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User guide for the Pipe Leakage Impacts map

Open Report OR/14/010

BRITISH GEOLOGICAL SURVEY

OPEN REPORT OR/14/010

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Pipes and culverts that transport water are susceptible to failure as a result of cracking, the formation of holes and ineffective seals. Leakage from pipes can result in wetting or saturation of the surrounding ground which can initiate or worsen ground movement compromising the leaking asset further or putting adjacent infrastructure at risk. This user guide describes the Pipe Leakage Impacts map, which has been developed by the BGS to indicate where pipe leakage may initiate or worsen ground instability. It considers which, and to what extent, ground stability hazards may be adversely affected by water leaking from pipes.

This map is intended for asset managers who are responsible for assessing the condition of underground pipes and culverts. In particular, the data may be useful for water companies or councils who need to determine where leaking pipes (or other sources of water) may impact ground instability, so that repairs, or other action, can be prioritised.

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1 Introduction

Founded in 1835, the British Geological Survey (BGS) is the world's oldest national geological survey and the United Kingdom's premier centre for earth science information and expertise. The BGS provides expert services and impartial advice in all areas of geosciences and has a client base that is drawn from the public and private sectors both in the UK and internationally.

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2 About the Pipe Leakage Impacts map

2.1 BACKGROUND

Buried utilities including pipes, drains and culverts enable the transport and supply of potable water, sewage and stormwater, and the conveyance of streams in channelized watercourses. Such assets are prone to leakage through cracks, holes and ineffective seals, resulting in wetting or saturation of the ground surrounding the asset. The failure of assets can occur for a wide variety of reasons including corrosion of the asset, ground movement (e.g. swelling clays or frost heave), pressurised flow or human-induced disturbance for example. Once failure has occurred, water leaking from assets can have a negative effect on the surrounding ground potentially causing leakage-induced ground movement. Depending on the scenario, it is possible that leaking water could:

- result in swelling of surrounding clay-rich deposits.
- increase the dissolution of soluble rocks leading to the formation of voids and associated subsidence.
- flush unconsolidated sediments into voids, or into the failed asset, resulting in the volume of voids around the asset increasing.
- alter the strength of the ground, which could increase compressibility, landslide or collapse.

In areas where ground movement can locally be affected by soil wetting or pipe leakage, the repair of assets should be prioritised to avoid additional instability that may threaten adjacent infrastructure.

The Pipe Leakage Impacts map indicates where pipe leakage may initiate or worsen ground instability. It considers which, and to what extent, ground stability hazards may be adversely affected by water leaking from pipes.

2.2 WHO MIGHT REQUIRE THIS MAP?

The Pipe Leakage Impacts map is relevant to those asset managers who maintain pipes, sewers and culverts that transport water. In particular the dataset will help:

- determine where leaks may cause ground instability
- prioritise the repair of leaking pipes.
- assess the risk posed to infrastructure adjacent to water pipes should they fail and leak.

The dataset is relevant to professionals involved in subsurface asset management in water companies, construction and other utility companies. It may also be of interest to solicitors, loss adjusters and the insurance industry. The map is derived from datasets at a scale of 1:50 000.

2.3 ABOUT THE DATASET

2.3.1 Overview

There are two versions of the map; summary and detailed. The contents of these are described in Section 2.3.2 and Section 2.3.3.

2.3.2 Detailed datasets

The Pipe Leakage Impacts map (detailed) comprises one GIS layer called ‘Leakage’. It provides information on whether leaking assets could increase the potential for ground instability (Figure 1). It includes a summary map providing an overview of the extent to which leakage may increase ground instability. It also includes a further six sub-layers providing information about which hazards might be impacted.

