Software for the assessment of primary flood defences

D-Soil Model

WTI2017

Functional Design

Deltares

Functional Design D-Soil Model

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Titel
Functional Design D-Soil Model

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Stochastic subsoil schematization, soil profile, soil properties, macro stability, piping, flow slide

Summary
This document contains the requirements and functional design for the application D-Soil Model, which will be a part of the WTI 2017 software. The application supports the (stochastic) subsoil schematizations for the failure mechanisms Macro stability and Piping. A subsoil schematization for soil segment consists of 1D and/or 2D soil profiles, profile properties, layer properties and soil material properties.

Samenvatting
Dit document bevat de eisen en het functioneel ontwerp voor de applicatie D-Soil Model welke deel uit maakt van de WTI-2017 software. De applicatie ondersteunt de (stochastische) schematisering van de ondergrond voor de faalmechanismen Macrostabiliteit en Piping. Per ondergrondsegment bestaat deze schematisering uit 1D en/of 2D profielen, profieleigenschappen, laageigenschappen en materiaaleigenschappen.

Versie	Datum	Auteur	Paraaf	Review	Paraaf	Goedkeuring	Paraaf
01	dec 2015	Irene van der Zwan		Kin Sun Lam		Joost Icke	
02	jun 2016	Irene van der Zwan		Kin Sun Lam		Joost Icke	
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				Hans van Putten			

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Contents

1 Introduction

1.1 Purpose and scope

This document contains the requirements and functional design for the application D-Soil Model, which will be part of the WTI 2017 software applications. This Functional design describes the functionality of the application.
The application supports the (stochastic) subsoil schematizations for the failure mechanism macro stability and piping and the storage of material parameters for zetting and beiing.
A subsoil schematization for macro stability and piping consists of segments; dike sections. The subsoil of these segments is described via soil profiles, profile properties, layer properties and material properties.

D-Soil Model is a software tool for schematization of the subsoil and is developed for the assessment of primary dikes according to the WTI2017. In this process of assessment the schematization of a stochastic subsoil model (WTI-SOS 2017) is a major source of information. This information is used in the basis modulen and Ringtoets (see figure below). The D-Soil Model development focus on use of this stochastic subsoil model (WTI-SOS 2017).

For background on the context of the WTI project and on the derivation or motivation of the supported schematizations, the reader is referred to the VTV 2017 and to its supporting technical reports and their background reports.

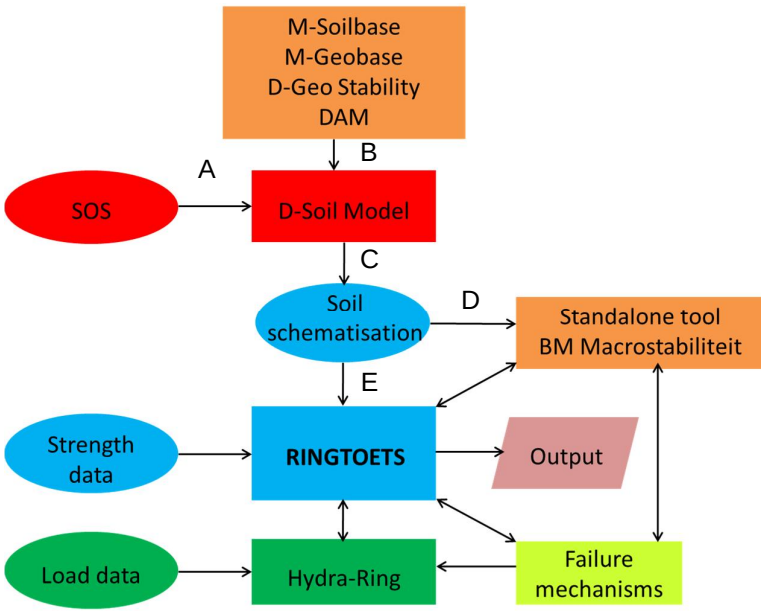


Figure 1.1 WTI components

D-Soil Model is connected to several other components of the WTI2017 as follows:

A. Data can be imported from the SOS database.
B. Data can be imported from data that is used by or created by tools that are not part of WTI (e.g. DAM or D-Geo Stability). This also includes data described by industry

standards as GEF-CPT for cone penetration tests (“Sonderingen” in Dutch) or GEF-Bore for borings (“Boringen” in Dutch).

C. D-Soil Model is a pre-processor that support the creation the soil schematization
D. The Ringtoets application can read the soil schematization
E. The standalone tool BM – Macrostabiliteit can read the soil schematization.

A glossary of used terms is placed in appendix A.

1.2 Other system documents

For the development of D-Soil Model different documents are available. The titles are posted in the table below.

Title	Content
Functional design	This document
Technical Design D-Soil Model [1]	Definition of the different software components and their interaction
Test plan and Test report [2]	Reports all test levels of the V model, as prescribed by the overall test plan
Technical Design Macro stability kernel [3]	Definition of the different software components and their interaction
Technical Design Piping kernel [4]	Definition of the different software components and their interaction

Table 1.1 Other system documents

1.3 Constraints and non-functional requirements

1.3.1 Constraints

CNS 1 As a general constraint, the software design needs to comply with the general design description for WTI software, contained in a separate document: De Waal, 2016 [5].

CNS 2 As a general constraint, the User Interface needs to comply with the relevant general requirements and further rules for the programming, documentation and testing of WTI software. This set of requirements and rules is contained document in Knoeff, De Waal, 2014 [6].

1.3.2 Non-functional requirements

The table of non-functional requirements and an explanation where or how the requirement is met is placed in appendix B.

1.3.3 Functional requirements

In table 1.2 the functional requirements are ranked from must-have to won’t-have. In the last column the corresponding paragraph of chapter 2 is given. For the release of 1-9-2016 the must-haves and should-haves are implemented. The other requirements are part of this document to have an overview of possible further development of D-Soil Model.
The full description of the requirements is placed in appendix F.

