
**Assessment methodologies and mitigation measures for the impacts of road projects on soils – ROADSOIL**

# Comprehensive Literature and Best-practice Review for Avoiding, Mitigating and Compensating for Impacts on Soil

Deliverable D4.1,4.2, Version 2.1
26 January 2022

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**CEDR Call 2019: Soils**

# Assessment methodologies and mitigation measures for the impacts of road projects on soils – ROADSOIL

## D4.1, 4.2 Comprehensive Literature and Best-practice Review for Avoiding, Mitigating and Compensating for Impacts on Soil

Due date of deliverable: 31/12/2021

Actual submission date: 26/01/2022

Start date of project: 01/03/2021 End date of project: 28/02/2023

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# Executive summary

Soil is defined as a biologically active mixture of organic matter, minerals, liquids, and gases built up from horizons consisting of different proportions of these components. It is the result of a long weathering process driven by biological, climatic, geological and topographic influences. A natural soil has four main functions: the habitat function, the production function, the regulation function and the archive function. Road construction entails soil sealing, compaction, pollution, and disposal of surplus material which compromise the soil functions with direct and indirect negative impact on people and their environment. Damage on soil must be avoided, mitigated, or compensated for. Therefore, soil has to be considered already in the road planning phase and soil protection measures must be consistently implemented in all phases of road construction projects. Soil protection measures are described in various directives and guidelines published by the European Union, several countries of Europe as well as scientific and professional associations of different industrial sectors. In this work package, we assess guidelines, soil information and best-practice examples of soil protection that relate to the planning and construction phase of a road construction project.

We carried out an explorative literature research on documents published by selected countries of Europe and professional associations within these countries. We used the Google Search engine and conducted the search with pre-defined search terms in the respective national languages. In addition, we interviewed experts of soil protection and road construction form administration and consultant companies to receive further suggestions about relevant documents and to estimate how relevant the documents are for practice.

The report presents the variety of documents and best practice examples found for the countries included in this study, with no claim to be complete. The appendix provides a compilation of the documents and the soil information. All selected countries have published guidelines or legal documents to integrate soil protection in construction projects which are usually based on legislations of environment protection or waste management. Most countries provide digital open access soil data including nationwide soil maps at a small scale and detailed soil surveys of parts of the countries. The methods of mapping and their content vary between regions and countries which makes the comparison difficult.

For the planning phase of a road construction project, the following soil protection approaches were found:

- Spatial planning specifications which are usually targeted on avoiding land-take on natural areas, forests and on farmland. These include target limits of land-take, priority areas for agriculture and soil function assessments.
- Approaches to reduce the sealed area, such as choosing alternatives of road alignments with tunnels or electronic toll stations at which the drivers do not have to stop and, therefore, no additional lanes are necessary.
- Dismantling road sections to compensate for soil sealing due to new road sections which is increasingly implemented in several countries in rural and urban areas.

In the construction phase, the following soil protection approaches were reported:

- Guidelines on soil handling to prevent soil compaction caused by wheeling or earth work on wet soil, on proper stockpiling and restoration of soil to avoid damaging the different layers, and on how to manage contaminated soils.
- Specifically trained and accredited “soil protection experts in construction supervision” to consult and supervise the construction engineers in soil protection measures.
- Large-scale soil restoration projects of which the success was proven in follow-up soil quality assessments.
- Management of surplus material to upgrade degraded soils and to build new habitat for pioneer species.

To conclude, many countries offer digital open access soil maps which can support the road planning phase. However, field surveys are mostly indispensable for detailed organisation of a road construction project. In addition, the basic principles of soil protection measures for road construction projects are usually known but that there is sometimes a lack of implementation. Interviewees emphasize that legal adjustments are only made very slowly, and national goals of soil protection need to be better included in the national transportation strategies. Most valuable are specifically trained experts of soil protection in construction who are able to apply the generic guidelines to local conditions and teach other stakeholders about soil and its functions that need to be protected.

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# 1 Introduction

In the RoadSoil project, we aim to develop methods and tools to assess the impact of road construction on soils by combining knowledge syntheses with novel approaches of data mining and modelling; to evaluate measures and best practices to mitigate and compensate for the impacts of roads by analysing expert knowledge and practical experiences; and to develop feasible practices that are effective in soil protection. We will pursue these objectives in a set of work packages. In this work package (WP4), we assessed guidelines and best-practice examples of soil protection that relate to the planning and construction phase of a road construction project.

Soil is a porous mixture of organic material, minerals, water and air, consisting of different layers. In simple terms, the upper layer, called topsoil, consists of a higher concentration of organic material and high biological activity, while the subsoil below contains less organic material and more mineral components and weathered rock. Below this is the parent material, rock or loose rock, which is not counted as soil in soil sciences. There are various types of soils which differ in composition, structure and thickness of the two layers. As described in WP1, the composition and structure of a soil enable it to perform certain functions that are the bases of ecosystem services of which humans benefit. Four main soil functions are defined:

- Habitat function: the ability to provide habitat for living organisms
- Regulation function: the ability to regulate the water, nutrient and carbon cycle as well as to filter and to buffer organic and inorganic contaminants
- Production function: the ability to generate biomass
- Archive function: the ability to conserve information about our natural and cultural history

The construction of a road can be divided into two phases. The planning phase includes the definition of the corridor for the road to be built and, in more detail, the sites needed for the construction work, as well as mitigation and compensation measures. The construction phase includes all executive activities such as preparing and managing the construction sites, handling and stockpiling the soil, the actual construction of the road and, finally, soil restoration at the sites that stay unsealed. In all of these phases soil protection is of high relevance to preserve the soil functions.

After the construction work has terminated, the area of the road is permanently sealed with pavement and, consequently, all its soil functions are destroyed. During the construction work the soil functions are impaired by compaction, pollution and mixing of different soil layers, caused by the excavation, relocation and interim storage of soils, as well as due to the load of construction traffic. These impacts on soil functions can either be avoided, mitigated or compensated for. The European Union and various countries in Europe as well as industrial associations and scientific interest groups have published regulations, standards and guidelines to protect soils in the context of road construction. Some of these stakeholders also provide soil information and other tools to ensure best possible soil handling.

The research objectives of WP4 were:

I) to compile guidelines of European countries that support soil protection in road construction;
II) to assess soil information and maps of these countries for the use in road construction projects;
III) to investigate best practices of soil protection in road construction in the countries studied.

This report gives an overview over the different approaches in the European Union and in a selection of European Countries and provides a compilation of guidelines, other documents and weblinks of relevance for practical use (cf. appendices). We additionally present best-practice examples for the planning and construction phase from the selected countries.

# 2 Methods

For searching scientific and grey literature, we followed the “Preferred Reporting Items for Systematic reviews and Meta-Analyses” (PRISMA) 2020 statement. It provides checklists for various types of literature reviews (with or without synthesis, original or updated reviews, and mix-method studies) and is therefore suitable as guidance for our literature and best practice review.

For the search of regulations, guidelines and best-practice examples we used Google Search as our main search engine but also the integrated search engines on websites of interest such as from companies and government departments connected to soil protection or road construction. Although the integrated search engines of websites had a smaller scope, they allowed us to estimate the policy sector and the legal power of a document. The documents relevant for this study are usually published by policy makers and governments and are, therefore, not included in databases such as the Web of Science or Google Scholar.

We defined the terms “soil protection”, “soil compaction”, “soil unsealing”, “excavation”, “soil storage” and “soil restoration” in combination with “construction”, “road construction” and “transportation infrastructure”. We additionally added the terms “guideline”, “guidance”, “standard” and “best practice example” as well as the name or abbreviation of the countries included in the review for the grey literature search. We also used specific terms such as “soil protection experts on construction sites” and “environmental impact assessment” which were known to be strongly connected to the topic. All these keywords were inserted in the language of the specific country.

The literature search was conducted in the respective national languages of the investigated countries. If several national languages existed, the search included all the languages of the regions that have more specific soil protection approaches than the nationwide standards. Due to the international research team with multiple language skills, we conducted comprehensive searches in English, German, French, Norwegian and Swedish.

In addition to the literature search, we interviewed experts in soil protection and/or road construction to make sure that we did not miss any relevant documents. This also allowed an estimate of how far the compiled documents are applied in practice. We first assessed the most relevant institutions linked to soil protection and road construction, and then addressed societies of soil science, national and regional departments of construction, environmental protection and agriculture, national traffic agencies as well as private companies involved in planning and environmental management.

The results were documented in a excel file containing the links and general information of the documents and other search results. We categorized the type of publisher and the type of result as shown in Table 1.

*Table 1: Type of publisher and type of document categories with explanation and examples.*

| Topic | Categories | Explanation/Examples |
|---|---|---|
| **Type of Publisher** | Authorities | governmental institutions e.g., Departments, Ministries and Municipalities |
| | Specialist | Non-Academic Institutions with expertise in soil, road construction, environmental |
| | Academic | Universities, Research Institutes, Journals |
| | NRA | National Road Administrations |
| | Other | Journalism, Independent Associations of other fields |
| **Type of Result** | Legislation | Laws, decrees, and regulations |
| | Guideline | Guidelines, Standards, |
| | Data | Raw data, maps, data collection projects |
| | Tool | Digital Tools to work with |
| | Association | Associations of interest for further inputs |
| | Report | Scientific and non-scientific articles |
| | Platform | Website with more information and useful links |

For our investigations, we selected the European countries according to the following criteria, whereas a country did not have to meet all criteria to be selected:

- the country has published legal documents, guidelines etc. for soil protection;
- the country provides soil data, maps or other soil information;
- different language regions are represented within the language skills of the project team;
- all PEB countries are represented.

We aimed to present a broad spectrum of guidelines, soil maps and best practice examples instead of a complete overview of all the countries of Europe. Therefore, we will not try to present best practice examples for the different aspects of soil protection in road construction for each country, but rather present the diversity of best practice examples based on the different countries.

# 3 Results

## 3.1 Overview on guidelines and soil information

Our internet search and expert interviews revealed a considerable number of documents and soil information for the investigated countries (Table 2). The appendix provides a compilation of all the legal documents, guidelines and soil data. In the section "Additional Information", we also list websites of other projects dealing with this topic, such as the RECARE project (https://www.recare-hub.eu). The additional Excel-file contains all documents together with weblinks to other valuable information.

*Table 2: Number of results found, sorted by category and country. The row "Additional Information" represents websites, reports, associations and examples besides the official guidelines and documents.*

| Countries | Legislations | Guidelines | Soil Data | Additional Information |
|---|---|---|---|---|
| **European Union** | 3 | 4 | 3 | 6 |
| **Switzerland** | 4 | 18 | 5 | 30 |
| **Norway** | 5 | 6 | 2 | 3 |
| **Sweden** | 4 | 5 | 4 | 5 |
| **Ireland** | 1 | 6 | 3 | 3 |
| **Germany** | 7 | 12 | 4 | 8 |
| **Austria** | 4 | 10 | 4 | 13 |
| **United Kingdom** | 5 | 11 | 6 | 4 |
| **France** | 3 | 6 | 2 | 12 |
| **Belgium** | 1 | 5 | 4 | 6 |
| **Sum** | 37 | 81 | 36 | 94 |

*Table 3: Overview of the disciplines of the interviewed experts per country with the number of respondents out of 68 persons originally contacted. The category "Soil Experts – Authorities" includes e.g. ministries of agriculture or environment. The category "consulting" includes experts from planning offices as well as from soil sciences.*

| Country | Soil Experts | | Road Experts | |
|---|---|---|---|---|
| | Authorities | Consulting | Authorities | Consulting |
| **Switzerland** | 2 | 3 | 1 | |
| **Norway** | | 1 | | |
| **Sweden** | 1 | 1 | | |
| **Ireland** | | | 1 | |
| **Germany** | | 1 | | 1 |
| **Austria** | 2 | | 1 | 1 |
| **United Kingdom** | | 2 | | |
| **France** | | | | 2 |
| **Belgium** | | 1 | | |

All countries address soil protection in the Environmental Impact Assessment (EIA) and provide fundamental legislation and guidance on the implementation of such an EIA. These regulations are closely related to the EU “Directive of Environmental Impact Assessment” (European Commission EC 2014a) which is supplemented by various guidelines and research documents (European Commission EC 2021). Together with the upcoming new EU soil strategy (European Commission EC 2021) it belongs to the most relevant documents for future soil protection strategies of EU member states. The EIA directive emphasises measures to avoid and compensate for land take but there is only little focus on mitigating the effects on soils during construction.

The selected countries of Europe have different approaches for addressing soil protection in general and in construction projects. Switzerland provides less regulation by law but an extensive number of guidelines and standards which are enforced by regional authorities, whereas countries such as Germany and Austria enacted national legislations to ensure comprehensive soil protection. In contrast, France or Ireland usually refer to legislations and guidelines provided by the European Union. In Belgium, regulations apply to single provinces, whereas in the United Kingdom all regions follow the same guidelines and standards.