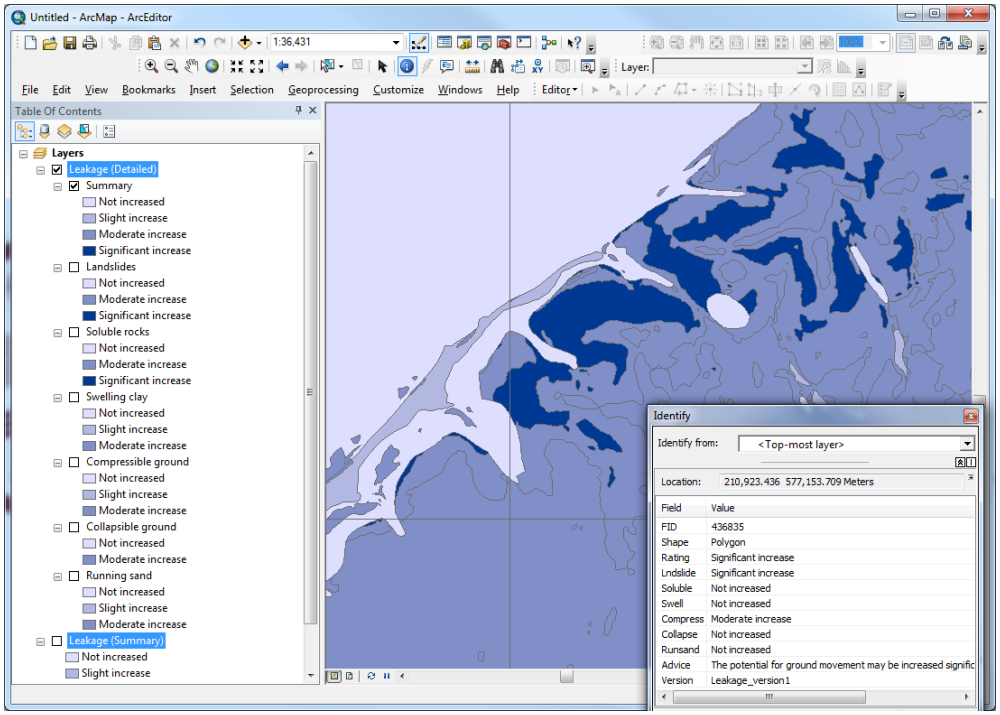

Figure 1 An example of the GIS layer that considers the potential for leakage to increase the potential for ground instability.

2.3.3 Summary datasets

The Pipe Leakage Impacts map (summary) comprises one GIS layer called 'Leakage_summary'. It provides information on whether leaking assets could increase the potential for ground instability (Figure 2). This summary map provides an overview of the extent to which leakage may increase ground instability, but it does not provide information on which hazards may be impacted.

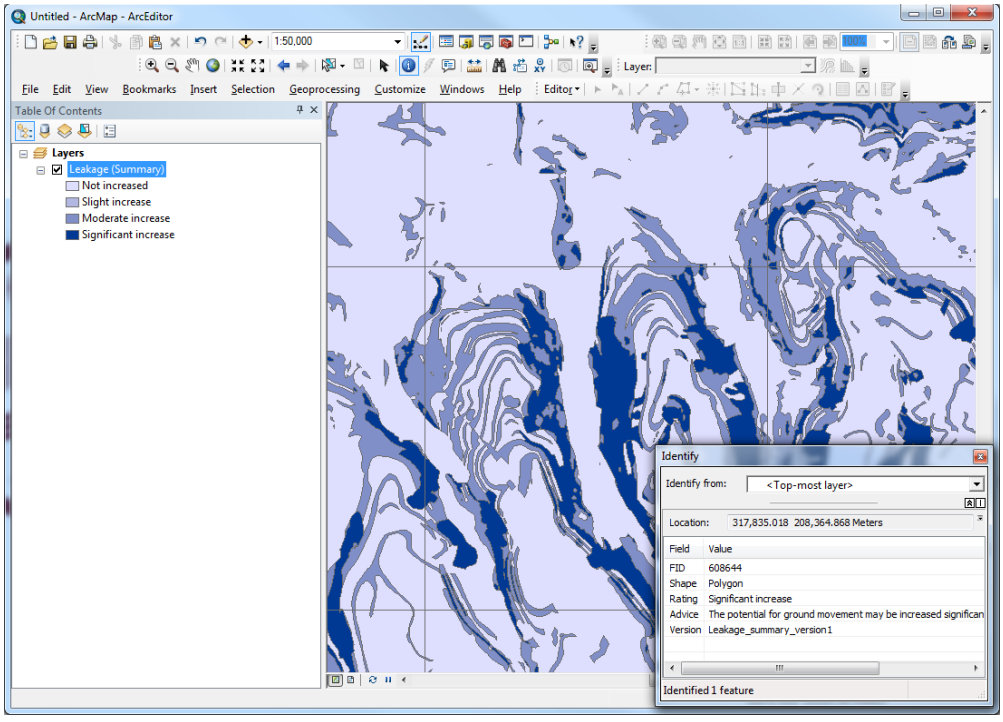

Figure 2 An example of the summary GIS layer that considers the potential for leakage to increase the potential for ground instability.

3 Using the dataset

3.1 SETTING UP THE GIS

To ensure that the dataset is used as designed, follow the proceedings steps to set-up the map:

a) Make sure the required data layers are present. For the summary map, the following GIS layer should be present:
   - Leakage_summary

   For the detailed map, the following GIS layer should be present:
   - Leakage

b) Import the data layers into the GIS software by importing the ArcGIS layer files (named as above). Layer files ensure that the colour and layout of the layers appear as recommended by BGS. For other GIS packages, import the layers manually. A .CSV file is provided with the recommended legend colours.