Description requirement	MoSCoW	Paragraph
REQ 3.1: Import data.	must-have	2.1.1
REQ 3.3: Select relevant SOS information for project	must-have	2.3.1
REQ 5.1: Supply the subsoil schematization and -parameters for the WTI macro stability kernel	must-have	2.3.2; 2.3.3; 2.4.2; 2.4.3; 2.4.4
REQ 5.2: Supply the subsoil schematization and -parameters for the WTI piping kernel.	must-have	2.5.2; 2.5.3; 2.5.4
REQ 5.4: All relevant subsoil information	must-have	2.4.4; 2.5.4
REQ 6.1: Stochastic characterization of the variables	must-have	2.4.3; 2.5.3
REQ 6.3: Separate segments for each failure mechanism	must-have	2.3.2; 2.3.3; 2.5.4
REQ 6.4: Definition of the location of the 1D profile for Piping and DFlowSlide	must-have	2.5.1
REQ 6.5: Profile properties	must-have	2.4.4
REQ 6.6: Layer properties	must-have	2.5.2
REQ 7.1: Stochastic subsoil information	must-have	2.3.4
REQ 8.2: Table view for soil parameters	must-have	2.1.3
REQ 8.4: Profile view to modify soil profiles	must-have	2.1.4
REQ 8.6: Show segments with labels	must-have	2.1.2
REQ 8.10: 1D Scenario overview	must-have	2.1.4
REQ 8.13: Show SOS scenario's in 2D profiles	must-have	2.2.1
REQ 9.1: Name soil materials	must-have	2.4.5; 2.5.5; 2.6.1
REQ 9.2: Edit the chances of a SOS scenario	must-have	2.3.4
REQ 9.3: Turn a 1D profile into a 2D profile	must-have	2.3.5
REQ 9.4: Draw 2D sti files	must-have	2.3.5
REQ 9.5: Have reference points to draw surface lines on 2D profiles	must-have	2.2.1
REQ 9.7: Define soil layers	must-have	2.3.5
REQ 9.8: Allocate soil material to layer	must-have	2.3.8
REQ 9.9: Define layer as aquifer or aquitard	must-have	2.4.2
REQ 9.10: Enter yield stresses for macro stability	must-have	2.4.4
REQ 9.12: Modify the location of de borehole or CPT in the 2D profile.	must-have	2.2.3
REQ 9.14: Minimal validity check on the data	must-have	2.7.1
REQ 9.18(a): Add another 1D profile to an existing 2D profile	must-have	2.2.1
REQ 9.20: Incorporate settlements underneath an embankment	must-have	2.2.4
REQ 9.23: Import soil area's and segments	must-have	2.1.4
REQ 3.2: Import and view all SOS data	should-have	2.1.2; 2.1.3; 2.1.4;
REQ 3.4: Import relevant reference data	should-have	2.1.1
REQ 7.2: Allocation of CPT's and boreholes to a segment	should-have	2.2.2
REQ 7.3: Overview of all available borings and CPT's in a segment or cross section	should-have	2.1.1; 2.1.2; 2.1.3
REQ 7.4: Overview of all available SOS scenario's in a segment	should-have	2.2.3
REQ 8.7: Show all soil investigation with labels in map view	should-have	2.1.2
REQ 8.8: Visualize the surface lines with their characteristic	should-have	2.2.1

Description requirement	MoSCoW	Paragraph
points		
REQ 8.12: Show data from AHN or a WMS server, or other shape files	should-have	2.1.2
REQ 8.14: Draw SOS profiles in one segment on the same height for comparison	should-have	2.1.4
REQ 8.15: Show ground investigation simultaneously to REQ 39 at the same reference level	should-have	2.1.4
REQ 8.16: Compatibility between different views	should-have	1.3
REQ 8.17: Visibility of yield stress	should-have	2.4.4
REQ 9.11: Copy/ paste segments for one failure mechanism to the next	should-have	2.3.7
REQ 9.21: Visualize minimum and maximum of layer boundaries from the SOS data	should-have	2.1.4
REQ 9.24: Table import/export	should-have	2.6.2; 2.6.3
REQ 5.3: Supply the subsoil schematization and -parameters for the WTI flow slide kernel.	nice-to-have	Partly implemented [1] 2.4.5
REQ 6.2: Determination of soil parameters	nice-to-have	Not implemented
REQ 8.1: Reference line	nice-to-have	Not implemented
REQ 8.3: Map view for soil area's	nice-to-have	Not implemented
REQ 8.5: Automatically project boreholes and CPT onto a cross section	nice-to-have	Not implemented
REQ 8.11: View Gef files with GefPlotTool	nice-to-have	Not implemented
REQ 9.6: Interpretation tools	nice-to-have	Not implemented
REQ 9.13: Logging of all changes to the database	nice-to-have	Not implemented
REQ 9.15: Extensive validity check on the data for Ringtoets	nice-to-have	Not implemented
REQ 9.16: Define n and gamma per material parameter for determination of design values	nice-to-have	Not implemented
REQ 9.17: Store lab data	nice-to-have	Not implemented
REQ 9.18(b): The user must be able to build a 2D schematization based on multiple 1D profiles.	nice-to-have	Not implemented
REQ 9.19: Draw a new subsoil configuration	nice-to-have	Not implemented
REQ 9.22: Longitudinal cut based on dike material	nice-to-have	Not implemented
REQ 4.1: Existing M-Soil Base functionality.	won't have; M-Soil Base functionality is not described in any document	Not implemented

Table 1.2 Functional requirements

[1] *The required material parameters,for D-Flow Slide are part of the material table via filter Zettingsvloeiing [appendix D].*

1.4 Interfaces

Using D-Soil Model the user can provide subsoil information to the WTI software. The schematization, made in D-Soil Model, can be imported in the WTI software.
Each WTI application can define which data to use from the D-Soil Model file (*.soil).
There is no API available. 

2 Functional design

D-Soil Model supports the user during the subsoil schematization process
D-Soil Model is a software tool for schematization of the subsoil and is developed for the assessment of primary dikes according to the WTI 2017. In this process of assessment the given schematization of a stochastic subsoil model (WTI-SOS 2017) is a major source of information. The D-Soil Model development focusses on use of this stochastic subsoil model. The process of subsoil schematization consists of the following steps:

1. Collect relevant subsoil information
2. Combine and compare these information
3. Define subsoil schematization for macro stability
4. Define subsoil schematization for piping
5. Store the schematization
6. Export data for use in other applications

The user must be able to make a local schematization using the WTI-SOS 2017 schematization and use this schematization for calculations of the failure mechanisms Macro stability and Piping.
This process is described in following use cases. There is one type user: the one who makes the subsoil schematization

2.1 Use case 1 Collect relevant subsoil information

The user must be able to import following data.
Input files:

a. Materials - optional
b. Existing 2D profiles - optional
c. WTI-SOS 2017
   Content of WTI-SOS 2017:
   - 1D profiles
   - Segments
d. Geometric data (surface line with characteristic points)
e. Soil survey; cpt, borings - optional
f. Maps; geo-related information in shape files - optional

Explanation
The main functionality of D-Soil Model is to let the user combine different information about the subsoil, to make a schematization of the subsoil.

Actions to support	***Requirement***	***Paragraph***
Import data	3 / 7.3	2.1.1
Show data on map	3.2 / 8.6 / 8.7 / 8.12	2.1.2
Show data in table	3.2 / 8.2	2.1.3
Show data in a cross section	3.2 / 8.1 / 8.3 / 8.14 / 8.15 / 9. 23	2.1.4
Start, open and save project	U123	2.1.5, 2.1.6, 2.1.7

Table 2.1 Use ca

2.1.1 Import data

Data formats to impo

File	Data	View
materials.mdb (only files created with MSoilBase version 14.1.1.4)	Materials including parameters	Table
*.sti (only files created with D-Geo Stability version 16.1.2.1)	2D profile	Table / Cross section
*.sti (only files created with D-Geo Stability version 16.1.2.1)	2D profile and soil parameters	Table / Cross section
soilprofiles.csv	1D profile	Table / Cross
segments.csv	Relation between segment and scenario (=profile and probability)	Table / Map / Cross section
segments.shp	Segment lines	Map
surfacelines.csv	X,y,z coordinates (RD, m NAP)	Table / Cross section
characteristicpoints.csv	X,y,z coordinates (RD, m NAP)	Table / Cross section
*.gef	CPT, Boring	Map[2] I Table/
*.shp	Not defined	Map

Table 2.2 Data formats import

All data can be imported separately, exce ems which are depending on each other:

- Characteristic points can only be imported w en connecting surface lines are present in the project.
- Soil segments (csv) can only be imported wh en connecting soil profiles are present in the project.
- Soil segments (shp) can only be imported wh en connecting soil segments (csv) is present in the project.