Many of the compiled documents are not written exclusively for road construction but for construction in general, or for soil protection in other fields such as agriculture, spatial planning or mining, but with relevant content for road construction projects. Examples are the soil restoration guidelines of the Swiss Gravel and Concrete Industry Association (Fachverband der Schweizerischen Kies- und Betonindustrie FSKB 2021) and the Austrian guidelines to reduce land take which primarily address spatial planners (Federal Ministery Republic of Austria Agricultur Regions and Tourism 2015).

The documents generally aim at protecting the soil functions as defined in section 1, regardless of specific soil types. However, in recent years, in terms of land-uses there has been a focus on agricultural soils in many documents. Whereas in the past the focus has mostly been on preserving forests (e.g. in Switzerland) and natural habitats. This is possibly due to the fact that building roads on agricultural land obviously leads to land-use conflicts and the perception that agricultural land is becoming ever rare due to increasing urbanisation. Therefore, we did not limit our search to agricultural soils but also present examples where pioneer ecosystems are re-created.

In the following, we highlight specific approaches to avoid, mitigate and compensate for impacts on soil. This includes best practice examples, guiding documents and specific soil information. The first part is relevant for the planning phase and the second part, with the same structure, for the construction phase.

## *3.2 Soil protection in the road planning phase*

### 3.2.1 Soil information

The European Union published basic soil maps of most of the EU member states (European Soil Data Centre ESDAC 2021) and most of the investigated countries provide various soil data open access from their soil information systems or soil observatories (e.g. Ireland, UK, Belgium, Austria). However, these country-wide soil maps are usually at small scales (1:150.000 or smaller) and sometimes derived from land-use maps, such as the Austrian ÖROK Atlas or the Swiss land-use suitability map. Large-scale soil maps were found for England and Wales (1:50.000), Scotland (1:25.000) and for the Belgian province of Wallonia that provides a digital soil map at the scale of 1:20.000. The Geological Survey of Sweden published soil maps for approximately two third of the country’s area at scales of 1:25.000 and 1:100.000. The digital soil map of Austria (bodenkarte.at) was created at the scale of 1:10.000

and some German states (e.g. Hesse, Bavaria; (Hessian Agency for Nature Conservation Environment and Geology 2017; Landesamt für Geologie Rohstoffe und Bergbau 2021a) and Swiss cantons (e.g. Basel Land, Lucerne) published soil maps at scales of 1:5000. Norway's detailed soil survey at the scale 1:5000 covers about 50 % of the agricultural land (kilden.nibio.no). These high-resolution soil maps could definitely be useful for the planning phase of road project but, usually, they cover only small parts of the country.

The scale is, though, not the only matter that restricts the use of the available soil maps for estimating potential impacts on the soil functions from road construction projects. Traditional soil maps usually focus on land suitability for agricultural purposes and do not cover other soil functions. Examples are the "provisional agricultural land classification" of England and Wales and the "land capability map for agriculture" of Scotland. In the early 1930ies, Germany produced high-resolution soil maps for taxation of the agricultural land (Landesamt für Geoinformation und Landentwicklung LGL 2021). Based on the Norwegian soil survey map, a model-based tool was developed to define value classes of farmland taking into account additional information such as drainage properties and depth of solid rock. It is part of an NRA Guideline for EIA-reports published by the Norwegian Road Administration (Norwegian Road Administration 2021). Since the information is based on a modelling approach, it has to be supplemented with field observations to exclude potential miscalculations, if e.g. the risk of flooding is not sufficiently integrated in the model.

Different keys were used to draw the soil maps depending on the country, region and scale of the map (Greiner, Keller, Grêt-Regamey & Papritz 2017). The international soil classification system "World Reference Base for Soil Resources" (WRB) was developed in the 1990ies by a working group of the International Union of Soil Sciences IUSS for naming soils and for creating legends of soil maps. Norway provides soil maps based on the international WRB-system (IUSS Working Group WRB 2015; ISRIC 2021) whereas Germany, Austria and France created their soil maps with their own traditional keys. In Switzerland, different soil mapping methods were applied for the German and the French part of the country due to different schools of soil mapping and the lack of a national leading institution. As stated by practitioners and soil scientists, this lack of unitary soil mapping approaches makes the comparison between regions or countries impossible. On the other hand, a global approach such as WRB is not detailed enough for the use in the construction phase of a road construction project.

### 3.2.2 Policy instruments to avoid land take and soil sealing

The planning of national roads has to be in line with national and supra-national legislation and strategies in the context of soil protection and spatial planning. The new EU soil strategy (European Commission 2021), published in autumn 2021, mentions as an important goal to "reduce the rate of land take, urban sprawl and sealing to achieve no net land take by 2050" (European Commission EC 2020). This implies for EU member states that any future construction activities, including roads, have to be carefully planned so that land take and soil sealing can be avoided as far as possible or mitigated or compensated for. However, national target limits of land take have hardly been achieved so far because they usually have too little influence on planning in the different political sectors (Oliveira, Leuthard & Tobias 2019). For example, Germany and Austria failed in reducing land take to their targets of 30 ha/day and 2.5 ha/day, respectively, until 2020. In addition, there are regional differences of land take in the countries. Land take usually is strongest in densely populated regions where, at the same time, most productive agricultural soils are found. In Sweden, for example, agricultural land is most threatened by development in counties of Skåne and Västra Götaland in the South and Southwest of the country (Swedish Board of Agriculture2021).

Norway, although not member of the EU, is a positive example of successful implementation of such target limits of land take. Agricultural land is limited to 3% of the country's surface and, therefore, the Norwegian Soil Protection Act states that "cultivated soil must not be used for any other purpose than agricultural production" (Norwegian Ministry of Agriculture and Food 1995). On this basis, Norway set up a soil protection strategy which successfully helped to reduce land take on agricultural land to less than the targeted 400 ha/year until 2019 (Norwegian Ministry of Agriculture and Food 2021). The updated soil protection strategy is based on a broad sustainability discussion (Bardalen, Aune-Lundberg & Ulfeng 2021) and sets even stricter limits for land take on agricultural land for the period of 2021 to 2025, i.e. less than 300 ha/year by 2025 (Norwegian Ministry of Agriculture and Food 2021). This strategy applies to all political sectors and is particularly important for the transportation sector. It provides the framework for planning new roads and road sections according to the forthcoming new transportation plan of Norway (Norwegian Ministry of Transportation 2021). The consumption of agricultural land has to be evaluated separately in the road planning process, and every road project has to contribute to reducing the yearly land take of the country. For this purpose, the municipalities have to assign the most valuable agricultural land in their land-use plans.

Many countries, such as England, France, Italy, Germany, Austria and Switzerland, have dedicated priority areas for agricultural land use that directly affect the planning of roads (Oliveira, Leuthard & Tobias 2019). However, there is usually not a strict ban of development on such priority areas and, therefore, they have notably shrunk in many countries due to urban or infrastructure development. Only the so-called "green zones" of the Austrian state of Vorarlberg have kept their size since their introduction in 1977 because every hectare of green zones lost has to be compensated for (Land Voralberg 2017). The Swiss prime cropland protection strategy follows a similar approach with the Sectoral Plan of Cropland Protection, enacted in 1992 (Federal Office for Spacial Developement ARE 2020). The feature of this Swiss instrument is that the confederation prescribes a certain quota of prime cropland for each canton that has to be preserved. To avoid falling below the mandatory quota, the cantons compensate for the loss of prime cropland by either assigning other areas that fulfil the criteria to prime cropland, or by upgrading degraded agricultural land to prime cropland quality (Canton Zurich; Canton Lucerne 2019). As the sectoral plan of cropland protection follows a national interest, it is a powerful instrument against new building zones planned by municipalities. However, national roads are of national interest as well and, therefore, basically of the same importance as the prime cropland protection. Several cantons complained that, in the past, infrastructure projects of the confederation used to consume prime cropland without compensation. Therefore, the revised version of the sectoral plan, enacted in 2020, explicitly mentions mandatory compensation for prime cropland lost in the context of federal construction projects (Federal Department of the Environment Transport Energy and Communications (DETEC) 2018).

The German Federal Act on Soil Protection explicitly mentions soil functions to be preserved (German Federal Office of Justice 1998). Consequently, some German states – Baden-Württemberg, Hesse, Rhineland-Palatinate, North-Rhine Westphalia and Hamburg – developed soil function assessment frameworks to support spatial planning (e.g. Miller 2012). Austria has adopted this system (Fachbeirat für Bodenfruchtbarkeit und Bodenschutzdes BMLFUW 2013). Soil function assessments provide a basis to discuss trade-offs between soil functions and land-uses and, thus, offer more flexibility in planning decisions (Oliveira, Leuthard & Tobias 2019). For intensively urbanised regions, maps were developed indicating the performance of soil functions according to a simplified scoring system, such as the Soil Atlas of Stuttgart (Stuttgart). Soil function assessment frameworks are based on unitary soil data from soil mapping campaigns, such as e.g. the soil map of Baden-Württemberg (Landesamt für Geologie Rohstoffe und Bergbau 2021b). As mentioned before, different soil mapping approaches are used for different countries, regions and scales. Therefore, soil

function assessment frameworks are rather used for urban planning at municipal or state level, and their application in the planning of national roads has not been documented yet. In the context of the revision of the Swiss sectoral plan of cropland protection, the discussion was raised about a Swiss soil function assessment framework. In a first step, Switzerland is elaborating the national soil information system NABODAT, which aims to “collect, harmonize and manage soil quality data of Switzerland” (Verbund NABODAT 2021).

### 3.2.3 Reduction of soil sealing for mitigating the impact on soil

The Norwegian Public Roads Administration (2021) published guidelines for the EIA-process and selection of alternatives in infrastructure projects according to their consequences for agricultural areas, archaeological sites, valuable natural habitats and a number of other topics because mitigation measures must already be included in the planning of new roads or road sections. This means in particular that the alignment of roads should be selected according to local soil conditions, or that new technologies should be applied to avoid extensive soil sealing. A good example of improved road alignment is the construction of the highway A9 in Valais in Switzerland. Already in 1979 Professor Ph. H. Bovy of the University of Lausanne was commissioned to propose a variety of alignments (Figure 1) to improve the original plans in regard of embedding the highway into the landscape, preserving cultural heritage, protecting agricultural land and mitigating environmental impacts (Dienststelle für Nationalstrassenbau (DNSB) 2020). Based on this study, the project was improved in the following years and ultimately approved in 2014. As a result, the road runs now partly underground and bypasses agriculturally and archaeologically valuable areas.

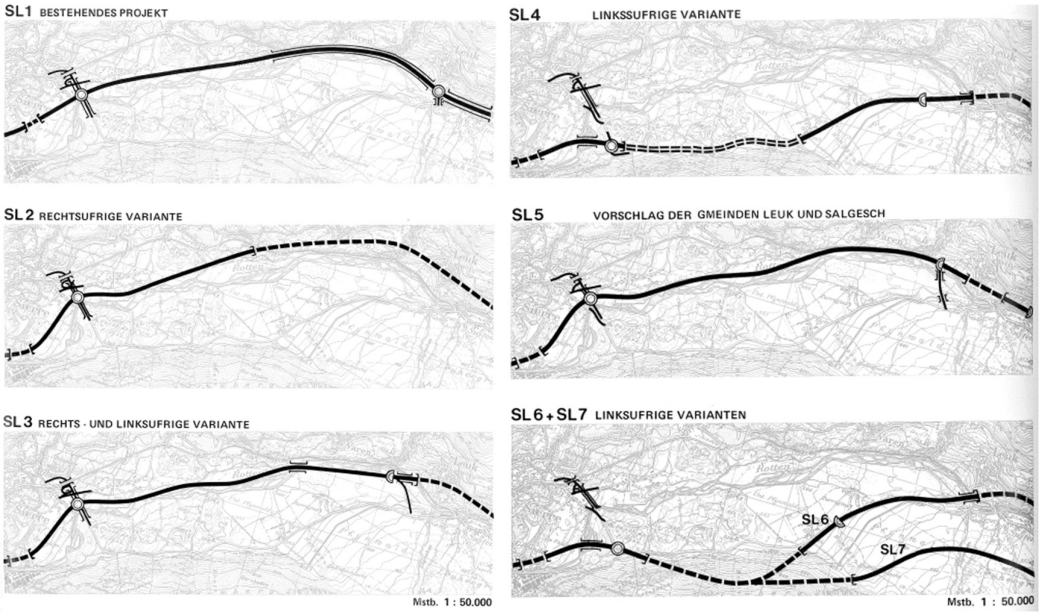


*Figure 1: Some of the variants for the road alignment proposed by a study of Professor Ph. H. Bovy. (Source: Tiré du rapport final de synthèse du réexamen N9 Riddes-Brig par Prof. Ph. H. Bovy, EPFL, nov. 1982).*

The new digital technology for toll stations provides an opportunity to reduce land take of road infrastructure (Figure 2). The free-flow electronic toll system (ETS) recognizes licence plates with cameras and thus drivers do not have to stop at toll stations with extensive sealed areas. This system is already known in Ireland (Transport Infrastructure Ireland TII 2021), in Norway (www.autopass.no), in Sweden for some cities and bridges (Swedish Transport Administration 2021a) and has recently been introduced in France (Eiffage 2020).