If you need support setting up the GIS, please contact digitaldata@bgs.ac.uk. The GIS should appear as shown in Figure 1 or 2 (for ArcGIS users).

3.2 USING THE DATA

Pan to a location of interest and view each dataset sequentially, following the flow charts shown in Figure 3.

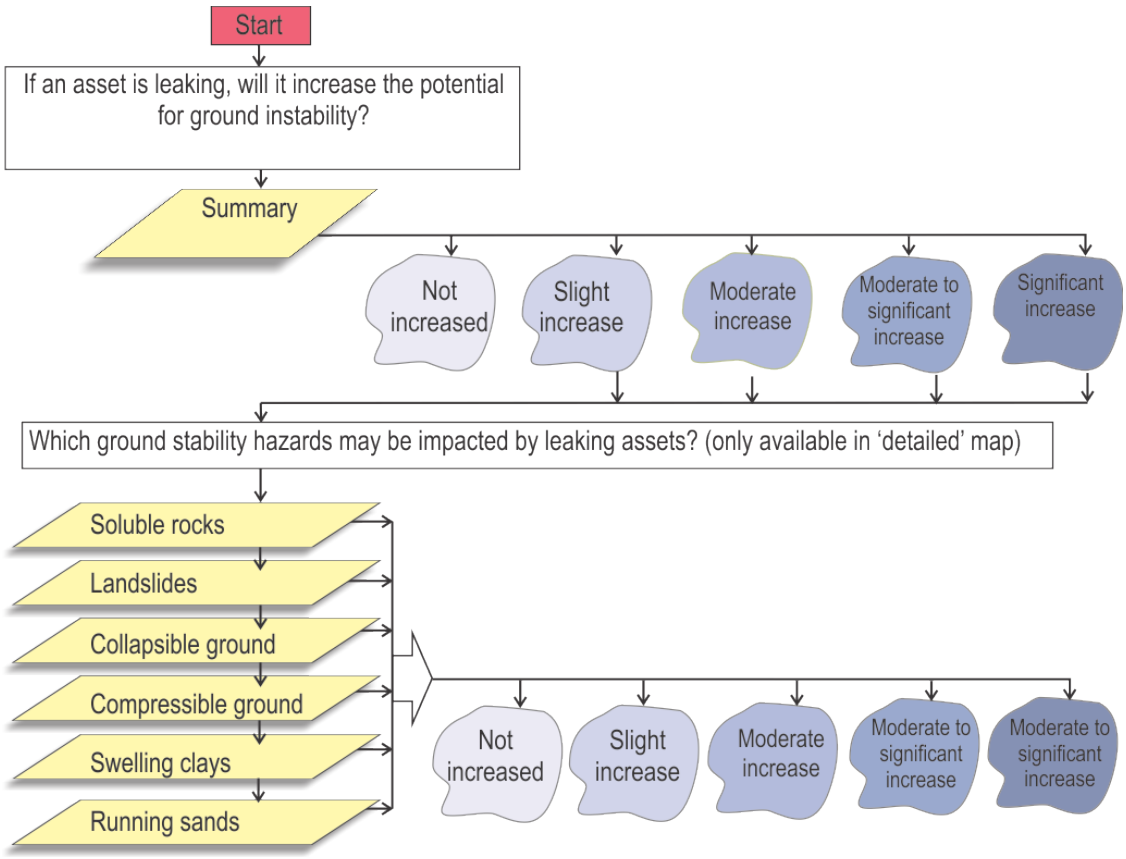

Figure 3 How to use the 'leakage' GIS layer

3.3 EXPLANATION OF SUB-LAYERS

Explanations of the sub-layer descriptions for the 'leakage' summary map are provided in Table 1. Explanations of the descriptions in the compress, swell, collapse, runsand, landslide and soluble sub-layers are provided in Tables 2 to 7.

Table 1 Summary field – Description of attributes

Attributes	Definition
Not increased	The potential for ground movement is unlikely to be increased as a result of leaking assets.
Slight increase	The potential for ground movement may be increased slightly as a result of leaking assets.
Moderate increase	The potential for ground movement may be increased moderately as a result of leaking assets.
Significant increase	The potential for ground movement may be increased significantly as a result of leaking assets.