For each failure mechanism the subsoil is described in soil segments consisting of one of more scenario(s). A scenario is a soil profile with a probability. These soil profiles are described in either 1D or 2D layer schematizat n. A soil segment can have a combination of 1D and 2D soil profiles. Each layer is describe h at least all the parameters needed for the relevant failure mechanism. This output is gathered in one file (*.soil), which can be directly imported in Ringtoets or BM – Macrostabiliteit (connection with D-Flowslide is not operational and BM – Piping is f e possibility).

The building blocks of the subsoil schematization in D-Soil Model and the data formats are presented in figure 2.1.

[2] *The application can import borehole and CPT as GEF-file. The location of the borehole and CPT can be viewed in map. If the location in RD is known, it is plotted in the right location. If the RD location is not known, it is not plotted on the map.*

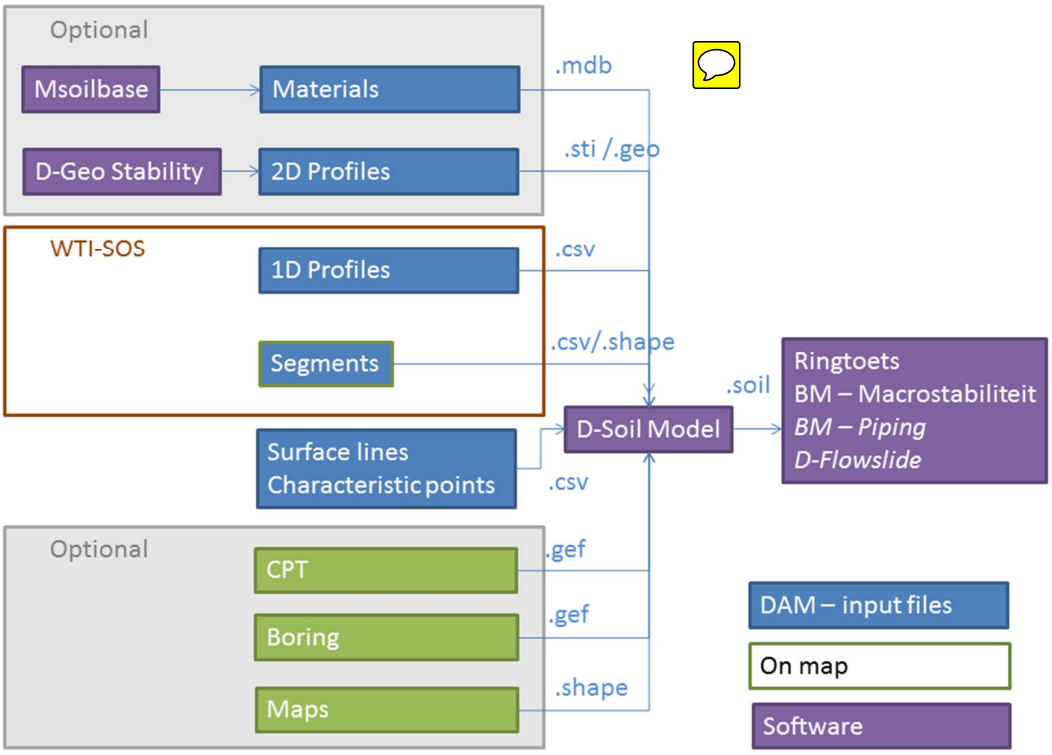


Figure 2.1 Building blocks

When a Soil Model project is used in Ringtoets or BM – Macrostabiliteit a minimum of data is required: soil profiles, soil segments, surface lines (incl. characteristic points). Other input data is optional and is back-ground information for the schematization; as soil material databases and 2D-soilprofiles, cpt's and borings and other map layers then PDOK.
The purple boxes refer to software, the blue boxes to similar input files of DAM and the green to other data. A green outline means that the data can be shown on a map.

When importing 1D profiles or geo-files (without reading a mdb file first) there are no soil parameters available, only material names. These names will be added to the material table with default parameters.

The file formats are described in appendix C.

2.1.2 Show data on map

If data contains coordinates the information must be shown on a map with labels (name of id of the item).
The map can have a background map (imported).
User defined shapes can be shown on the map.

For general functionality of the map window, see Brinkman 2014 [7].

2.1.3 Show data in table

All imported data must be visible in a table, per row one item and information about this item in columns.

For general functionality about tables in UI, see Brinkman 2014 [7].

2.1.4 Show data in cross section or length profile (segment).

Soil profiles

1D Soil profiles of WTI-SOS 2017 must be visible in a cross section so the user can see the layers in different (adjustable) colors.

The layers of the SOS soil profiles, modal and their minimum and maximum values of the layer limits must be clear in the cross section.

2D Soil profiles (*.sti-files) must be visible in a cross section so the user can see the layers in different (adjustable) colors.

Surface lines

Surface lines must be visible in a cross section.

Soil segments

Show all 1D profiles of 1 segment on the same reference level. The user must get a good visual overview of all available scenarios of soil profiles.

For general functionality of the cross section window, see Brinkman 2014 [7].

2.1.5 Start a new project

It must be possible to start a new project. An existing project must be closed and after a check with the user for saving the project, all its data should be removed from the user interface.

2.1.6 Open an existing project

It must be possible to open an existing D-Soil Model project database.

2.1.7 Save current project

It must be possible to save all the data to a project database.

Units of the parameters are saved in the base and derived units of the International System of Units (Si-units). In appendix D the display units of the parameters are given.

A user must be warned if he wants to close the application without saving changes.

2.2 Use case 2 User must be able to combine subsoil information and view the combination

Explanation

The main functionality of D-Soil Model is to let the user combine different information about the subsoil, to make a schematization of the subsoil. Not all combinations are useful.

Combination of the surface line results in new 2D profiles.

In table below are the combinations mentioned of the base item and the item to add (blue).

	Cpt	Boring	1D Profile	2D Profile	Segment	Surface line
Cpt						
Boring						
1D Profile	x	x	x		x	x
2D Profile	x	x	x		x	x
Segment	x	x				x (only for macro stability)
Surface line			x	x		

Table 2.3 Combinations

Actions to support	***Requirements from [1]***	***Paragraph***
Combine items in the cross section (one to one)	7.3 / 8.3 / 8.8 / 8.9 / 8.13/ 9.5 /	2.2.1
Connect items in batch (several to one)	7.3 / 8.5	2.2.2
View combination in a cross section.	7.3 / 7.4 /9.14 / 9.18	2.2.3
Incorporate settlements underneath an embankment.	9.20	2.2.4

Table 2.4 Use case 2

2.2.1 Combine items in the cross section (one to one)

Paragraph 2.1.4. describes how imported data must be visualized in the cross section window. When the combining the data as described in paragraphs below, the view of the data is also combined; the view of the separate data remains when combining. Most important is the Z-value; all data must be visualized at the same hei

2.2.1.1 1D Profile can be combined w

- Cpt
- Boring
- 1D profile
  In WTI-SOS 2017 a 1D profile is already combined with other 1D Soil profiles of the same soil segment.
- Segment
  In the WT-SOS 2017 the connection is already present; the segment contains soil scenarios; profiles with a probability.
- Surface line
  Combining a 1D profile with a surface line results in a 2D Soil profile. So the combination creates a new item.