*Figure 2: Comparison of a toll station with a sealed surface of about 10 extra lines and an illustration of the new eFlow Barrier free toll system with no extra lanes (Source: Erolf Productions pour APRR).*

Road construction projects often trigger land reallocation of agricultural soils, and the local farmers can benefit from windfall gains. In the construction process of the A355 in France, the land used for the construction work together with other surrounding land was rededicated after

the construction work, so that larger contiguous agricultural areas were created (Arcos & Vinci Autoroutes 2019). Land reallocation after road construction has a long tradition in Norway as well, following the procedures described in the Act for Land Consolidation (Norwegian Ministry of Agriculture and Food 2013). This allows optimisation of use by, on the one hand, splitting the areas according to their characteristics and the targeted uses and, on the other hand, a more efficient agricultural management (Figure 3). In addition, land reallocation is the main planning instrument for assigning areas for any type of ecological compensation measures.

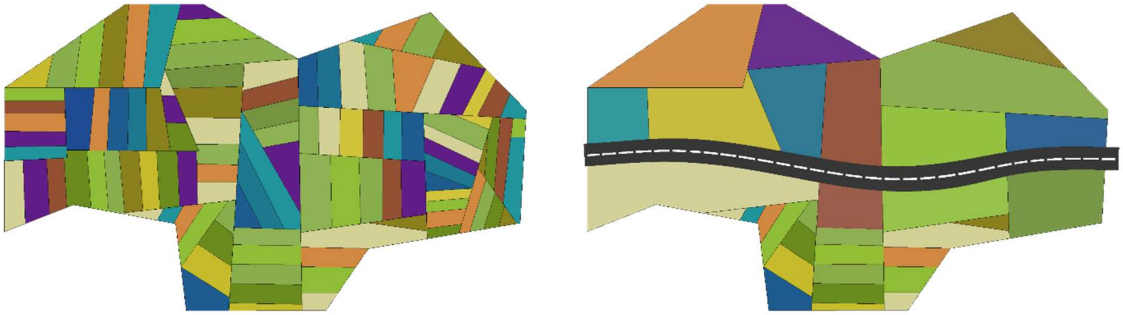

*Figure 3: Before (on the left) and after the reallocation (on the right) of the parcels with the newly constructed road and larger contiguous agricultural areas after reallocation. (Source: T. Geiges)*

### 3.2.4 Soil unsealing to compensate for impacts on soil

In many countries, it is mandatory to compensate for negative impacts on soil or the environment in general caused by infrastructure projects. Therefore, the planning phase of roads has to include compensation measures. In Germany the nature conservation act states that “unavoidable significant impairments are to be compensated for” (§13, Bundesamt für Justiz 2009) and that they have to be “recorded in a compensation register” (§17, Bundesamt für Justiz 2009). For this reason, the regional authorities provide regulations on how compensation registers have to be set up and used such as the compensation register ordinance of Baden-Württemberg (Ministry of the Environment Climate Protection and the Energy Sector 2005). These compensation registers are managed by more local authorities and do not only list compensation measures in the context of accomplished infrastructure projects but also additional nature conservation measures “in reserve” which can be counted as compensation measures in future construction projects. But since these measures do not need to have “a direct spatial connection between the intervention and the compensation area” (§200a, Bundesamt für Justiz 1960), the compensation measures are not necessarily carried out in the same geographical region as the new infrastructure construction. In addition, it is possible to compensate for damages on soil with other ecological compensation measures. A number of news-paper articles (Philip Bethge 2004; Hagen 2020) questioned whether this “pool” of compensation measures can adequately compensate for interventions in the environment. Nevertheless, these registers allow to track and evaluate compensation measures such as in Hüfingen (Germany), where the expansion of the B27 national road to four lanes was compensated by unsealing and narrowing a minor road with a total area of 16’860 $m^2$ where the sealed surface was removed (Regierungspräsidium Freiburg 2013).

A crucial question in the road planning phase is about the geographic perimeter around the new road sections in which compensation measures should take place. The German system explained above might result in large distances between the regions affected by road construction and the regions benefiting from compensation measures. On the other hand, if

the area of influence is restricted to the actual road area, as given e.g. in the Swedish Road Act (Väglagen 1971:948), extensive compensation measures might hardly be possible due to lack of space.

Dismantling roads is the most effective way to reduce the traffic burden of the neighbouring residential areas, but it leads to detours for those who regularly used these parts of the roads. This was debated when a road crossing the border between Switzerland and France near Geneva was downgraded for pedestrians and agricultural traffic, and to improve the local nature conservation areas. To test, if the nearby border crossing was able to handle the additional traffic load, the municipality of Meyrin closed the road for a month (Magnin 2010).

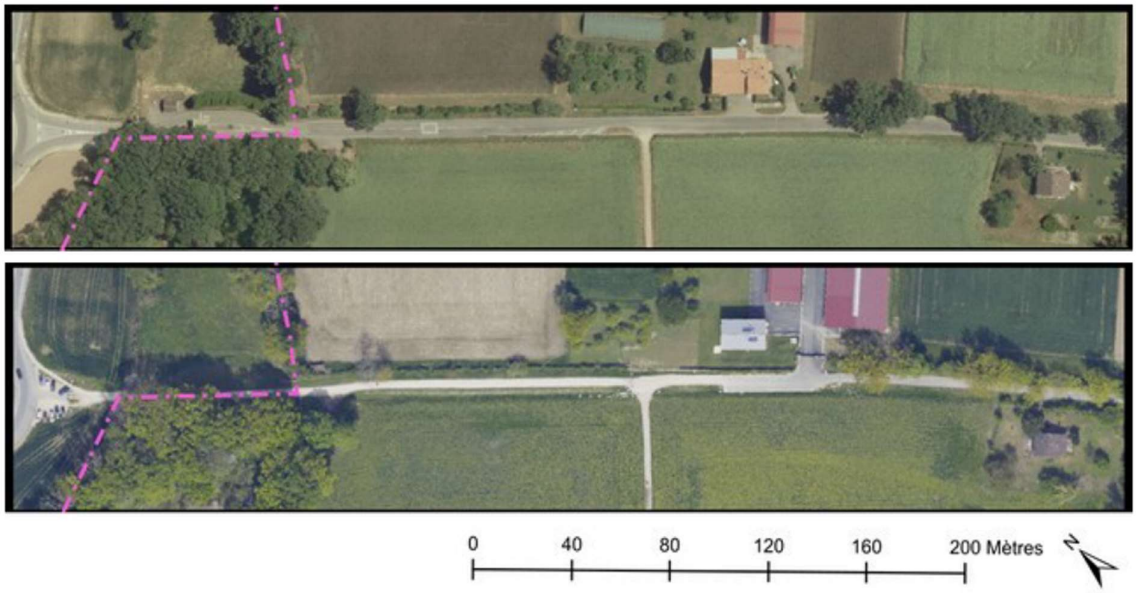


*Figure 4: Aerial image of the situation at the border of France (on the left of the purple line) and Switzerland before (upper image) and after (lower image) the intervention (Source: GIS Geneva, Editing B. Lai)*

With this approach the municipality could convince the opponents of the project, which insured a smooth implementation. In this project 45% of the previously sealed surface was unsealed. Gravel was used as a permeable surface for the new, narrower road and the soil of the completely unsealed areas was restored (Figure 4).

Unsealing roads as a compensation measure is, however, not restricted to rural regions. In the city centre of Vienna (Austria), the local authorities unsealed 1900m$^2$ of a former road to create an urban park of about 3390m$^2$ (Figure 5).

*Figure 5: The Else-Feldmann park in Vienna under construction. The previously existing road was unsealed and connected with the surrounding trees and pedestrian areas into a larger recreational area within the city of Vienna (Source: P. Gugerell, Vienna, Wikimedia Commons).*

## 3.3 Soil protection in the road construction phase

During the construction phase soils are exposed to several risks. There is a risk of soil compaction when heavy construction machinery is used. Different soil layers are exposed to the risk of being mixed up during excavation, storage and heaping. And soil can take damage when temporal stockpiles/deposits are not properly heaped up and maintained. These risks can be avoided, mitigated and compensated for.

### 3.3.1 Soil management on construction sites to avoid impacts on soil

Various countries have published guidelines for careful handling of soil on construction sites (Bundesamt für Umwelt Wald und Landschaft BUWAL 2001; Landesamt für Natur Umwelt und Verbrauchschutz LANUV 2009; British Standard Institute BSI 2013, 2015; Destain 2013; Federal Office for Environment FOEN 2015). Their emphasis is on preventing soil compaction caused by wheeling or earth work on wet soil, and on proper stockpiling and restoration of soil to avoid mixing and damaging of the different soil layers. They further advise how to manage contaminated soil on construction sites (e.g. Bundesamt für Umwelt BAFU 2005). The Swiss standard "*SN 640 581* Earthworks, Soil: Soil protection and construction" by the association of Swiss road and transport professionals was initially published for soil protection in road construction projects but has now been widely used for general construction projects (Schweizerischer Verband der Strassen- und Verkehrsfachleute (VSS) 2019).

Switzerland introduced an accrediting procedure for "soil protection experts in construction supervision" in 2005. These soil protection experts consult the construction engineers in all soil issues of large infrastructure construction sites, such as natural gas pipelines or road constructions (Hunziker & Stammler 2018). They are responsible of mapping the soil on the planned alignment and consult the construction engineers in planning the earth work in order to avoid conditions of susceptible soil. During construction, the soil protection experts monitor soil moisture with tensiometers in the field and are committed to intervene, if the soil is too wet

to carry the load of the construction machinery. They are authorized to stop the construction process in situations where the risk of soil compaction is high. They further supervise the entire construction process from a soil protection perspective, e.g. the choice of machinery, the use of excavator support mats and how to create and maintain the soil storages. After construction, the soil protection experts supervise soil restoration and approve restored soils before they are handed over to the owners. Several Cantons jointly provide current online information about soil moisture in soil monitoring networks which support the work of the soil protection experts. Examples are the soil monitoring networks of North-western Switzerland (Meteotest AG 2021), of Eastern Switzerland (ZHAW & IAS 2019) as well as for the Cantons of Lucerne (Canton Lucerne 2021) and Ticino (Osservatorio Ambientale della Svizzera Italiana 2021).

*Figure 6: Soil protection measures at Scheltenstrasse, Solothurn, Switzerland; crawler instead of tyre machinery, axes to be driven on, separate excavation and storage of different soil layers, and erosion control measures on steeper slope of soil deposits (Source: M. Stettler).*

An example of such a construction supervision by a soil protection expert is a road realignment in the Canton of Solothurn (Switzerland) to avoid the risk of rockfall (Figure 6). Here, the expert additionally had to supervise erosion control measures on the batters.

The Swiss Soil Science Society accredits these soil protection experts in construction after

specific education and exam (Soil Science Society of Switzerland BGS 2014). The accredited experts are obligated to attend regular advanced training courses in order to stay on the Soil Science Society's list of recommended soil protection experts in construction. In the course of environmental impact assessments, cantonal authorities usually stipulate to involve accredited soil protection experts in infrastructure construction. A number of cantons (e.g. Zurich, Lucerne, Aargau) developed specification sheets that can be downloaded and used as the basis of a contract between the construction company and the soil protection expert. The Swiss system of soil protection experts in construction is currently being adopted in Austria (e.g. Upper Austria) and discussed in Germany.

### 3.3.2 Soil restoration to mitigate the impact on soil

Contrary to organic soils in wetlands which are susceptible to the decay of organic material under aeration, well drained agricultural soils can successfully be restored with the appropriate technique (Figure 7). Several countries have published specific guidelines describing proper soil restoration on areas which were temporarily used during road construction or gravel excavation. Examples are from Switzerland (Fachverband der Schweizerischen Kies- und Betonindustrie FSKB 2021), Austria (Fachbeirat für Bodenfruchtbarkeit und Bodenschutz & Arbeitsgruppe Bodenrekultivierung 2012), Germany (German Institute for Standardization DIN 2019), the UK (Departement of Environment Food and Rural Affairs DEFRA 2009), Sweden (Swedish Transport Administration, 2021b) and Norway (Hauge & Haraldsen 2017). The guidelines stress the importance that the top- and sub-soil layers are not mixed but excavated and stored separately in order to conserve soil structure and the living conditions of the soil organisms. In addition, the guidelines point out that after restoration only minimal agricultural intervention without heavy machinery should take place on the soil during a period of several years because freshly restored soils are very susceptible to compaction. Thorsteinsen et al. (2020) reported on projects of restoring peat soils and other types of soils in coastal areas in Norway.