Table 2 Compressibility (Compress) sub-layer – Description of attributes

Attributes	Definition
Not increased	No increased likelihood of compressibility hazard
Slight increase	The potential for ground movement may be increased slightly as a result of leaking water pipes.
Moderate increase	The potential for ground movement may be increased moderately as a result of leaking water pipes.

Table 3 Shrink-swell (Swell) sub-layer – Description of attributes

Attributes	Definition
Not increased	Additional instability due to leaking water pipes unlikely
Slight increase	The potential for ground movement may be increased slightly as a result of leaking water pipes.
Moderate increase	The potential for ground movement may be increased moderately as a result of leaking water pipes.

Table 4 Collapsible deposits (Collapse) sub-layer – Description of attributes

Attributes	Definition
Not increased	Additional instability due to leaking water pipes unlikely
Moderate increase	The potential for ground movement may be increased moderately as a result of leaking water pipes.

Table 5 Running sands (Runsand) sub-layer – Description of attributes

Attributes	Definition
Not increased	Additional instability due to leaking water pipes unlikely
Slight increase	The potential for ground movement may be increased slightly as a result of leaking water pipes.
Moderate increase	The potential for ground movement may be increased moderately as a result of leaking water pipes.

Table 6 Landslides (lndslide) sub-layer – Description of attributes

Attributes	Definition
Not increased	Additional instability due to leaking water pipes unlikely
Moderate increase	The potential for ground movement may be increased moderately as a result of leaking water pipes.
Significant increase	The potential for ground movement may be increased significantly as a result of leaking water pipes.

Table 7 Dissolution (soluble) sub-layer – Description of attributes

Attributes	Definition
Not increased	Additional instability due to leaking water pipes unlikely
Moderate increase	The potential for ground movement may be increased moderately as a result of leaking water pipes.
Significant increase	The potential for ground movement may be increased significantly as a result of leaking water pipes.

4 What information does the dataset provide?

4.1 OVERVIEW

This section describes the datasets included in the Pipe Leakage Impacts map.

4.1.1 Summary map

The summary map provides an overview of the extent to which leakage may increase ground instability. It is derived from the datasets described in Sections 4.1.2 to 4.1.8.

4.1.2 Soluble rocks

Some types of ground contain layers of material that can dissolve in water (e.g. from leaking pipes), causing underground cavities to develop. The ground above cavities can collapse, resulting in subsidence. More commonly, water can flush away unconsolidated sediment into dissolution voids, potentially leading to the collapse of overlying materials. Leaking pipes can accentuate dissolution or flushing of fines resulting in more significant impacts around underground assets and adjacent infrastructure.

This component data layer is derived from the soluble rocks (dissolution) layer of the BGS GeoSure dataset. The data layer has been reclassified to provide an indication of the potential for ground instability as a result of pipe leakage. Information about the original dataset can be viewed at: http://www.bgs.ac.uk/products/geosure/soluble.html.

4.1.3 Landslides

A landslide is an outward and downward movement of material on a slope, due to the force of gravity. A slope is under stress from gravity but will not move if its strength is greater than this stress. If the balance is altered so that the stress exceeds the strength, then movement will occur. If a leak occurs from a pipe or culvert, leaking water could alter the strength of the deposit, leading to a more significant subsidence hazard.

This component data layer is derived from the landslide (slope instability) layer of the BGS GeoSure dataset. The data layer has been reclassified to provide an indication of the potential for landsliding as a result of pipe leakage. Information about the original dataset can be viewed at: http://www.bgs.ac.uk/products/geosure/landslides.html.

Landslide hazards present along the coastline may be under-represented in this dataset due to inaccuracies in the digital terrain model along the coastline.

4.1.4 Compressible ground

Many geological deposits contain water-filled pores. When the ground is compressed by a building or other load, the water in the pore space can be squeezed out, causing the ground to compress. This may cause uniform or non-uniform settling, resulting in tilting, cracking or distortion of underground assets. Leakage of water from pipes could alter the strength of the deposit, leading to more significant ground movement.

This component data layer is derived from the compressible ground layer of the BGS GeoSure dataset. The data layer has been reclassified to provide an indication of the potential for ground instability as a result of pipe leakage. Information about the original dataset can be viewed at: http://www.bgs.ac.uk/products/geosure/compressible.html.

4.1.5 Swelling clays

Clays susceptible to shrink and swell, change volume significantly according to how much water they contain. All clay deposits change volume as their water content varies, typically swelling in winter and shrinking in summer, but some do so to a greater extent than others. Leaking pipes are a significant contributory factor that can change the moisture content of clay resulting in swelling. This may result in uplift or lateral stress on part or all of an asset; any such movement may cause cracking and distortion.