2.2.1.2 2D Profile can be combined wit

- Cpt
- Boring
- 1D profile
- Segment
- Surface line
  The combination of a 2D Soil profile and a surface line results in a new 2D profile. The desired behavior is described in appendix E.

2.2.1.3 Segments can be combined wit

- C
- B
- Surface line
  The combination of a segment (only macro stability) and a surface line results in a segment with all new 2D profiles by combining the surface line with each 1D profile of the segment. The probability of t profiles stays unchanged.

2.2.1.4 A surface line can be combined with:

- 1D Profile
  Combining a surface line with a 1D profile results in a 2D profile. So the combination creates a new item.
- 2D Profile
  Combining a surface line with a 2D profile results in a new 2D profile. The design of how the combination should be made is described in [7].

2.2.2 Connect items in batch (several to one)
The combination of cpt/borings to a segment can be done in batch, not only one by one.
The user can make a selection of the cpts or borings in the table or on the map and connect them to a segment.

2.2.3 View combination in a cross section.
To all combinations it is important that the Z-values remain intact (in m +NAP); show items at the right height. There is no definition of the x-value of 1D profiles, only Z values.

For some combination there are more detailed requirements:

2.2.3.1 1D profile – other 1D profiles of the soil segment
All 1D profiles of one soil segment must be visible at the same time. With large (>6) numbers of 1D profiles a 'filmstrip' is provided, so the user can scroll through the 1D profiles.

2.2.3.2 2D profile - cpt and boring
The cpt and boring are placed in the middle of the 2D soil profile. The user can drag them to the desired X-coordinate.

2.2.3.3 2D profile – surface line
When combining 2D profiles and surface lines there is a mapping necessary for the x-coordinates.
This mapping is done based on the reference line. The user can define this X-value in the 2D profile. On the surface line is the reference line situated at the middle of the characteristic points 'Kruin buitentalud' and 'Kruin binnentalud'.
The behavior when the length of 2D profile and surface line is not equal is described in the user manual of D-Soil Model.

2.2.3.4 Soil segment – Cpt/borings
When a soil segment is combined with cpt and borings a cross section of the soil segment is needed. The soil segment is drawn as a straight line and the cpts and borings are situated relatively among this line. This is called a length profile.

2.2.4 Incorporate settlements underneath an embankment.
The user must be able to define settlements underneath the embankment.
After combining a 1D soil profile the user can draw vertical geometry lines under the slope until the aquifer layer. So the user can define the settlement by dragging the soil layers under the embankment. This is not automated because a divided aquifer layer is not accepted by the macro stability kernel.

2.3 Use case 3 User must be able to adapt the WTI-SOS 2017 to local situation.

Explanation

The WTI-SOS 2017 is a general schematization of the subsoil at the inner toe of the primary dikes in the Netherlands. To perform the assessment it is needed that this schematization is adapted to the local situation (more detailed).

Actions to support	***Requirement from [1]***	***Paragraph***
Save a selection of the WTI-SOS 2017 as a new project	3.3	2.3.1
Splitting the soil segments per failure mechanism	5.1 / 6.3	2.3.2
Deleting soil profiles per segment	5.1 / 6.3	2.3.3
Changing probability of the soil profiles	7.1 / 9.2	2.3.4
Make and edit 2D soil profiles	9.3 / 9.4 / 9.7 / 9.18	2.3.5
Adding 1D and 2D soil profiles to a soil segment	9	2.3.6
Copy/ paste segments for one failure mechanism to the next	9.11	2.3.7
Add materials to the material table	9.8	2.3.8

Table 2.5 Use case 3

2.3.1 Save a selection of the WTI-SOS 2017 as a new project

The user can make a selection of segments, based on failure mechanism and/or location, and save this as a project. All soil profiles of these soil segments are included in this project, as well as all their materials. Also by user connected cpts and borings are included in this project.

2.3.2 Splitting the soil segments per failure mechanism

The user can add a split location to a soil segment in the map or in the length profile. When splitting the soil segment, all soil profiles and their probability are connected to both new soil segments. The name of the new segments consists of the old name and a number.

2.3.3 Deleting soil profiles per soil segment

The user can remove soil profile(s) from a soil segment. If the total probability is not 100%, a message should be given. The probability of a soil profile can be zero.

2.3.4 Changing probability of the soil profiles

A soil segments consists of one or more scenarios. A soil scenario is defined by a soil profile and its probability.

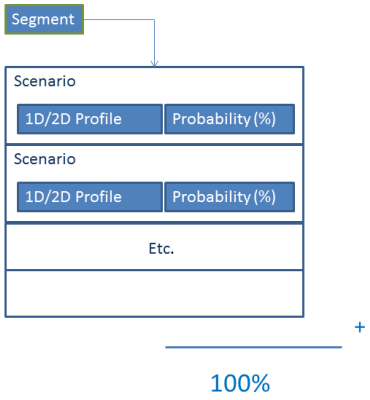


Figure 2.2 Soil scenarios

The user can edit the probability of soil profile(s) of a soil segment. If the total of the scenarios is not 100%, a message should be given.

2.3.5 Make and edit 2D soil profiles

The user can make 2D soil profiles either from scratch, either from using 1D Soil profile. The user can draw lines to make soil layers. Per layer a soil material can be defined.
The general functionality of the geometry editor is described in ….[ ]
1D Profiles can be edited by changing layers; changing height, material or deleting layers.
If there is no soil assigned to a layer, a message is given in validation tab.

2.3.6 Adding 1D and 2D soil profiles to a segment

The user can add soil profile(s) to a soil segment with a probability (a scenario). If the total probability of the scenarios is not 100%, a message should be given.

2.3.7 Copy/paste segments for one failure mechanism to the next

The user can copy a segment of one failure mechanism and use it for another failure mechanism. This will not be implemented because the desired functionality is not clear yet.

2.3.8 Add materials to the material table

The user can add new materials to the material table, so this can be used in new or changed soil profiles. The soil parameters must be entered by the user (or imported via a mdb file).

2.3.9 Deleting items

Deleting of items is not possible if the item is used in the project. By 'use' is mend combination with other data or being a part of other data, as mentioned in table below:

	Material	Cpt	Boring	1D Soil profile	2D Soil profile	Soil segment	Surface line
Material				Part of	Part of		
Cpt				Combined with	Combined with	Combined with	
Boring				Combined with	Combined with	Combined with	
1D Soil profile						Part of	
2D Soil profile						Part of	
Soil segment							
Surface line				New item	New item	New item	

Table 2.6 Use of items

Soil segments can be deleted.
Surface lines can be deleted.

2.4 Use case 4 Define subsoil schematization for the failure mechanism 'Macrostabiliteit binnenwaarts (STBI)'

Explanation
For the assessment the user must be able to define the subsoil schematization for the failure mechanism 'Macrostabiliteit binnenwaarts (STBI)'.

Actions to support
Save soil segments for the failure mechanism 'Macrostabiliteit binnenwaarts (STBI)'.