A successful large-scale soil restoration project is documented in the context of constructing a new high-speed railway line in the Canton of Berne in Switzerland. A large amount of soil had to be restored, not only on installation sites but also on the top of opencast tunnels and on areas where old railway lines were dismantled. A follow-up study on part of the restored area of an installation site (Figure 8) confirmed that no significant difference in the soil properties between the control area and the restored area were found (Stettler, Stettler & Huber-Eicher 2010). Experts involved in this project said that it was crucial to involve farmers and other stakeholders in an early stage of the project to ensure their cooperation in all steps of the work. This includes specific greening strategies at the beginning of the construction work, careful management of the soil deposits, and a follow-up management with only little farming intervention.

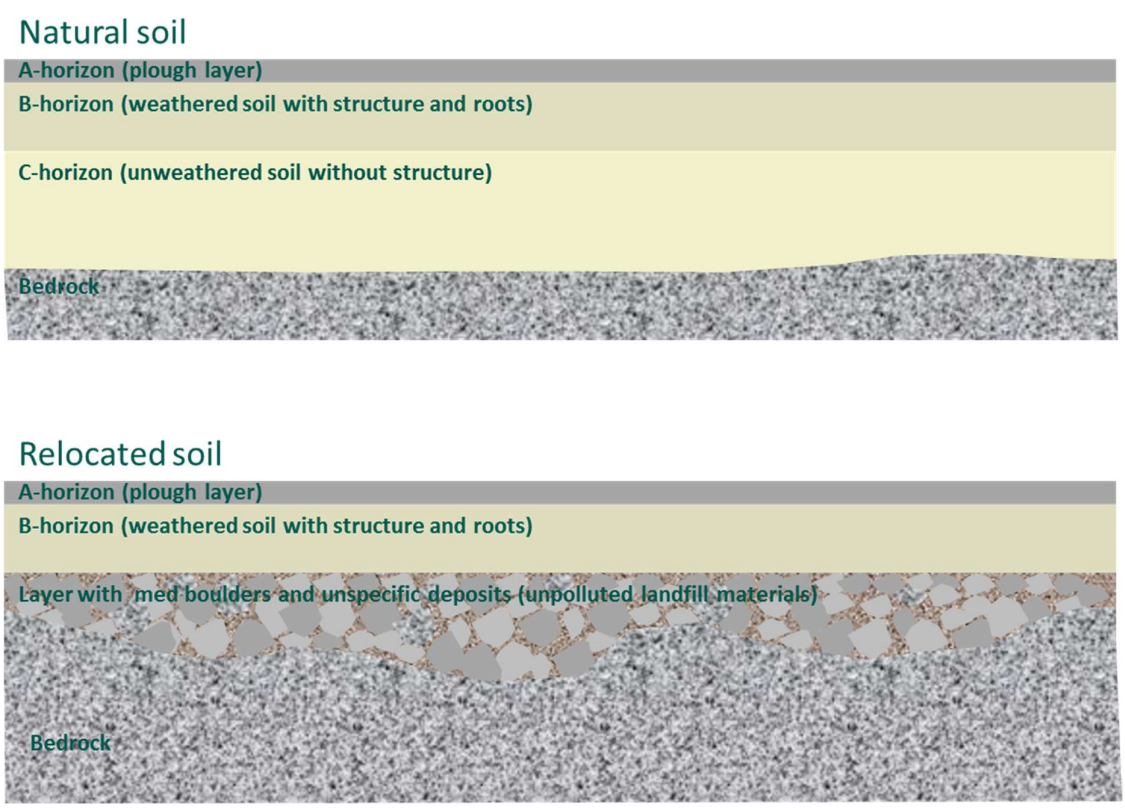


*Figure 7: Generic profiles of a natural and restored soil (Source: Modified from Hauge & Haraldsen 2017).*

*Figure 8: Blue are the new built railway lines. Red is the restored perimeter on which also the follow-up study took place (Photo: geo.admin.ch, Editing T. Geiges).*

Another example is in the Lier valley in Norway where a new water pipeline was built through particularly productive agricultural land (Figure 9). The different layers were excavated and stored separately. The area, which was driven on during construction, was loosened up before the soil was restored. In addition, those areas with acid subsoil and reduced root development were treated by liming to decrease acidity. The restored soil was also evaluated a few years later. After restoration of the layers, the productivity of the soil stayed at the same level or even increased in some areas, most likely due to control of compaction and loosening of the subsoil with excavators as well as the liming treatment (Sloreby 2009a, 2009b).


*Figure 94: Water pipeline through agricultural area (2005) and growing cabbage at the replaced soil (2018) (Source T.K. Haraldsen).*

### 3.3.3 Management of surplus material to compensate for impacts on soil

In most construction projects, some of the excavated material cannot be reused on the initial site due to lack of space, unfavourable structure or contamination. This includes not only surplus soil but also rock and parent material. Consequently, the following guidelines and examples are not restricted to the reuse of surplus soil as defined in section 1. However, we consider it important to discuss the reuse of rock as well because it can contribute to restore and improve the soil functions, for example the habitat function for endangered species.

The Irish Environmental Protection Agency provides basic guidance for managing soil and stone by-products to insure that valuable material is not disposed as waste (Environmental Protection Agency EPA 2019). The Swedish Road Administration provides guidance on the use of excavated surplus material of construction projects according to the current environmental and waste legislation for the management (Swedish Road Administration 2019). The Wallonian non-profit-association Walterre (WALTERRE & ASBL 2021) is responsible of certifying and tracing excavated soils. On their online platform utiliTerre (Atrasol SPRL 2021) they provide information about available soil material and potential locations for certified soils. The soils are certified within five categories from high quality natural soils to low quality construction debris. Various Norwegian ministries, such as environment, agriculture, fisheries, transportation and finances, launched a cross-sectoral project to explore the challenges and the different regulations about managing uncontaminated soil and stone. The project elaborated a number of measures and policy instruments to ensure responsible, predictable and more resource-efficient management of excess soil and stone whilst protecting environment, climate and land-use (Norwegian Environment Agency 2021).

As a consequence of the Swiss prime cropland protection strategy (cf. section 3.2.2; Federal Office for Spacial Developement ARE 2020), surplus soil is often used to increase soil depth of degraded agricultural land to achieve prime cropland quality in Switzerland (Canton Zurich;

Canton Lucerne 2019). In the Canton of Zurich, for example, a regional road was widened to create a cycling path and the surplus soil was used to upgrade agricultural soils in the neighbourhood (Figure 10). As the Canton of Zurich is short of prime cropland areas, it provides an open access map of degraded agricultural land so that new locations for surplus soil from construction sites can easily be found on the website (Canton Zurich). According to the handbook for “Risk assessment and measures for polluted soils” (Federal Office for Environment FOEN 2005), contaminated soil of this road construction site was reused locally on soils of similar contamination. In some cases, the nutrient conditions of the surplus soil, particularly subsoil material, have to be improved for the intended vegetation. NIBIO did extensive research on mixing surplus soils with organic material to improve soil quality for the use in urban green spaces in Norway (Haraldsen & Pedersen 2003; Haraldsen, Brod & Krogstad 2014). The findings have resulted in guidelines for soil properties and soil management in the road environment as part of the handbook for road construction (Norwegian Public Roads Administration 2015). They are additionally included in the forthcoming revised Norwegian standard 3420K for designing urban green spaces (Standards Norway 2021).

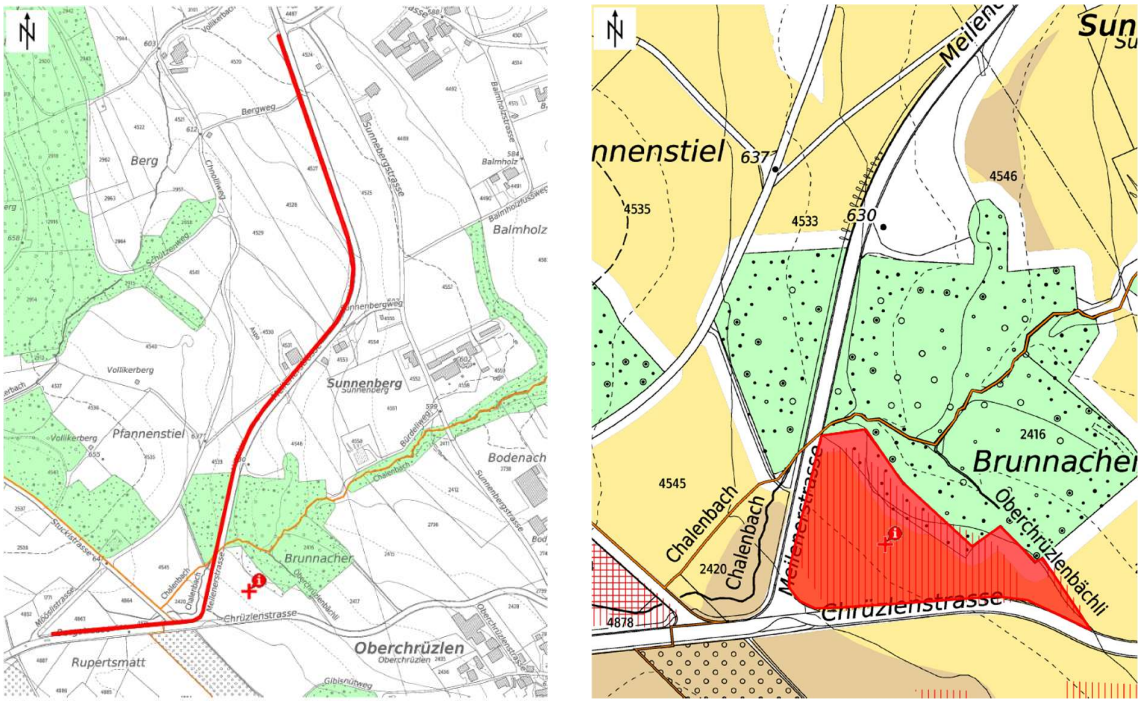


*Figure 10: Section of the Cantonal geographic information system of Zurich with the course of the newly created cycling path (indicated as red line in the image on the left) and the nearby area (red cross in the centre) in which the surplus material was used. And a view of anthropogenically degraded soils (indicated with red hatching in the image on the right) and the area upgraded with surplus material (outlined in red). (Source: GIS of the Canton of Zurich, Editing: T. Geiges).*

Digging tunnels through mountains produces large amounts of rubble that can hardly be used as top- or subsoil but can be used for terrain modelling. In Switzerland, the surplus material from national road construction projects and especially from the tunnel construction of the New Railway Link through the Alps (NRLA) was used to create islands and shallow water zones at the Reuss river’s entry to the Lake of Lucerne (Figure 11). The project’s objectives were to improve the ecological conditions of the local river delta and to reduce erosion at the shores which was a result of the intensive gravel mining in the early 20th century. In total, 3.3 million

tonnes of surplus material were filled into the lake to create 12 hectares of shallow water zones as well as islands for nature protection and swimming (Bühlmann 2018; Justizdirektion des Kantons Uri & Amt für Umweltschutz 2018).

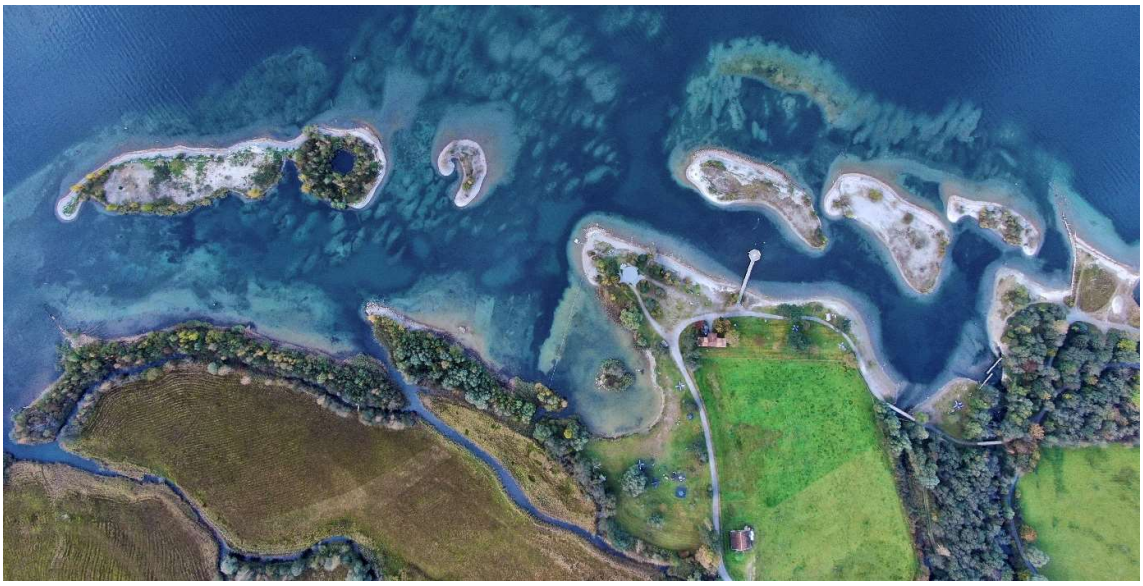

*Figure 51: The Reuss delta with the created islands. (Photo: Matthias B. Andrews).*

In the Southern part of Switzerland, tunnel excavation material was used to lift agricultural soil that was suffering from a high groundwater table. To release the city of Locarno, squeezed between a lake and a mountain, from transit traffic, a tunnel was drilled through the mountain for a bypass road in the 1990ies. At the same time, the fields in the Magadino plain at the upper end of Lago Maggiore were waterlogged because the lake's water table was raised at its outflow on the Italian side. Extensive land improvement was carried out where top- and subsoil were removed, the excavated material from the tunnel construction was spread on the parent material and soil horizons were heaped again in the same area.

