	Loss of soil biodiversity can affect the sustainability of species and habitats which rely on soil biodiversity. Soil organisms keep some pests and diseases in check; loss of these can make plants and animals more susceptible to pests and diseases. Many plants depend on soil organisms to

						enable them to grow properly; loss of these can result in poor plant growth. Soil biodiversity is an important part of the food chain; loss of this can affect availability of food for animals living above ground.
Climatic factors Interactions with soil include soil as a carbon sink and soil as a source or sink of greenhouse gases e.g. methane, nitrous oxide, carbon dioxide.	Carbon loss to the atmosphere as carbon dioxide through oxidation of exposed organic soils resulting in feedback to climate change.	When a soil is sealed it is no longer able to assimilate / take up any more carbon.	Excess Nitrogen in soil under certain conditions can lead to soil nitrous oxide (N_2O) emissions.	Changes in soil stability related to effects of climate change. Loss of carbon storage function of soils and peat due to erosion of more organic topsoil layers.	Possible increases in the flux of greenhouse gases such as nitrous oxide to the atmosphere from compacted soils affecting climatic factors.	Soil organisms play a vital role in soil carbon and nitrogen turnover and thus in the exchange of greenhouse gases with the atmosphere. The condition of the soil and the type of soil organisms present determine the type of gas emitted; loss of soil biodiversity

						will affect these processes and thus may contribute to climate change. Soil organisms create and maintain soil structure; loss of these can result in poor soil structure, which may in turn lead to conditions which favour greenhouse gas emissions thereby contributing to climate change.
Air Interactions with soil include air acting to transport and deposit contaminants.	Dust / particulates can affect soil functions.	When soil is sealed it is no longer able to exchange gases with the atmosphere.	Atmospheric processes leading to deposition of pollutants on soil and effects of gaseous emissions / uptake from soils e.g. ammonia, greenhouse	Dust / particulates can lead to contamination of soil.	Impacts on gas exchange between soil and the atmosphere.	Soil organisms affect soil structure and the biological processes occurring in soil; loss of these can therefore affect the concentration

			gases.			of gases in the air.
Water Interactions with soil include water acting to transport and deposit contaminants, as a force affecting soil stability, and the impact of soil on water pollution and storage.	Reduced capacity to store nutrients thus increased risk of leaching and water pollution – including eutrophication. Reduced capacity to remove potential pollutants from water filtering through or flowing over the soil. Reduced capacity to store water – increased risk of flooding / water pollution. Potential for increase in water pollution as many pollutants e.g. heavy metals, pesticides are bound to organic	Reduction in infiltration of water caused by soil sealing can cause changes in hydrological regimes in rivers e.g. rate of runoff and peak flows which can affect flood risk. Increase in water pollution from potential contaminants being washed straight into water courses rather than being filtered out by the soil.	Soil acidification through deposition of oxides of sulphur or nitrogen affects the production of biomass and the buffering capacity of soils – may contribute to water acidification resulting in subsequent changes to the water environment. Nutrient Nitrogen deposition can lead to soil eutrophication and potential water eutrophication if the nitrogen is then transferred into adjacent watercourses.	Soil particles are a major contributor to the sediment load carried by streams and rivers affecting water quality and resources. Possible effects include silting up and reduced capacity of water supply reservoirs, loss of fish spawning areas through the deposition of fine sediment on riverbed gravels and contamination of water by nutrients (mainly phosphorus) or pesticides attached to the soil particles.	Increased surface runoff from compacted soils may increase transport of sediment and adsorbed nutrients and pesticides leading to greater pollution of aquatic ecosystems and increases risk of flooding.	Soil organisms can break down potential contaminants thereby cleaning the soil. Loss of soil biodiversity may therefore lead to soil contamination and potentially increase the risk of water contamination if contaminated soil particles are then eroded into water courses. Soil organisms create and maintain good soil structure and so allow water to filter through the soil and be retained in pores. Poor soil structure caused by loss of

	matter. Increase of dissolved organic carbon concentration in surface water courses leading to discolouration of drinking water supply.		Surface water runoff, migration and leaching through soils of potential contaminants and natural toxic substances may cause adverse effects on the water environment.			soil biodiversity can therefore lead to a reduction in the capacity of soil to filter and store water thus increasing the risk of water pollution and flooding.
Population & human health Interactions include effects on human health of soil contamination and reduction in infiltration levels.	Reduced water holding capacity thus increased risk of erosion and flooding. Decline of aggregate stability thus increased risk of erosion and runoff and therefore flooding. Reduced filtering capacity has the potential to affect human health if contamination	Reduced water holding capacity and increased run off thus increased risk of flooding.	Direct contact, inhalation and ingestion of contaminated soils and uptake through plants may cause adverse effects on human health.	Impact of landslides potentially includes broken communication links and infrastructure disruption (road, rail, telecomms, energy) and consequent impact on population movement and health.	Water retention capacity will be reduced in compacted soils – leading to greater runoff and potential increase in flooding.	Loss of biodiversity may result in loss of potential medicines. Loss of soil biodiversity may affect water and air quality which may affect human health.

	enters water / air.					
Material assets Interactions include soil as a resource e.g. land as a basis for agricultural productivity.	Loss of organic matter leads to loss of nutrients which leads to loss of fertility / productivity.	Loss of soil through mining / quarrying resources. Loss of soil through removal for landscaping / horticulture etc.	Contamination of soil through addition of potential pollutants to soil.	Soil erosion and / or landslides can damage built infrastructure by undermining foundations and the deposition of sediments.		Loss of soil biodiversity may result in loss of potential medicines.
Landscape Interactions include amenity	Loss of organic matter may result in changes to the habitats which can be supported.	Soil sealing as a result of changes in land use may affect visual amenity.		Erosion / landslides may result in changes to landscape character.		Loss of soil biodiversity may result in changes to the habitats which it can support.
Cultural heritage Interactions include soil as a medium to protect cultural heritage assets	Loss of peat bogs may result in loss of any artefacts which have been historically preserved within the peat.	Damage or loss of archaeological features and cultural soils.	Direct contact with soil contamination may cause adverse effects on the built and historic environment.	Soil erosion poses a threat to the historic environment / archaeological features e.g. buried crop marks / shallow buried artefacts and structures.	Damage or loss of the historic environment e.g. cultural soils.	