Actions to support	***Requirement from [1]***	***Paragraph***
Save soil segments for the failure mechanism 'Macrostabiliteit binnenwaarts (STBI)'.	5.1	2.4.1
Define aquifer layers per soil profile.	5.1 / 6.6	2.4.2
Define soil parameters for the failure mechanism 'Macrostabiliteit binnenwaarts (STBI)'.	5.1 / 6.1 / 7.1	2.4.3
Define yield stresses per 2D soil profile (optional for undrained calculations).	5.1 / 6.3 / 6.5 /8.17 / 9.10	2.4.4
Filter of the soil parameters needed for the use in the Basis Module tool 'BM-Macrostabiliteit'	9.1	2.4.5

Table 2.7 Use case 4

2.4.1 Define aquifer layers per soil profile.
The user must be able to define a layer as an aquifer. A soil profile can contain more than one aquifer.

2.4.2 Save soil segments for the failure mechanism 'Macrostabiliteit binnenwaarts (STBI)'.
The user must be able to save the soil segment with all their connected data, such as the soil profiles (including yield stresses), materials, cpt and borings.

2.4.3 Define soil parameters for the failure mechanism 'Macrostabiliteit binnenwaarts (STBI)'.
The user must be able to define the soil parameters needed for the failure mechanism 'Macrostabiliteit binnenwaarts (STBI)'. These soil parameters are defined in appendix D.
Note that this concerns the soil parameters. Other parameters from [10], such as yield stresses, are layer properties and not mentioned in this table.

2.4.4 Define yield stresses per 2D soil profile (optional for undrained calculations).
The user can define yield stresses in a 2D soil profile. For the definition of yield stresses, see the Schematiseringshandleiding Macrostabiliteit [7].

2.4.5 Filter the soil parameters needed for the use for failure mechanism 'Macrostabiliteit binnenwaarts (STBI)'.
This filter is defined in appendix D.

Note: User must also be able to define and filter the soil parameters needed for the use of D-Flowslide (failure mechanism Zettingsvloeiing).
This filter is defined in appendix D.

2.5 Use case 5 Define subsoil schematization for the failure mechanism Piping (STPH)

Explanation
For the assessment the user must be able to define the subsoil schematization for the failure mechanism Piping (STPH).

Actions to support	***Requirements from [1]***	***Paragraph***
Define 1D soil profiles in 2D soil profiles.	5.2 / 6.4	2.5.1
Define aquifer layers per soil profile.	5.2	2.5.2
Define soil parameters for the failure mechanism Piping (STPH).	5.2 / 6.1 / 7.1	2.5.3
Save soil segments for the failure mechanism Piping (STPH).	5.2 / 6.3	2.5.4
Filter the soil parameters needed for the use in Ringtoets - Piping	9.1	2.4.5

Table 2.8 Use case 5

2.5.1 Define 1D soil profiles in 2D soil profiles.
When 2D soil profiles are used, the user must be able to define a failure mechanism location where a 1D soil profile is available for the piping kernel.

2.5.2 Define aquifer layers per soil profile.
The user must be able to define a layer as an aquifer. A soil profile can contain more than one aquifer.

2.5.3 Define soil parameters for the failure mechanism Piping (STPH).
The user must be able to define the soil parameters needed for the failure mechanism Piping (STPH). These soil parameters are defined in appendix D.
Note that this concerns the soil parameters. Other parameters from [10], such as top and cover bottom layer, are profile properties and not mentioned in this table.

2.5.4 Save soil segments for the failure mechanism Piping (STPH).
The user must be able to save the soil segment with all their connected data, such as the soil profiles, materials, cpt and borings.

2.5.5 Filter the soil parameters needed for the use for failure mechanism Piping (STPH).
This filter is defined in appendix D.

2.6 Use case 6 Export data for use in other applications

Explanation
D-Soil Model is developed for the WTI-2017. Therefore it is necessary that the schematizations from D-Soil Model can be used in Ringtoets and the Basis Module (BM - Macrostabiliteit).

Actions to support
Make a selection for the soil parameters needed for the use:
- for failure mechanism Piping (STPH).
- for failure mechanism Macrostabiliteit binnenwaarts (STBI).
- of deterministic calculations (Basis Modulen)
- of probabilistic calculations (Ringtoets)

Actions to support	***Requirements from [1]***	***Paragraph***
Make a selection of the soil parameters needed for the use: • for failure mechanism Piping (STPH). • for failure mechanism Macrostabiliteit binnenwaarts (STBI). • of deterministic calculations (Basis Modulen) • of probabilistic calculations (Ringtoets)	9.1	2.6.1
Export (part of) tables	9.24	2.6.2
Import (part of) tables	9.24	2.6.3

Table 2.9 Use case 6

2.6.1 Make a selection of the soil parameters.
The usage of a D-Soil Model project in Ringtoets or the Basis Modules differs in soil parameters (the use of deterministic or probabilistic values) and the failure mechanism. The user must be able to see this difference, so the user knows which parameters are used.

2.6.2 Export

2.6.2.1 Tables
Complete tables must be exportable to a csv file (defacto standard). Also part of tables (columns, rows or cells) must be exportable by copying and pasting.

2.6.2.2 Map layers
Map layers must be exportable to a shape file (ESRI standard).

2.6.2.3 Map as picture
The map must be exportable as a picture in *.png, *.bmp and *jpg format (industry standards).

2.6.3 Import (part of) tables
Complete tables and part of tables (columns, rows or cells) must be importable by copying and pasting.

2.7 Error handling

In case of malfunction of the program the user must be informed via messages. This takes place via log messages and validation messages. There are two tabs; 'Log' and 'Validation' in the tables window.

2.7.1 Validation messages
Validation means checking the input data against certain requirements. This results in a list of errors and warnings. If there are no errors, calculations in a Basis Module and/or Ringtoets are possible, otherwise calculation is prohibited. If there are warnings, calculation is discouraged, but not prohibited.
The project can always be saved, even if there are errors (and/or warnings) in the validation window.

Validation happens against simple requirements:

Material parameters:
- an exceeded minimum and maximum value (like mentioned in appendix D)
- absence of parameters (like mentioned in appendix D)

Only the visible materials will be validated

Layers
- No soil assigned; layers must be linked to a material

Segments
- Total of probabilities is not equal to 100%

The user will be informed about the errors and warnings and if present, the user will be supported to solve them. This support is a suggested repair action, when possible.
The repair option shows the severity (error or warning), the subject (object to which the error or warning applies), the properties (one or more properties of the subject to which the error or warning applies) and the suggested repair action (example: "Assign maximum value").

2.7.2 Log messages
After each import by the user, the activity is mentioned in the log window.
Possible log messages about the imported data are given in the log window. Possible errors are non-compatible data (example: GEFs referring to a tiff-file) or missing data (example; 1D profiles with materials without defined parameters).