Admittedly, the trigger of both projects was disposal of the waste material from the tunnel excavations. However, they are in line the Swiss Waste Ordinance which allows, in specific cases, the use of uncontaminated construction rubble for terrain modelling. Particularly for the delta project, it had to be proved that the ecological benefit from re-creating the natural habitats exceeded the economic savings because the waste material was not transported over long distances.

Several companies in Norway have specialized in sorting and refining surplus soil and bedrock material from construction areas. Such procedures can take place in the course of a construction project with the advantage that a place to deposit the mineral material needn't be found. The sorted rock fractions can be used as building material, for mitigation and compensation measures and for urban green spaces when mixed up with soil (Figure 12). However, experienced experts in soil protection have to supervise the reuse of stony excavation material because, depending on the structure of the excavated material, it might have negative consequences. Blasting drive creates boulders whereas the material from drilling advance is very fine-grained with low water permeability. In the region of Bergen (Norway), known for high precipitation, tunnel drilling material was mixed with peat for the restoration of agricultural land which resulted in poor drainage properties of the soil. We will discuss the legislation and procedures for the reuse of surplus soil and other material from road construction projects in more detail in the report of WP6.

*Figure 62: Making rock and soil-based fractions from construction areas by crushing and sorting (Photo: T. K. Haraldsen).*

### 3.3.4 Soil borne pathogens and harmful organisms

Soil is a huge gene-pool for useful and harmful organisms and invasive species are a threat to biodiversity. Therefore, many European countries have adopted regulations and measures to combat invasive species. For example, the Swedish Environment Protection Agency (2021) provides information about where invasive species occur and how to combat them. The Swedish Environmental Code prescribes precautionary measures for any infrastructure project, unless the spread of invasive species is excluded in a precursory risk analysis (Pettersson et al. 2016). The national transport agency Transport Infrastructure Ireland TII (2020) has published a specific technical guide to assess the situation and management of invasive species along national roads. Some Swiss cantonal authorities provide guidelines for constructors and planning offices about controlling alien plants on construction sites (e.g.Canton Zurich 2019). The measures against invasive alien species depend on the species to be controlled. Consequently, the guidelines of the single countries differ according to the invasive species locally present. Measures against invasive alien plants on construction sites in Switzerland include regular assessments, local species-specific removal, disposal of infested soils, immediate revegetation of fallow and restored areas, and monitoring of these areas up to five years after the construction work has been completed. In the example of *Reynoutria japonica*, the soil must be removed within a radius of three metres around the plant stand and at a depth of up to three metres, as even millimeter-sized root pieces can lead to the further spread of this species. These soils must then either be disposed of in specially approved landfills, incinerated or cleaned in soil washing plants. Transport to such a processing site is also strictly regulated: during transport, the material must be covered to prevent material from being lost while driving and the transport vehicle must be cleaned before it transports other material (Canton Zurich 2019). In Norway a survey of foreign organisms is mandatory for infrastructure and building projects. The Norwegian regulation on foreign organisms provides a long list of organisms of which spreading must be prohibited (Norwegian Ministry of Climate and Environment 2015). Particularly weeds that can spread rapidly and can cause large yield losses of agricultural crops, such as *Avena fatua* and *Echinochloa crus-galli*, have be controlled road construction sites. The Norwegian Ministry of Food and Agriculture (2015) prescribes that, soils on which *Avena fatua* is present must not be moved to another location but must be reused on site. It has to be noticed, though, that roads are pathways for the spread of alien plants because the cars transport the seeds over long distances on their coachwork and tyres. Recent research in UK and Switzerland is developing techniques to detect invasive plants from image processing using artificial intelligence (UK Centre for Ecology and Hydrology 2021; Swiss Federal Institute WSL 2021). Another issue is soil-borne

pathogens damaging agricultural crops. Many of these are host specific and affect specific crops, such as potatoes and other *Solanum* species. Depending on the pathogen species, excavated soils must be deposited for up to 40 years in isolation before they might be reused. This applies e.g., for soils contaminated with potato cyst nematodes (PCN) in a road or railway construction site in Norway. The procedures of soil management in relation to weeds, plant pathogens and invasive species will be discussed in more detail in the report of WP6.

# 4 Synthesis

Our results give an overview of regulations, guidelines and soil information that support soil protection in road construction from nine selected countries of Europe as well as from the European Union. We showed the implementation of the soil protection measures in road construction with a selection of best practice examples of the investigated countries. The selected countries differ in the provision of legal bases and guidance to protect soils in road construction projects as well as in the availability of soil data. As we selected the countries according to the criteria in section 2, our results make no claim to be complete for entire Europe.

## *4.1 Planning phase*

Soil maps are important documents to include soil protection issues in the road planning phase. In many cases, though, they do not cover the entire country, or only at a small scale. Some interviewees said, the reason why nation-wide soil maps are missing is the lack of an institution at national level that takes the lead in this task and ensures that all stakeholder interests considering the content of the soil maps are taken into account. The current development towards open access digital soil maps offers promising opportunities for easier integration of soil protection in road planning. Particularly the maps of soil function assessment frameworks, as developed in Germany and Austria, could be useful in the road planning phase.

Spatial planning instruments, such as target limits of land take or priority areas for agriculture, may help to reduce soil sealing in the context of road construction. For this, however, the spatial planning targets must be included in national transportation concepts or plans, as implemented in Norway. In this way, the spatial planning specifications have an influence on the road alignments and call for alternatives to facilities with extensive sealed areas, such as digital toll stations. The potential of digitalisation should, actually, be exploited stronger for traffic management (drop-counter traffic lights, flexible speed limits to avoid traffic jams, road-pricing etc.). This could help to use the road infrastructure capacities more evenly and to confine additional soil sealing.

In order to pursue the goal of reducing net soil sealing, compensation measures have to be included already in the planning of new roads, road sections (e.g. new feeders to motorways) or road widenings. Recently, projects of unsealing road sections have become more frequent. Beside the reduction of the traffic burden of the neighbouring regions, unsealing projects are beneficial for agriculture, biodiversity or the urban population. However, unsealed soils are usually restricted in their multifunctionality compared to natural soils (Tobias et al. 2018), why it is always better to avoid soil sealing. Compensation registers document the single compensation measures and motivate to initiate compensation projects and even to stock up on them. However, the geographic perimeter is crucial for the effect of reconciliation, and compensation measures have to be planned within a feasible distance to the new road sections. Finally, compensation measures provide opportunities to reuse surplus soil from construction sites. Therefore, they are often triggered by large infrastructure projects, as seen in the example of the artificial islands in the Swiss Lake of Lucerne.

## *4.2 Construction phase*

Guidelines and standards for proper soil handling during the construction phase are available in many countries, elaborated by a variety of experts. During the construction phase, the measures of soil protection in construction do not differ much among various kinds of projects and, therefore, guidelines from other industrial sectors can be useful for road construction

projects and vice versa. An example for the integration of soil protection standards in road construction with origins of another sector is the soil restoration guideline of the Swiss Gravel and Concrete Industry Association (Fachverband der Schweizerischen Kies- und Betonindustrie FSKB 2021) which is used as a standard in any kind of construction project.

Most of the soil protection measures described in the guidelines are not new and well known among experts of some countries. Therefore, deficient soil protection on construction sites is rather due to incomplete implementation of the measures than to a lack of knowledge, as experts mentioned during the interviews. An expert from Germany was concerned that soil protection is rather neglected in politics and that the necessary legal adjustments are made very slowly. In addition, there is a need for a control authority which makes sure that the existing soil protection guidelines are implemented in road construction. The implementation of soil protection measures differs among industry sectors as well. In Norway, entrepreneurs in the road construction sector are less driven to soil protection than farmers, whereas in Switzerland the construction industry sometimes treats soil more carefully than agriculture.

The difficulties in implementing soil protection measures have been approached in Switzerland with the introduction of the “soil protection experts on construction sites”. The strength of this system is that the expert adapts the generic descriptions in the guidelines to local conditions. According to the experience of soil protection experts, it can be reasonable to set up temporary installation sites at places with high-quality agricultural soils because these soils are less susceptible to damage from restoration due to their physical and mechanical properties. In this way, vulnerable soils which are difficult to restore, such as peat soils, can be preserved. The experts therefore already take measures during supervision of the construction work that will only later be relevant for the successful soil restoration. They also ensure that the valuable surplus material can be used in compensation projects instead of being disposed as waste. In summary, the action of the experts begins already in the planning phase with the elaboration of all necessary measures according to the guidelines, which may have to be adapted during the construction phase and ends with ensuring the follow-up management until final acceptance.

Interviewees also stressed the importance of good communication and of involving all interest groups early in the project. Farmers play a crucial role in preparing their soils for the upcoming construction work by planting specific vegetation to reduce the impacts on soil. Communication skills are further needed to explain the reasons for implementing soil protection measures and the procedures described in the guidelines. This can be hard work until all agents involved (machine operators, landowners, builders, planners, etc.) understand and agree to the necessary soil protection measures. Good communication is a long-term task, as it has to ensure the implementation of the soil restoration measures until their approval by the soil protection office. Even small errors in the follow-up management can cause significant and permanent damage on the restored soil.

More opportunities to train experts with such a wide skillset from knowledge on soil properties up to stakeholder-oriented communication should be offered at universities and training centres to overcome the already existing shortage of soil protection experts, as a German interviewee said.

## *4.3 Conclusion and Outlook*

The results of our internet search and expert interviews show that, although considerable information for soil protection in road construction is available in the investigated countries, there are still difficulties in implementation. The procedures generally described in the guidelines have to be adapted to individual cases with specific soil conditions and stakeholder interests. In addition, the full potential of soil information and soil protection measures has not

been tapped yet. Digital soil maps, soil function assessment frameworks and innovative approaches to avoid extensive soil sealing could be helpful to better integrate soil protection in the road planning phase. For the construction phase, the individual supervision by soil protection experts and platforms for conveying surplus soil between production and reception spots seem promising tools.

We will address these issues in WP5 with the survey and workshop among soil experts and will focus on:

I) How far the documents and soil protection measures are known and implemented in the investigated countries;

II) How the experts assess the soil protection measures and best practices in terms of effectiveness for soil protection as well as legal, technical and political feasibility;

III) The most relevant problems in implementation and potential solutions to approach them.