This component data layer is derived from the shrink-swell clays layer of the BGS GeoSure dataset. The data layer has been reclassified to provide an indication of the potential for ground instability as a result of pipe leakage. Information about the original dataset can be viewed at: http://www.bgs.ac.uk/products/geosure/shrink_swell.html.

4.1.6 Running sands

Running sand conditions occur when loosely-packed sand, saturated with water, flows into an excavation or other type of void. The pressure of the water filling the spaces between the sand grains reduces the contact between the grains causing them to be carried along by the flow. This can lead to subsidence of the surrounding ground. If a failed pipe is leaking, the flow of water may cause sands to flow, thereby resulting in subsidence of surrounding ground.

This component data layer is derived from the running sand layer of the BGS GeoSure dataset. The data layer has been reclassified to provide an indication of the potential for ground instability as a result of pipe leakage. Information about the original dataset can be viewed at: http://www.bgs.ac.uk/products/geosure/running_sand.html.

4.1.7 Collapsible ground

Collapsible ground comprises fine-grained materials with large pore spaces. Such deposits can collapse when loaded and then become saturated by water. If the ground below a building collapses it may cause the building to sink. If the collapsible ground is variable in thickness or distribution, structures may suffer from distortion, tilting or cracking. If a pipe leaks, the additional water may accentuate the ground stability issue resulting in more significant hazards.

This component data layer is derived from the collapsible ground layer in the BGS GeoSure dataset. The data layer has been reclassified to provide an indication of the potential for ground instability as a result of pipe leakage. Information about the original dataset can be viewed at:
http://www.bgs.ac.uk/products/geosure/collapsible.html.

4.2 DATA SUMMARY

The original datasets used in the creation of the Pipe Leakage Impacts map are detailed in Table 8.

Table 8. Details of the original datasets used in the Pipe Leakage Impacts map

Data layer	Layer ID	Original dataset	Dataset owner	Scale
Summary	Summary	N/A	BGS	1:50 000
Soluble rocks	Soluble	GeoSure v6	BGS	1:50 000
Landslides	Lndslides	GeoSure v6	BGS	1:50 000
Compressible ground	Compress	GeoSure v6	BGS	1:50 000
Swelling clay	Swell	GeoSure v6	BGS	1:50 000
Running sand	Runsand	GeoSure v6	BGS	1:50 000
Collapsible ground	Collapse	GeoSure v6	BGS	1:50 000

5 Technical Information

5.1 PRE-REQUISITE REQUIREMENTS

To use the Pipe Leakage Impacts map, a computer with vector-based GIS software is required.

It is highly beneficial to have a topographic GIS layer. If unavailable, see the Ordnance Survey website (http://www.ordnancesurvey.co.uk/) for the provision of OpenData.

5.2 CREATION OF THE DATASET

The 'Leakage' dataset is directly derived from the datasets listed in Table 8. The polygons in the original datasets were reclassified with five attributes (e.g. see Tables 2 to 7) and neighbouring polygons with the same attribute were merged. A summary map was generated by reporting the greatest potential for an increase in ground movement.

5.3 SCALE

The Pipe Leakage Impacts map is produced for use at 1:50 000 scale providing 50 m ground resolution. The mapping scales on which the original geological linework are based are shown in Appendix 1.

5.4 DATASET HISTORY

BGS is strategically surveying and resurveying areas of Great Britain, improving and updating the geological maps. It is anticipated that a new version of the dataset will be released once a significant proportion of the underlying dataset has changed. This report describes the first version of the Pipe Leakage Impacts map, generated during 2013.

5.5 COVERAGE

The data covers Great Britain, but not the Isle of Man.

5.6 DATA FORMAT

The Pipe Leakage Impacts map has been created as vector polygons, which are available in a range of GIS and CAD formats, including ArcGIS (.shp) and MapInfo (.tab).

5.7 LIMITATIONS

- The Pipe Leakage Impacts map has been developed at 1:50 000 scale and must not be used at high resolution.

- The Pipe Leakage Impacts map is based on, and limited to, an interpretation of the records in the possession of the British Geological Survey at the time the dataset was created.
- The dataset does not consider the pressure of the water leaking from a pipe; it considers the impact of leaking water on stability hazards.
- This dataset is not an alternative for a ground investigation.
- Site observations represent the properties of the ground more accurately than the data provided by the Pipe Leakage Impacts map.
- Other more specific and detailed ground instability information may be held by BGS, and an assessment of this could result in a different outcome.
- An indication of potential natural ground instability does not necessarily mean that a location will be affected by ground movement or subsidence. Such an assessment can only be made by inspection of the area by a qualified professional.

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Appendix 1

Mapping scales