3 References

1 Bokma, J. et al. (2016), WTI D-Soil Model- Technical Design, Deltares report 1209430-003-DSC-0021

2 Trompille, V. (2016), WTI D-Soil Model- Testplan, Deltares report 1230088-026-DSC-0002

3 Brinkman, R. et al.(2016), WTI2017 Failure Mechanisms - Macro Stability Kernel, Deltares report 1230095-002-HYE-0012

4 Visschedijk, M. et al. (2015), WTI2017 Failure Mechanisms - Piping Kernel, Deltares report 1230084-008-GEO-0001

5 De Waal, J.P. de (2016), Basisrapport WTI 2017, Deltares report 122078-001-GEO-004

6 Knoeff, H., De Waal, J.P. de (2014). Uitgangspunten WTI 2017. Deltares report 1209429-001-GEO-0011

7 Brinkman, R. (2014), Deltares Framework, Deltares report 1209430-000-DSC-0020

8 Geotechnisch uitwisselformaat voor boor-data (GEF-bore-report) versie 1.0.0, CUR, maart 2002

9 Geotechnical exchange format for cpt-data, CUR, april 2004

10 Lam, K.S. (2016), WTI Parameterlijst, Deltares memo 1220081-005-GEO-0003

A Glossary

Following glossary is partly a selection from Terminologielijst [6], completed with terms used in this document

Term (ENG)	Term (NL)	Definition
1D (soil) profile	1D-(ondergrond)profiel	
2D (soil) profile	2D-(ondergrond)profiel	
aquifer	aquifer	Soil layer with a high permeability compared to aquitards (i.e. Sand layers).
aquitard	aquitard	Soil layer with a low permeability compared to aquifers (i.e. clay layers). The horizontal flow in a aquitard is very low, while a vertical flow could be significant.
berm	berm	Enforcement in dike profile, also named shoulder.
characteristic points	karakteristieke punten	Characteristic points of the surface level, right-angled at the dike.
crest	kruin	1. Area between inner and outer crest. 2. Highest point in dike geometry 3 Outer crest line
crest inner slope	kruin binnentalud	The intersection point of the slope at the polder side and the crest of the dike
deterministic	deterministisch	During assessment the parameter is considered as 'known' and not modelled as a stochast.
failure mechanism	faalmechanisme	Process that leads to the failure of the system. This is often the result of a sequence of partial processes, derived from partial failure or the system, but without complete function loss.
geometry	hoogtegeometrie	Collection of points in RD coordinates on a straight line, perpendicular on the dike line with a height in m+NAP, which represent the geometry of the dike. Outside/riverside is always visualized on the left side.
inner slope	binnentalud	Sloping face of the embankment at the inner side.
inside toe	teen dijk binnenwaarts	Lower boundary of the embankment at the land side (transition to ground level)
macro stability	macrostabiliteit	The mechanism that causes slope shear failure of dike embankments
soil (material)[3]	materiaal	Name and parameters of soil material
outside slope	buitentalud	Sloping face of the embankment at the water side.
outside toe	teen dijk buitenwaarts	Lower boundary of the embankment at the water side (transition to ground level or foreland)
probabilistic analysis	probabilistische analyse	Probabilistic determination of failure probability, using stochastically distributed variables for loading and strength.
(soil) profile[4]	(ondergrond) profiel	A sequence of subsoil layers, either 1D or 2D.
shoulder	berm	See berm
(soil) scenario[5]	(ondergrond) scenario	Soil profile with certain occurrence probability, in case of stochastic subsoil modeling

[3] Long term, soil material, is preferred. When lay-out and readability is an issue (i.e. in UI or diagrams) short terms are used.

Term (ENG)	Term (NL)	Definition
(soil) segme	(ondergrond) segment	In the SOSWTI2017 the dikes are divided in segments. Soil segments are line elements (soil areas are polygons).To each segment soil scenarios with possible soil profiles are assigned.
stochastic (soil) scenario	stochastisch (ondergrond) scenario	The soil profile, together with its chance of occurrence, is a scenario.
stochastic variable	stochastische variabele	Stochastic variable is a variable whose value is subject to variations due to chance.
stochastic (as in WTI-SOS 2017)	stochastisch	'Stochastic' means that a certain aspect is variable. These variability is visible in the chances of occurrence of the soil profiles.
subsoil schematization	ondergrond-schematisatie	A schematic reproduction of (a part of) the subsoil for a certain area.
surface line	hoogtegeometrie	See geometry
toe dike inner side	teen dijk binnenwaarts	The intersection point of the surface level at the dike side and the slope of the shoulder at the inner side (if no shoulder: dike)
toe dike outer side	teen dijk buitenwaarts	The intersection point of the slope of the berm at the outer side and the surface level at the outer side
(vertical) yield stress	grensspanning	Vertical yield stress per soil layer

B Non-functional requirements

In following table the non- functional requirements of D-Soil Model are summed up (sorted in alphabetic order in excel). Second column is a remark about how or where the requirement is met.

Description	D-Soil Model	Where or how the requirement is met:
De WTI2017 software dient het toetsproces volledig te ondersteunen	x	workshop
nieuw: de applicaties moeten gebruikt kunnen worden met standaardrechten. Het moet dus niet nodig zijn om de applicatie uit te voeren met administrator rechten	x	acceptatie test rapportage
nieuw: er moet een installatietest inclusief een testdataset worden meegeleverd met de applicatie, zodat technisch beheerders na installatie eenvoudig kunnen controleren of de applicatie werkt.	x	workshop
nieuw: Het technisch ontwerp moet minimaal bevatten: in overleg in te vullen door Deltares en WVL.	x	review
nieuw: in Het functioneel ontwerp moeten minimaal de onderstaande onderwerpenbeschreven zijn. Hierbij is het niet absoluut noodzakelijk dat deze informatie allemaal in het FO zelf staat, maar het moet wel beschikbaar zijn (mag dus eventueel ook in TO of architectuurdocument of zo staan). • Een contextdiagram • Procesbeschrijvingen met uitgeschreven functionaliteit en de relatie met de requirements • Een datamodel met definities, relaties en constraints • Beschrijving van de relatie tussen functionaliteit en data (de gegevensstromen) • Indien van toepassing: beschrijving van rollen, RACI tabel Het FO moet de gerealiseerde situatie beschrijven, dus consistent zijn met de applicatie.	x	review
nieuw: uitkomsten moeten herleidbaar zijn tot de geschematiseerde gegevens, geschematiseerde gegevens moeten herleidbaar zijn tot brongegevens. (dit is een verdere detaillering van eis TOI15)	x	workshop
PSA 5: Vanwege de verantwoordelijkheid van RWS is het aan te bevelen de database met hydraulische randvoorwaarden zodanig te beveiligen dat deze niet door derden aangepast kan worden. Omdat dit in de praktijk lastig is gebleken, is afgesproken om de informatie niet hard te beveiligen, maar een controle in te bouwen om wijzigingen te detecteren.	nvt	
PSA2: Omdat Ringtoets zowel bij RWS als de waterschappen geïnstalleerd moet worden, moet Ringtoets ook onafhankelijk van tools van RWS kunnen functioneren	x	workshop
PSA3: Uitgangspunt bij de applicatiearchitectuur moet zijn dat de software in de productieomgeving geen licentiekosten kent en de implementatie bij RWS (en mogelijk andere organisaties) op basis van Citrix of SCCM moet plaats vinden.	x	zie acceptatie test rapportage, workshop
PSA7: Normatieve referentie: Aquo metadata standaard (www.aquo.nl) De Aquo metadata standaard dient vooral toegepast aan de “buitenkant”; dat wil zeggen dat de interfaces van Ringtoets met de omgeving Aquo-compliant moeten zijn. Wanneer geconstateerd wordt dat metagegeven-items ontbreken binnen Aquo, dan dienen deze bij de beheerder van Aquo, het “InformatieHuis Water”, aangevraagd te worden (www.ihw.nl).	x	datamemo / workshop
PSA8: Zowel de hydraulische randvoorwaarden als de gebiedskennis dienen in een database opgeslagen te worden die voldoet aan de eisen die RWS daaraan stelt. Tevens is het vanwege de licentiekosten aan te raden gebruik te maken van open source software.	x	workshop
R13: Software product wordt getest conform test afspraken (dus inhoudelijke test en acceptatietest). Er is voor elke productie stap een helder testplan, in de testen wordt aangetoond dat de functionaliteit is gerealiseerd	x	testrapportage en acceptatie test rapportage