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# 5 Annex

## *5.1 Legal Documents*

| Country | Describtion | Documents Titel & Weblink | Autor | Date | Publisher Information | Publisher Category | Document Category | Comments |
|---|---|---|---|---|---|---|---|---|
| AUT | Nature conservation law | NÖ Naturschutzgesetz 2000 (NÖ NSchG 2000) StF: LGBl. 5500-0 | | 2015 | | Authorities | Legislation | In the Nature Conservation Act, compensation measures are only required when implementing a project that would otherwise result in significant changes. (Paragraph 7, Section 2) |
| AUT | Soil protection law | NÖ Bodenschutzgesetz (NÖ BSG) StF: LGBl. 6160-0 | | 2015 | | Authorities | Legislation | |
| AUT | Landfill regulations | ÖNORM S 2126: Gesamte Rechtsvorschrift für Deponieverordnung 2008, Fassung vom 10.03.2021 | | 2008 | | Authorities | Legislation | Considering deposition of soils and waste productes |
| AUT | Law of environmental compatibility in | Bundesrecht konsolidiert: Gesamte Rechtsvorschrift für Umweltverträglichkeitsprüfungsgesetz 2000, Fassung vom 22.04.2021 | | | | Authorities | Legislation | |

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|---|---|---|---|---|---|---|
| BE | Decree for soil improvements | Décret relatif à la gestion et à l'assainissement des sols | 2018 | Authorities | Legislation | The aim of the Soil Decree is to preserve and improve soil quality. It contains "Code Wallon de Bonnes Pratiques (CWBP) |
| CH | Federal law on environmental protection | Bundesgesetz über den Umweltschutz (USG) | 1983 | Authorities | Legislation | Chapter 1, Art. 1: "This Act is intended to protect [...] the fertility of the soil." Chapter 5 is about soil pollution |
| CH | Federal Act on Spatial Planning | Bundesgesetz über die Raumplanung (RPG) | 1979 | Authorities | Legislation | Art. 1: "By means of spatial and regional planning measures, they shall in particular support efforts to [...] protect natural resources such as soil[…]" |
| CH | Ordinance on the Handling of Organisms in the Environment | Verordnung über den Umgang mit Organismen in der Umwelt | 2008 | Authorities | Legislation | Includes directives about invasive species. |
| CH | Ordinance on the Avoidance and the Disposal of Waste | Verordnung über die Vermeidung und die Entsorgung von Abfällen | 2015 | Authorities | Legislation | Aims to protect the environemnt from waste and to |

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|---|---|---|---|---|---|---|---|
| CH | Ordinance on pollution of the soil | Verordnung über Belastung des Bodens | | 1998 | Authorities | Legislation | Aims to preserve the soil fertility by defining to observe and maintain soil quality. |
| DE | Act on the Protection against Harmful Soil Changes and the Remediation of Contaminated Sites | Das Bundes-Bodenschutzgesetz vom 17. März 1998 (BBodSchG) | Gesetz zum Schutz vor schädlichen Bodenveränderungen und zur Sanierung von Altlasten | 1998 | Authorities | Legislation | The special law BauGB regulates in the first place, the general law for the protection of soil BBodSchG supplements where BauGB no longer regulates soil issues. |
| DE | Material requirements of soil protection law | Bundes-Bodenschutz- und Altlastenverordnung | | 1999 | Authorities | Legislation | The examination sequence and decision-making standards are precisely regulated in the BBodSchG and the BBodSchV. |
| DE | Building code | Baugesetzbuch | | 2006 | Authorities | Legislation | Provides legal basis for environmental impact assessement |
| DE | Nature Conservation and Landscape Management Act | Gesetz über Naturschutz und Landschaftspflege (Bundesnaturschutzgesetz - BNatSchG) | | 2009 | Authorities | Legislation | According to the Federal Nature Conservation Act (BNatSchG), interventions in nature and landscape must either be avoided or at least compensated. |

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| DE | Federal Soil Protection and Contaminated Sites Ordinance | Bundes-Bodenschutz- und Altlastenverordnung (BBodSchV) | 1999 | | Authorities | Legislation | It is a supplement to the Federal Soil Protection Act. It specifies the handling of contaminated sites and suspected contaminated sites in the federal territory. |
| DE | Regional regulation about eco-accounts | Verordnung des Ministeriums für Umwelt, Naturschutz und Verkehr über die Anerkennung und Anrechnung vorzeitig durchgeführter Maßnahmen zur Kompensation von Eingriffsfolgen (Ökokonto-Verordnung – ÖKVO) | 2010 | Landesanstalt für Umwelt Baden-Württmberg | Authorities | Legislation | This is an example for an regional regulation on this matter. Other regions do have similar documents. |
| DE | Regional regulation about intervention measures | Verordnung des Ministeriums für Umwelt, Naturschutz und Verkehr über die Führung von Kompensationsverzeichnissen (Kompensationsverzeichnis-Verordnung – KompVzVO) | 2011 | Landesanstalt für Umwelt Baden-Württmberg | Authorities | Legislation | This is an example for an regional regulation on this matter. Other regions do have similar documents. |
| EU | Environmental Impact Assessment Directive of EU | on the assessment of the effects of certain public and private projects on the environment | 2014 | EU | Authorities | Legislation | Usually referred to as the "Environmental Impact Assessment Directive") |

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|---|---|---|---|---|---|---|---|
| EU | Initative of new soil strategy | Healthy soils – new EU soil strategy | 2020 | European Commission | Authorities | Legislation | The goals are to: protect soil fertility, reduce erosion and sealing, increase organic matter, identify contaminated sites, restore degraded soils, define what constitutes ‘good ecological status’ for soils. |
| EU | EU regulation on invasive species | on the prevention and management of the introduction and spread of invasive alien species | 2014 | European Commission | Authorities | Legislation | |
| EU | EU directive on waste | DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives | 2008 | EU | Authorities | Legislation | Art. 2: "The following shall be excluded from the scope of this Directive: […] (c) uncontaminated soil and other naturally occurring material excavated in the course of construction activities where it is certain that the material will be used for the purposes of construction in its natural state on the site from which it was excavated; [...]" |

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| FR | Evironmental law in France | Code de l'environnement | 2000 | FR | Authorities | Legislation | |
| FR | Urban Planning Code | Code de l'urbanisme | 1973 | FR | Authorities | Legislation | Content<br>Book Ier: Regulation of urban planning<br>Book II: Pre-emption and Land Reserves<br>Book III: Land Development<br>Book IV: regime applicable to constructions, developments and demolitions<br>Book V: location of services, establishments and companies<br>Book VI: Advisory Bodies and Miscellaneous Provisions |
| FR | Construction and housing code | Code de la construction et de l'habitation | 1978 | FR | Authorities | Legislation | Construction and housing code brings together the legislative and regulatory provisions relating to construction real estate development, social housing and other issues relating toreal estate |
| IE | The Planning and Development Act 2000 | The Planning and Development Act 2000 | 2000 | Department of Housing, Local Government and Heritage | Authorities | Legislation | |

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|---|---|---|---|---|---|---|---|
| NOR | Soil Law | Lov om jord (jordlova) | 1995 | Norwegian Ministry of Agriculture and Food | Authorities | Legislation | The important points with regard to soil protection is § 9 “Cultivated soil must not be used for other purpose than agricultural production. Soil that can be used for agricultural production must not be destroyed in a such way that agricultural use will be impossible in the future” |
| NOR | Plan and building law | Lov om planlegging og byggesaksbehandling (plan- og bygningsloven) | 2008 | Norwegian Ministry of Municipal sector and Modernisation | Authorities | Legislation | In Norway all infrastructure projects are planned according to the procedures in the Plan and building law, which makes it possible to use agricultural land and potentially other areas which can be used for agricultural production for building purpose. |
| NOR | New transport plan for Norway | National plan for transportation 2022-2033 | 2021 | Norwegian Ministry of Transportation | Authorities | Legislation | A proposal for a new transport plan for Norway was launched 19 March 2021. In this transport plan the new soil protection strategy is included as a framework for planning new road projects. |

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|---|---|---|---|---|---|---|---|
| NOR | Regulation on measures against pollution | Forskrift om begrensning av forurensning (forurensningsforskriften) | 2004 | Norwegian Ministry of Climate and Environment | Authorities | Legislation | Chapter 2 describes the procedures for excavations and management of polluted soils. Chapter 4 describes procedures needed to avoid erosion and pollution from levelling of agricultural |
| NOR | Updated soil protection strategy | Oppdatert jordvernstrategi | 2021 | Norwegian Ministry of Agriculture and Food | Authorities | Legislation | Strategy for minimizing loss of agricultural land in Norway |
| SE | Swedish Environmental Code | The Swedish Environmental Code | 2000 | | Authorities | Legislation | The enviroenmental code brougth together 15 existing environmental laws. |
| SE | Road Act | Väglag (1971:948) | 1971 | Department of Infrastructure RST TP | Authorities | Legislation | |
| SE | Environmental Code | Miljöbalk (1998:808) | 1998 | Ministry of the Environment | Authorities | Legislation | Chap 3 §4: Agriculture and forestry are of national importance. Usable agricultural land may be used for buildings or facilities only if it is necessary to satisfy essential societal interests |

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|---|---|---|---|---|---|---|---|
| SE | Report about the Swedish environmental legislations and waste regulation | Environmental Legislation and the Regulation of Waste Management in Sweden | 1995 | National Renewable Energy Laboratory | Authorities | Report | This study examines the regulatory aspects of waste management in Sweden, with a particular emphasis on regulating organic compounds produced by waste-to-energy facilities. |
| UK | The Town and Country Planning (Environmental Impact Assessment) Regulations 2017 | The Town and Country Planning (Environmental Impact Assessment) Regulations 2017 | 2017 | | Authorities | Legislation | Environmental Impact Assessment in the context of town and country planning in England is governed by the Town and Country Planning Regulations 2017 |
| UK | The Construction (Design and Management) Regulations 2015 | The Construction (Design and Management) Regulations 2015 | 2015 | UK | Authorities | Legislation | |
| UK | Environmental Law | Environmental Protection Act 1990 | 1990 | UK | Authorities | Legislation | |
| UK | Scottish Crop Production Sectoral Plan | Crop Production Sectoral Plan | 2019 | Scottish Environment Protection Agency | Authorities | Legislation | Chapter 5. Potential environmental impacts and how they are managed |
| UK | The new Soil Strategy for England – Safeguarding our Soils – outlines the Government's approach to safeguarding our soils for the long term | Safeguarding our Soils A Strategy for England | 2009 | DEFRA | Authorities | Legislation | Strategy how to regulate and guide soil protection in England |

## *5.2 Guidelines*

| Country | Description | Documents Titel & Weblink | Autor | Date | Publisher Information | Publisher Category | Document Category | Comments |
|---|---|---|---|---|---|---|---|---|
| AUT | Guidelines for proper soil restoration of agricultural and forest land | Richtlinien für die sachgerechte Bodenrekultivierung land- und forstwirtschaftlich genutzter Flächen | | 2012 | Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, | Authorities | Guideline | This guideline specifically focuses on linear construction projects, soil storages and soil restoration. |
| AUT | Measures to reduce the consumption of agricultural soils | Reduzierung des Verbrauchs Landwirtschaftlicher Böden - Massnahmenvorschläge | | 2015 | Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, | Government | Guideline | The working group of the Advisory Council on soil fertility and soil protection proposed measures to reduce land take of agricultural lands |
| AUT | Brochure for planners, constructors, companies about soil protection on construction sites | Information zum Bodenschutz beim Bauen für Bauherren, Planer und Baufirmen | | 2018 | Abteilung Umweltschutz Land Oberösterreich | Authorities | Guideline | |
| AUT | Keeping land free for linear infrastructure projects: Basics, need for action & proposed solutions | Flächenfreihaltung für linienhafte Infrastrukturvorhaben: Grundlagen, Handlungsbedarf & Lösungsvorschläge | Kanonier A. Schönegger C. | 2013 | ÖROK | Authorities | Guideline | Soil protection is hardly mentioned, reference is made to an EU strategy to be adopted (p.122). |
| AUT | Online portal about environmental impact assessement procedures | Information Platform about environemental impact assessement procedures | | 2021 | Unternehmensserviceportal | Authorities | Guideline | Information on requirements, deadlines, procedures etc. |

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|---|---|---|---|---|---|---|---|
| AUT | Land consumption of compensation measures. Proposals for balancing the interests of nature conservation and agriculture | Flächeninanspruchnahme durch Kompensationsmaßnahmen. Vorschläge für einen Interessensausgleich zwischen Naturschutz und Landwirtschaft | 2019 | Bundesministerium für Nachhaltigkeit und Tourismus | Authorities | Guideline | |
| AUT | Environmental supervision and monitoring of construction sites | RVS 04.05.11 Umweltbauaufsicht und Umweltbaubegleitung | 2015 | Forschungsgesellschaft Straße - Schiene - Verkehr (FSV) | Specialist | Guideline | The guideline "RVS 04.05.11" was revised by the Research Association Road - Rail - Transport (FSV) in cooperation with experts from the Federal Ministry, the Asfinag, the federal provinces, science and industry. On 2 February 2015, the Federal Ministry declared this guideline as a binding document for the federal roads sector . |
| AUT | Website about "Soil protection on construction sites" in Upper Austria | Bodenkundliche Baubegleitung Information zum Bodenschutz beim Bauen für Bauherren, Planer und Baufirmen | 2018 | Oberösterreich Abteilung Umweltschutz | Authorities | Guideline | They refer to Swiss websites. |

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|---|---|---|---|---|---|---|---|---|
| AUT | Assessment of soil functions in planning procedures | „Pilotprojekt Boden“ - Bewertung von Bodenfunktionen in Planungsverfahren | | 2010 | Land Oberösterreich Direktion Umwelt und Wasserwirtschaft Abteilung Umweltschutz | Authorities | Guideline | On page 69 are statements about which soil maps are useful for the planning process. And page 74 provides further recommendations for guidelines. |
| AUT | Soil function assessment: Methods for the implementation of ÖNORM L 1076 | Bodenfunktionsbewertung: Methodische Umsetzung der ÖNORM L 1076 | Fachbeirat für Bodenfruchtbarkeit und Bodenschutzdes BMLFUW | 2013 | Bundesministerium für Land-und Forstwirt-schaft, Umwelt undWasserwirtschaft, Stubenring | Authorities | Guideline | The guideline helps for the evaluation of important soil functions to specifically implement the standard ÖNORM L 1076. The ÖNORM L 1076:2013 is the Austrian standard for the evalution of soil functions. |
| BE | Code of Good Practice which is part of the Soil Decree of 2018 | Code Wallon de Bonnes Pratiques (CWBP) | | 2018 | Government of Wallonia | Authorities | Guideline | |
| BE | Guide for use of soil materials and earth work | Gebruik van bodemmaterialen - grondverzet | | | Office vaudois de l'assurance-maladie OVAM | Authorities | Guideline | OVAM is a Flemish government service that ensures that Flanders deals with waste, materials and soil in a well-considered and environmentally aware manner. |
| BE | Soil Management Reference Guide | Guide de référence relatif à la gestion des terres (GRGT) | | 2018 | Département du sol et des déchets (SPW ARNE) | Scientific Institution | Guideline | |

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|---|---|---|---|---|---|---|---|---|
| BE | Guide for avoiding compaction of agricultural and forest soils | Guide de compaction agricole / Guide de compaction des sols forestiers | Gembloux Agro-Bio Tech | 2013 | Government of Wallonia | Authorities | Guideline | Soil protection is described as an interdisciplinary goal, but it does not specifically address soil protection in construction projects. |
| BE | Guideline for managing soils that are polluted with plastic softeners | Bodeminformatie voor ontharders - Gebruikershandleiding | | 2021 | Office vaudois de l'assurance-maladie OVAM | Authorities | Guideline | |
| CH | Information campaign of the Swiss federal government | Bodenschutz lohnt sich | | | Cercle Sol | Authorities | Guideline | This campaign provides information documents and guidelines and various topics of soil protection. Among others; how to define soil quality, on optimising excavation or management of surplus material. |
| CH | Environmental checklist for construction sites | Umweltcheckliste für Baustellen | | 2013 | Cercle Sol | Authorities | Guideline | Soil section relatively short, but still a helpful tool |
| CH | Regional Guidlines for handling soils on construction sites | Umgang mit Boden | | | Zentralschweizer Umweltfachstellen | Authorities | Guideline | Combined basic guidelines for soil protection on construction sites of the regions of Central Switzerland |
| CH | Soil function assessment and soil index points: Concepts and ways of implementation | Bodenfunktionsbewertung und Bodenindexpunkte: Konzepte und Wege zur Umsetzung | | 2017 | Nationale Bodenbeobachtung (NABO), Agroscope, Zürich | Government | Guideline | |

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|---|---|---|---|---|---|---|---|
| CH | Soil and construction: State of the art and practices | Boden und Bauen: Stand der Technik und Praktiken | 2015 | Bundesamt für Umwelt BAFU | Government | Guideline | This document is an update of the older document: "Soil protection in construction" by the Swiss Federal Office for Environment FOEN |
| CH | VSS Standard SN 640 581 Earthworks, Soil: Soil protection and construction | VSS Norm SN 640 581 Erdbau, Boden: Bodenschutz und Bauen | 2019 | Schweizerischer Verband der Strassen- und Verkehrsfachleute | Other | Guideline | This standard describes the protection of natural and anthropogenic soils anthropogenic soils during the construction of transport facilities as well as other infrastructure and construction projects. It addresses the project managers and describes the tasks of "soil protection experts on construction sites". |
| CH | Soil restoration guidelines of the Swiss Association of the Gravel, Sand and Concrete Industry | FSKB Rekultivierungsrichtlinien | 2021 | FSKB Fachverband der Schweizerischen Kies- und Betonindustrie | Other | Guideline | |
| CH | Guidline for follow-up management of restored soils of Canton of Solothurn | Folgebewirtschaftung rekultivierter Flächen | 2021 | Kanton Solothurn, Amt für Umwelt | Authorities | Guideline | |
| CH | Guidline for handling invasive species during construction projects. | Gebietsfremde Problempflanzen (invasive Neophyten) bei Bauvorhaben | 2019 | Kanton Zurich | Authorities | Guideline | Provides general information as well as how to handle biological waste |

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|---|---|---|---|---|---|---|---|---|
| CH | Leaflet about soil improvement in Canton Lucerne | Merkblatt Bodenverbesserung | | 2017 | Kanton Luzern UWE | Authorities | Guideline | |
| CH | Leaflet for managing excavated soil | Wegleitung Verwertung von ausgehobenem Boden (Wegleitung Bodenaushub) | | 2006 | Bundesamt für Umwelt BAFU | Authorities | Guideline | This document shows how excavated soil can be assessed and recovered and when it must be deposited as waste. It replaces Communication No. 4 of 1993 of SAEFL and the former FAC-Liebefeld on the recovery of excavated topsoil. |
| CH | Assessment of soil for its reuse | Beurteilung von Boden im Hinblick auf seine Verwertung | | 2021 | Bundesamt für Umwelt BAFU | Authorities | Guideline | |
| CH | Canton of Zurich: Leaflet about managing soil in construction projects | Merkblatt Umgang mit dem Boden bei Bauvorhaben | Fachstelle Bodenschutz Zürich | | Canton of Zurich | Authorities | Guideline | An overview is provided for the phsyical and chemical measures for soil protection. |
| CH | Leaflet on upgrading degraded agricultural soils | Merkblatt Bodenprojekte: Anforderungen und Grundsätze für die Erarbeitung eines Bodenprojekts als Teil eines Bauprojekts ausserhalb Bauzonen | Fachstelle Bodenschutz Zürich | 2012 | Canton of Zurich | Authorities | Guideline | It briefly explains the basics and gives an overview of the most common measures, as well as providing further links. |
| CH | Best practice examples for soil protection on linear construction sites in the canton of Zurich | Musterbauweisen für Linienbaustellen | | | Canton of Zurich | Authorities | Guideline | |

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| CH | Risk assessment and management of polluted soils | Gefährdungsabschätzung und Massnahmen bei schadstoffbelasteten Böden | | 2005 | Bundesamt für Umwelt BAFU | Authorities | Guideline | This text concretises legal principles and aims to promote uniform enforcement. |
| CH | Soil restoration guideline of the canton of Zurich | Rekultivierung von Böden | | 2017 | Canton of Zurich | Authorities | Guideline | |
| CH | Soil protection during construction | Bodenschutz beim Bauen | | 2001 | Bundesamt für Umwelt BAFU | Authorities | Guideline | The document provides a comprehensive overview of soil protection measures in construction projects with detailed explanations of the basic background. |
| DE | Soil protection guideline for authorities of land use planning | Bodenschutz in der Umweltprüfung nach BauGB | | 2009 | Bund/Länder-Arbeitsgemeinschaft Bodenschutz (LABO) | Other | Guideline | The guideline builds on the working aids of the various federal states on the topic of taking soil protection concerns into account in planning and on the topic of the environmental assessment. |
| DE | Recommendation for soil classification for spatial planning | Empfehlung zur Klassifikation von Böden für räumliche Planung | Planungsgruppe Ökologie und Umwelt GmbH | 2003 | Bund/Länder-Arbeitsgemeinschaft Bodenschutz (LABO) | Other | Guideline | Summary of relevant methods and procedures for the classification and evaluation of soil functions for spatial planning |

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| DE | The soil resource in spatial planning: assessment of natural soil functions and implementation in procedures of planning and approval | Das Schutzgut Boden in der Planung: Bewertung natürlicher Bodenfunktionen und Umsetzung in Planungs- und Genehmigungsverfahre | | 2018 | Bayerisches Geologisches Landesamt<br><br>Bayerisches Landesamt für Umweltschutz | Authorities | Guidelines | Manual for administrations to include soil protection issues in land-use planning |
| DE | Soil function assessment in the frame of the nature conservation impact regulation for road construction projects | Bewertung von Bodenfunktionen im Rahmen der naturschutzgerechten Eingriffsregelung bei Straßenbauvorhaben | | 2018 | Bundesministeriu m für Verkehr und Digitale Infrastruktur, Abteilung Straßenbau, Bonn | Government | Guideline | |
| DE | Soil protection in construction; guideline of Lower Saxony | Bodenschutz beim Bauen - Ein Leitfaden für den behördlichen Vollzug in Niedersachsen | | 2019 | Landesamt für Bergbau, Energie und Geologie; Niedersachsen | Authorities | Guideline | |
| DE | DIN Norm for soil protection in construction projects | Soil protection during planning and execution of construction projects | | 2019 | https://dx.doi.org/10.31030/3073049 | Authorities | Guideline | |
| DE | Documentation of Website about technical and legal aspects of soil protection in construction projects | Bodenschutz beim Bauen Dokumentation der LANUV-Internetseiten | | 2009 | Landesamt für Natur, Umwelt und Verbraucherschut z Nordrhein-Westfalen (LANUV NRW) | Authorities | Guideline | |
| DE | Guideline for soil protection in practice | Das Schutzgut Boden in der Planung, Bewertung natürlicher Bodenfunktionen und Umsetzung in Planungs- und Genehmigungsverfahre | Bayerisches Geologisches Landesamt und Bayerisches Landesamt für Umweltschutz | 2003 | Bayerisches Geologisches Landesamt | Authorities | Guideline | |

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| DE | Planning information on soil protection. Leaflet and checklists for the consideration of precautionary soil protection in urban land use planning | Planungshinweise zum Bodenschutz Merkblatt und Checklisten zur Berücksichtigung des vorsorgenden Bodenschutzes in der Bauleitplanung | | 2015 | Senatsverwaltung für Stadtentwicklung und Umwelt | Authorities | Guideline | |
| DE | Guideline for soil protection in urban planning | Leitfaden Bodenschutz bei Planungs- und Genehmigungsverfahren Materialien zum Bodenschutz | | 2008 | Sächsisches Landesamt für Umwelt und Geologie | Authorities | Guideline | |
| DE | Guideline for evaluation and compensation for soil interventions | Das Schutzgut Boden in der naturschutzrechtlichen Eingriffsregelung | | 2012 | LUBW Landesanstalt für Umwelt, Messungen und Naturschutz Baden-Württemberg | Authorities | Guideline | Providing legal and practical background explaining the "ecopoints" evaluation system.The ecopoint system allows for a project-independent assessment and collection of ecological support measures, which can also be used at a later date to compensate for negative impacts from another project. |
| DE | DIN standard for soil protection in construction projects | DIN 19639 \| 2019-09: Bodenschutz bei Planung und Durchführung von Bauvorhaben | | 2019 | | Specialist | Guideline | |
| EU | Guidelines on best practice to limit, mitigate or compensate soil sealing | Guidelines on best practice to limit, mitigate or compensate soil sealing | European Commission | 2012 | European Commission | Government | Guideline | |

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| EU | Guidelines on best practice to limit, mitigate or compensate soil sealing | Guidelines on best practice to limit, mitigate or compensate soil sealing | | 2014 | Directorate-General for Environment (European Commission) | Authorities | Guideline | This guideline provide a background on the magnitude of soil sealing in EU countries and best practice examples on avoiding, mitigating and compensate for soil sealing. |
| EU | Book about Soil conservation and protection in Europe | SCAPE: The way ahead (Soil Conservation and Protection in Europe) | | 2015 | SCAPE steering committee | Authorities | Guideline | |
| EU | Report on soil sealing in various countries | Report on best practices for limiting soil sealing and mitigating its effects | | 2011 | | Authorities | Guideline | See Page 178 for compensation systems. |
| FR | Environmental assessment of projects | L'évaluation environnementale des projets | DRIEE Île-de-France | 2021 | Ministère de la Transition écologique | Government | Guideline | |
| FR | Guide for the reuse of potentially polluted soil | Guide de valorisation hors site des terres excavées issues de sites et sols potentiellement pollués dans des projets d'aménagement | BRGM Bureau de recherches géologiques et ministères | 2017 | Ministère de la Transition écologique et solidaire | Authorities | Guideline | Document that gives a proposition on how to reuse excavated soil that might be polluted on development project Look for Chapter : «La gestion des terres excavées» |

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| FR | Practical guide for protecting aquatic environments during the construction phase | Bonnes pratiques environnementales - Protection des milieux aquatiques en phase chantier | | 2018 | Agence française pour la biodiversité - AFB | Authorities | Guideline | Practice guide of the French Agency for Biodiversity addressing actors on construction sites. In particular, it gives advice for the management of excavated soils, erosion control of bare soils, and for limiting degradation of neighbouring ecosystems (wetlands, for example). |
| FR | French standard on measuring compaction of soils and ground material | NF P94-063 Juin 2011 – Sols : reconnaissance et essais – Contrôle de la qualité du compactage – méthode au pénétromètre dynamique à énergie constante – Principe et méthode d'étalonnage des pénétrodensitographes – exploitation des résultats – interprétation | AFNOR | 2011 | Normalisation institution | Other | Guideline | Standard on how to measure the compaction level of a soil in the field with penetrometers |
| FR | Guide for EIA of transportation infrastructures | L'évaluation environnement des projets d'infrastructures linéaires de transports | Cerema | 2020 | State research center for risks, environment, mobility and spatial development | Authorities | Guideline | Explains the procedure of environmental impact assessments particularly for linear transportation infrastructure projects. The chapter on soil is missing, but it may be added later (p. 119) |