Description	D-Soil Model	Where or how the requirement is met:
R18: Ringtoets werkt volgens data-afspraken zoals beschreven door cluster datamanagement op het gebied van hydraulische belastingen en sterkte eigenschappen van waterkeringen	x	workshop
R19: Er is een werkende data-aansluiting tussen Ringtoets en D-Soil model en tussen Ringtoets en MorphAn.	x	acceptatie test rapportage
R20: Er zijn een handleiding, testplannen, testrapporten en systeemdocumentatie aanwezig	x	review
R27: Er zijn testplannen, testrapporten en systeemdocumentatie aanwezig.	x	review
R6: Voldoet aan standaard format (toetsschema's, mechanisme beschrijving, schematisatiehandleiding, functioneel ontwerp mechanismemodel).	x	reviews obv afspraken
R7: Sluit aan op andere producten van WTI	x	Generale repetitie
R9: Product is praktisch toepasbaar	x	Generale repetitie
SLA1: Alle nieuw te ontwikkelen applicaties dienen te voldoen aan de architectuureisen en de bouwstenencatalogus van de RWSCIV. Deltares dient zich te allen tijde te verzekeren dat de systemen die men voor Rijkswaterstaat ontwikkelt, passen op de Technisch Doelarchitectuur van Rijkswaterstaat. De applicatiearchitect van RWSCIV OSR WM dient de specificaties en kenmerken van de doelarchitectuur (Bouwstenencatalogus), op verzoek van Deltares beschikbaar te stellen, en nieuw te starten ontwikkelingen in opdracht van de Functioneel Beheerder vooraf te toetsen aan deze doelarchitectuur.	x	workshop
SLA2: Indien nieuwe functionaliteit wijziging vraagt in de technische RWS architectuur wordt dit tijdig (minimaal 6 maanden voor oplevering) door Deltares gesignaleerd bij de functioneel beheerder. Functioneel beheer is verantwoordelijk voor het indienen van het wijzigingsverzoek bij RWSCIV. De RWS CIV realiseert de voorgestelde wijziging. Indien de wijziging onmogelijk is wordt gezamenlijk een alternatieve oplossing gezocht.	x	
SLA3: Datastandaarden. Voor alle nieuwe instrumenten die Deltares ontwikkelt ten behoeve van IenM wordt gestreefd dat deze voldoen aan de Aquo-standaard op koppelvlakken bij datauitwisseling. Voor alle data die IenM aanlevert ten behoeve van werkzaamheden door Deltares wordt gestreefd dat deze voldoen aan de Aquo-standaard op koppelvlakken bij datauitwisseling. Daar waar deze Aquo-standaard van toepassing is, worden de afspraken in de requirements vastgelegd. Bij projecten/werkzaamheden door Deltares of derden in opdracht van Deltares ten behoeve van IenM, waarbij mariene data worden ingewonnen dient te worden gehandeld conform het "Protocol Mariene Data" dat wordt beheerd door het Informatiehuis Marien. Bij deze projecten dienen vooraf afspraken te zijn gemaakt over de inwinning, de opslag, de opwerking, het beheer, en de open data vrijgave van de basisdata. Daar waar dit protocol van toepassing is, worden de afspraken in de requirements vastgelegd. Andere dan de hierboven genoemde standaarden dienen in requirements te worden vastgelegd.	x	workshop
SLA6: Beveiliging Software wordt door Deltares met een adequate beveiliging (autorisatie) opgeleverd. De relevante onderdelen van de Baseline Informatiebeveiliging Rijksdienst BIR 2012 geven invulling aan het voorschrift informatiebeveiliging rijksdienst VIR 2007 en is waar mogelijk van toepassing, per 1-1-2015 nader ingevuld.	x	workshop; zie afspraken met CIV
TOI 3 Het instrumentarium dient als middel om een beeld te genereren van de veiligheid	nvt	
TOI13: De toetsing moet uitvoerbaar zijn voor beheerders en adviesbureau's, en er moet ruimte zijn voor een beheerderoordeel	nvt	in Ringtoets
TOI15: Het dient mogelijk te zijn om de toetsing in afzonderlijke delen (toetssporen, secties, kunstwerken) op te delen ten behoeve van de efficiëntie van de uitvoering van een toetsronde.	nvt	
TOI5: Zorg voor traceerbaarheid en controleerbaarheid. Zorg voor navolgbaarheid, herleidbaarheid en reproduceerbaarheid van uitkomsten. Zorg voor inzichtelijkheid en leesbaarheid / begrijpelijkheid van zowel het STV, de software en de bijbehorende documentatie.	nvt	moet in het proces (door beheerder) geregeld worden