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| FR | Guidelines for vegetation management on construction sites | Règles professionnelles de mise en œuvre et d'entretien des plantes | Unep (Union des entreprises du paysage) | 2012 | Professional association of landscape design | Specialist | Guideline | |
| IE | Guidance on surplus material | Guidance on Soil and Stone By-products | | 2019 | Environmental Protection Agency | Independent Institution | Guideline | This guideline aims to prevent the disposal of excess material from construction sites as waste. |
| IE | Guidance on waste management inlcuding the handling of soils | The Management of Waste from National Road Construction Projects | | 2017 | Transport Infrastructure Ireland (TII) | NRA | Guideline | The aim of this document is to provide an overview of the avoidance of surplus material as waste in national road construction.<br><br>Chapter 5.4.1 : Topsoil and Sub-soil storage |
| IE | Guide for Landscape Treatments | A Guide to Landscape Treatments for National Road Schemes in Ireland | | 2006 | Transport Infrastructure Ireland (TII) | NRA | Guideline | |
| IE | Guide for EIA | Environmental Impact Assessment of National Road Schemes – A Practical Guide | | 2008 | Transport Infrastructure Ireland (TII) | NRA | Guideline | General approach guiding for an EIA not specifically for soils. Soils are only mentioned briefly. |
| IE | Guidance for invasive species handling | The Management of Invasive Alien Plant Species on National Roads – Technical Guidance | | 2020 | Transport Infrastructure Ireland (TII) | NRA | Guideline | |

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| IE | EIA Guidelines | Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment | 2018 | Irish Government | Authorities | Guideline | The new EIA regulations and associated Guidelines aim to ensure compliance with the highest international standards in considering environmental issues in development projects, and to ensure that environmental considerations are fully addressed as part of the planning process and properly managed thereafter. |
| NOR | Norwegian Standard 3420K Specification texts for building, construction and installations — Part K: Landscaping works | Norwegian Standard 3420K | 2022 | Standard Norway | Specialist | Guideline | In this standard detailed specifications for soil propertied for landscaping and urban greening are given |

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| NOR | Guidelines for preserving surplus soil in building projects according to regional land-use plans | Veileder til matjordplan | | 2018 | Vestfold and Telemark county 2021 | Authorities | Guidline | The county Vestfold and Telemark has been very focused on soil protection and made instructions to all municipalities within the county about soil awareness in planning construction work. All development projects that are part of the regional land-use plans of Vestfold and Telemark have to include a plan for relocation of surplus topsoil (plough layer) for use on other agricultural land. |
| NOR | Levelling and soil relocation – execution and maintenance | Planering og jordflytting – Utførelse og vedlikehold | Hauge, A. & Haraldsen, T.K. | 2017 | NIBIO | Academic | Guideline | In order to make better recommendations both for levelling and soil relocation Haraldsen & Hauge (2017) made updated descriptions for execution and maintenance |
| NOR | Handbook: Standard description for road contracts. Main process 1-7 | Prosesskode 1. Standard beskrivelse for vegkontrakter. Hovedprosess 1-7 | | | Norwegian Public Roads Administration | Authorities | Guideline | In Norway many soil manufacturers offers soil mixtures according to these recommendations. These recommendations will be included in the revised Norwegian Standard 3420 K. of |

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| NOR | Soil management in construction - from problem to resource | Jordmasser - fra problem til ressurs | | NLR and NIBIO | Academic + advisory | Guideline | A guideline for management of soils in construction projects in coastal areas, also including peat soils |
| NOR | Guideline for the evaluation according to procedures for analyses of consequences. | Konsekvensanalyser. Veiledning. Håndbok V712 | | The Norwegian Public Roads Administration | Authorities | Guideline | |
| SE | Guidelines for handling contaminted soils | Riktvärden för förorenad mark | | Naturvardsverket | Authorities | Guideline | |
| SE | Re-establishment of vegetation with reclaimed excavated | Återetablering av vegetation med tillvaratagna | 2021 | Trafikverket | Authorities | Guideline | Leaflet about the advantages and reduce costs of soil restoration |
| SE | Interpretation of the Swedish Waste Legislation from the National Road | Juridisk tolkning och tillämpning av lagstiftning för masshantering | 2019 | Trafikverket | Authorities | Guideline | Trafikverket's legal interpretation of legislation regarding mass handling |
| SE | Guidelines for environmental impact assessment | Miljöprövning – miljöprövningsförordningen | | Naturvardsverket | Authorities | Guideline | |
| UK | Construction Code of Practice for the Sustainable Use of Soils on Construction Sites | Construction Code of Practice for the Sustainable Use of Soils on Construction Sites | 2009 | DEFRA | Authorities | Guideline | Provides guidance on the legal background as well as for soil protection during the planning and construction phase. |
| UK | New guidance note: soils in construction | Guidance Document 3 | 2021 | British Society of Soil Science | Independent institution | Guideline | A very basic overview on soil protection issues during construction works. |

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| UK | Land use planning - Good Practice Guide for Handling Soils | Good Practice Guide for Handling Soils | 2000 | Ministry of Agriculture, Forestry and Fisheries MAFF | Authorities | Guideline | This guideline provides a best practice approach on how to handle soils with excavation machinery and when driven on with trucks. |
| UK | UK Onshore Scheme: Soil Handling and Storage Protocol | UK Onshore Scheme: Soil Handling and Storage Protocol | 2017 | VikingLink nationalgrid | Authorities | Guidleine | |
| UK | Guide for soil improvements | Guidance on suitable organic material applications for land restoration and improvement | 2015 | Earthcare Technical Ltd. (Scotland) | Specialist | Guideline | This guidelines does not specificalls mention soil protection in connection with construction projects. |
| UK | Guideline for soil management on construction sites | PLANNING GUIDANCE (PG) Soil Management & After Use of Soils on Development Sites | 2021 | West Lothian Council, Development Management | Authorities | Guideline | The Planning Guidance aims maintaine landscapes, to conserve prime quality soils and to improve soil handling to minimise problems such as erosion. |
| UK | British Standards (BS) Norm for Specifications for topsoil | BS 3882:2015 Specification for topsoil | 2015 | British Standards Institute BSI | Other | Guideline | Content: chemical analysis and testing, classification systems, soil sampling, top soil, texture, stone, soil testing, soils, storage, chemical properties, soil improvement, grades (quality), soil classification tests, soil profile, contamination, size, soil science, materials handling |

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| UK | British Standards for Specification for suboil and requierements for use | BS 8601:2013 Specification for subsoil and requirements for use | 2013 | British Standards Institute BSI | Other | Guideline | Content: Classification systems, soil classification tests, soil profile, subsoil, soil improvement, soils, soil testing, soil science, soil sampling, specifications |
| UK | Guideline on soil handling for farmers, growers, and land managers | Protecting our Water, Soil and Air A Code of Good Agricultural Practice for farmers, growers and land managers | 2009 | Ministry of Agriculture, Forestry and Fisheries MAFF | Authorities | Guideline | |
| UK | Soil restoration guidelines | Defra Guidance for Successful Reclamation of Mineral and Waste Sites | 2004 | Department for Environment, Food & Rural Affairs DEFRA | Authorities | Guideline | |
| UK | Guidelines of Soil Handling | Valuing Your Soils: Practical guidance for Scottish farmers | 2016 | Farming & Water Scotland | Specialist | Guideline | Guideline addressing farmers |

## *5.3 Soil Information*

| Country | Description | Documents Titel + Weblink | Autor | Date | Publisher Information | Publisher Category | Document Category |
|---|---|---|---|---|---|---|---|
| AUT | Land-use Mapping | ÖREK Atlas | Österreichische Raumordnungskonferenz | | | Authorities | Data |
| AUT | Soil information platform from the Austrian Soil Science Society | Österreichische Bodenkundliche Gesellschaft | | | | Specialist | Data |
| AUT | Soil information system from Austria | Die Informationsdrehscheibe rund um das Thema Boden in Österreich | | | | Authorities | Data |
| AUT | Federal project for soil maps in Austria | BORIS | | 2013 | | Authorities | Data |
| BE | Soil information platform of Belgium (1: 250'000) | Cartographie des sols en Belgique : aperçu historique et présentation des travaux actuels de valorisation et de révision de la Carte Numérique des Sols de Wallonie | Xavier Legrain, Pierre Demarcin, Gilles Colinet, Laurent Bock | 2011 | | Academic | Data |
| BE | Soil information platform for the Wallonian region in Belgium | Carte Numérique des Sols de Wallonie 1:20000 | | 2008 | Service public de Wallonie (SPW) | Authorities | Data |
| BE | Legend for the soil Maps in Belgium | Légende de la Carte Numérique des Sols de Wallonie (Belgique) | Faculté universitaire des Sciences agronomiques de Gembloux, Région Wallonne | 2007 | Univ. Liège-Gembloux Agro-Bio Tech. Département Sciences et Technologies de l'Environnement. Unité de Science du Sol. Passage des Déportés | Academic | Legende |
| BE | Soil data platform for Belgium | Grodnbank | | | Grondbank | Specialist | Platform |
| CH | National project for a soil information system of Switzerland | NaBoDat | | | | Authorities | Data |
| CH | Soil Maps for the Canton of Zurich | Soil Maps Canton of Zurich | | | Canton of Zurich | Authorities | Data |

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| CH | Swiss National Geoinformation System for Soils | Geodaten Boden geo.admin.ch | | | Geoportal des Bundes | Authorities | Data |
| CH | Collection for opendata sources for swiss soil data | opendata.swiss search | | | Open Government Data | Authorities | Data |
| CH | Example for a map about soil moisture in Switzerland for the Cantons in the Northwest of Switzerland | Bodenmessnetz Nordwestschweiz | | 2011 | Meteotest AG | Authorities | Data |
| DE | Soil function maps in Germany on the example of Bavaria | Bodenfunktionskarte 1:25.000 | | | Bayerisches Landesamt für Umwelt | Authorities | Data |
| DE | Soil maps in the State of Hesse with scale of 1:5,000 to < 1:35,000 depending on the properties | Bodenviewer Hessen | | 2017 | Hessisches Landesamt für Naturschutz, Umwelt und Geologie | Authorities | Data |
| DE | Soil maps in Germany on the example of the state of Badem-Württemberg with scale of 1:50'000 | Kartenviewer Baden-Württemberg | | | Landesamt für Geologie, Rohstoffe und Bergbau | Authorities | Data |
| EU | Website European Soil Data Centre | European Soil Data Centre (ESDAC) | | | | Authorities | Data |
| EU | European Project for Soil Data with a grid size of 2km x 2km | Project LUCAS | Commission of the European communities | 2018 | Eurostat | Authorities | Data |
| FR | Maps in France on over then 150 topics | Gissol | | 2011 | Institut national de la recherche agronomique INRAE | Academic | Data |
| FR | Report on soil data availability in France | Etude de parangonnage sur les dispositifs d'information concernant la qualité des sols agricoles | Claude Gitton, Gérard Fallon | 2020 | CGEDD, CGAAER | Authorities | Report |
| IE | Irish Soil Information System (1:250'000) | Irish Soil Information System | | 2014 | Teagasc – the Agriculture and Food Development Authority | Authorities | Data |
| IE | Soil Maps for each region | Soil map | | | Teagasc – the Agriculture and Food Development Authority | Authorities | Data |

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| IE | Geographic information system of the Evironmental Protection Agency (EPA) with a scale of 1:250'000 | geographic information system of the evironmental protection agency EPA | | Environmental Protection Agenca (EPA) | Authorities | Data |
| NOR | Datasets of soil properties in Norway | NGU Datasets | | Geological Survey of Norway | Authorities | Data |
| NOR | Soil Maps Norway with WRB classification with a scale of 1:5'000 | Soil Maps Norway | | NIBIO, Kartverket | Academic | Data |
| SE | Soils 1:25 000-1:100 000" map viewer provides an overview of soil properties | Jordarter 1:25 000-1:100 000 | 2020 | Svergies geologiska undersökning | Authorities | Data |
| UK | Soil maps of Scotland provided by the Government (1:25'000) | Soil map of Scotland (partial cover) | | | Authorities | Data |
| UK | National soil map for England and Wales in the Scale of 1:50'000 | National Soil Map of England and Wales - NATMAP | | | Academic | Data |
| UK | British Geological Survey | British Geological Survey | | British Geological Survey | Specialist | Data |
| UK | UK Soil Observatory is a collaboration of institutions focusing on soil data | UK Soil Observatory | | British Geological Survey | Specialist | Data |
| UK | Provisional Agricultural Land Classification into five grades (ALC) ( 1:250'000) | Provisional Agricultural Land Classification (ALC) | | Natural England | Specialist | Data |
| UK | Data about Land Capability for Agriculture in Scotland | Land Capability for Agriculture in Scotland | | James Hutton Institute | Academic | Data |