Description	D-Soil Model	Where or how the requirement is met:
TOI6: De consequenties van de eventuele invoering van het nieuwe instrumentarium moeten duidelijk zijn. Het is van belang de resultaten van de nieuwe toetsmethode (TOI) te kunnen vergelijken met de resultaten van de 3e of 4e toetsronde om verschillen en overeenkomsten inzichtelijk te maken	x	Generale repetitie
TOp1: De software moet de Wettelijke verplichte toets op basis van de “omgevingswet” mogelijk maken. Dit is het hoofdproces dat gefaciliteerd moet worden. De software mag tijdens de wettelijk periode inhoudelijk niet veranderen en is tot 1/1/2023 “bevroren”. § deze modellen mogen niet wijzigingen in de toetsperiode	x	Software is onderdeel van het instrument
TOP10: Wens: data van de toetsing moet per beheerder op een unieke plek bewaard worden	x	workshop
Top11: tussen geschematiseerde data in de toetsmodellen en de brondata bij de beheerders (in de legger) moet een relatie blijven bestaan, meta data moet bewaard worden. noodzakelijk voor toetslaag 3 (de geavanceerde toets, waar eigen modellen gebruikt mogen worden. Kwaliteitsborgings eis ligt dan bij de beheerder., noodzakelijk voor andere procesen als ontwerp en beleidsstudies)	nvt	moet in het proces (door beheerder) geregeld worden
TOp3: Er zijn geen licentie rechten voor de gebruiker. Zie dit als “belastingdiskette”, de software horende bij de wet. Licentie rechten voor ontwikkelaar mogen wel (moet expliciet in alle systeemdocumenten vastgelegd zijn). Betrouwbaarheid levering moet worden beschreven.	x	workshop
Top6: Dit toetsproces is uit te voeren door elke waterbeheerder. Dit zijn 23 waterschappen (zie website unie), 6 rijkswaterstaatsregios (zuid, zee-delta, wnzuid, wnnoord, oost, noord, midden). Noot, In werkelijkheid worden alle partijen geassisteerd door de markt (dit is niet vastgelegd in de wet). Elke beheerder voert dit anders uit via inhuur of door het op de markt zetten van specifieke klussen	x	Generale repetitie
TOP7: Software moet uitbreidbaar zijn voor andere processen: ontwerpen (in OI2018), beleidsstudies (vanaf 2017 of 2018?), voor beheer van de rivier (vanaf 2017). Consistentie tussen de software voor de verschillende processen is een eis. Toetsen (deze casus), Ontwerpen (vanaf 2018), tot 2017 is de software van WTI2011 geldig, Beheer en onderhoud waterkeringen, Duiding bij crisis (duiding van de voorspelde data)	x	workshop, bibliotheken
TOP8: Modulaire opbouw is hierbij (top 7) verplicht.	x	workshop, bibliotheken
Top9: Software moet kunnen werken bij Rijkswaterstaat en bij alle beheerders.	x	Generale repetitie
Topuitgangspunten: Het WTI is een instrumentarium waarmee men in alle gevallen tot een oordeel kan komen. Geen oordeel is geen uitkomst van de toets.	x	workshop
Topuitgangspunten: het instrumentarium is consistent over alle faalmechanismen	x	Generale repetitie
U108: De WTI software programma schrijft een format voor de schematisaties die in Ringtoets worden ingelezen. Het format sluit aan bij de Aquo standaard die door het Informatiehuis Water in opdracht van IPO, RWS en Waterschapshuis wordt uitgewerkt en geïmplementeerd in de waterveiligheidssector.	x	datamemo / workshop
U109: Het gebruik van schematisaties uit VNK 2 wordt ondersteund, voor zover dat nuttig is voor de toepassing van het WTI2017 instrument	x	workshop
U123: De WTI Software moet tot een eenduidig en reproduceerbaar resultaat leiden	x	Testscript
U124: De WTI Software moet robuust zijn voor kleine variaties in de invoer.	x	Testscript
U125: Zodra een software component in een van de afzonderlijke lagen wordt gedeeld tussen twee of meer applicaties moet deze component in een bibliotheek worden ondergebracht.	x	workshop, bibliotheken
U126:De componenten in de schil, de UI laag, de IO laag en de onderliggende bibliotheken zijn uitsluitend gebaseerd op C#. De ondersteuning voor deze breed toegepaste taal is optimaal voor MS-Windows systemen, met de mogelijkheid om (via de mono compiler) ook naar Linux te poorten.	x	workshop
U127: De rekenbibliotheken hebben hun entry point in C#, maar zijn mogelijk in Fortran geïmplementeerd (dus niet verplicht). De rekenroutines zijn daardoor eenvoudig vanuit C# aan te roepen en vanuit Fortran zal dit gebeuren met een C++-tussenlaag.	x	workshop

Description	D-Soil Model	Where or how the requirement is met:
U128: De componenten in bibliotheken mogen componenten uit andere bibliotheken aanroepen, zolang dit in een hiërarchische aanroepstructuur gebeurt.	x	workshop, bibliotheken
U129: Alle componenten binnen een bibliotheek moeten foutcodes retourneren met een gestandaardiseerde (nog nader vast te stellen) betekenis of gebruiken excepties om fouten door te geven.	x	workshop
U13: Het WTI 2017 instrumentarium gebruikt de open AQUO standaard, zodat de data die straks voor WTI wordt verzameld herleidbaar is en in andere processen kan worden gebruikt	x	datamemo / workshop
U13: Vanuit alle lopende programma's rondom toetsen, ontwerpen, programmeren verbeterprojecten en actieve zorgplicht wordt gewerkt aan standaard uitwisselingsformaten voor het uitwisselen van informatie. Daarbij wordt conform de open standaard AQUO gewerkt, zodat wordt toegewerkt naar één standaard voor het uitwisselen van gegevens voor alle lopende processen. Ook het WTI 2017 instrumentarium gebruikt de open AQUO standaard zodat de data die straks voor WTI wordt verzameld herleidbaar is en in andere processen kan worden gebruikt.	x	datamemo / workshop
U130: De gebruikte feedback functies (functies die gedetailleerde melding geven van voortgang, waarschuwingen en fouten) moeten een identieke (nog nader vast te stellen) interface hebben voor alle componenten in het raamwerk. De feedbackfuncties worden gedefinieerd in de UI laag, en vervolgens toegankelijk gemaakt aan de software in de andere lagen en in de bibliotheken. Dit betekent dat de visuele verschijningsvorm kan verschillen per applicatie.	x	workshop, Generale Repetitie
U131: Om de bibliotheken te kunnen testen levert elke bibliotheek testsoftware mee in de vorm van unit tests	x	see technische documentation and testcoverage in test report
U132: De IO laag sluit altijd aan op een intern bestand voor opslag van de invoer- en (tussen)resultaten. Voor relatief kleine hoeveelheden data is dit bij voorkeur een XML bestand, met een rechtstreekse binding op de datastructuur van de IO laag. Voor grotere hoeveelheden data ligt een geoptimaliseerde database voor de hand. De IO laag kan eventueel ook meerdere alternatieve bestandsformaten ondersteunen.	x	workshop
U133: De WTI tools worden standaard alleen uitgeleverd met een Nederlandstalige UI en met Nederlandstalige meldingen en rapportages	x	testscript, all
U134: De UI en onderliggende bibliotheken en functies moeten wel zijn voorbereid op later configureerbare meertaligheid, door middel van bestanden. Dit geldt ook voor de feedback functies	x	workshop
U139: Elke applicatie moet de mogelijkheid geven om invoer- en uitvoer ten dele per tabel te exporteren naar - en/of te importeren van - CSV bestanden. Daarnaast kan een invoer in Excel mogelijk zijn	nvt	
U140: Elke applicatie moet de mogelijkheid geven om (ruimtelijke) invoeren uitvoerdata ten dele per tabel te exporteren naar - en/of importeren van - shp bestanden. Dit faciliteert aansluiting op willekeurige en versie-onafhankelijke GIS software	nvt	
U141: De applicaties sluiten waar mogelijk aan op standaard databronnen zoals DINO. Daarin komt naar verwachting steeds meer ondergronddata beschikbaar in het kader van de wet "Basis Registratie Ondergrond" (BRO)	nvt	
U142: Ringtoets maakt gebruik van eenzelfde configureerbare aansluiting op de actuele databases met kerndata van de waterkeringbeheerder als DAM. Dat geldt zowel de gebiedsdata als de ondergronddata. Dit impliceert dat data die klaarstaat voor toetsing ook direct kan worden gebruikt voor andere toepassingen (leggers, beleidsstudies, real time systemen) en omgekeerd. Aangesloten wordt op de Open AQUO standaard.	nvt	
U143: Het is wenselijk dat Ringtoets per doorsnede invoerdata kan exporteren voor een gedetailleerde analyse met de stand-alone WTI tools. Deze invoerdata bevat zowel de gegevens van de waterkering als de hydraulische randvoorwaarden. AQUO standaard geldt ook voor exporteren van gegevens	nvt	

Description	D-Soil Model	Where or how the requirement is met:
U144: De grafische interface moet voor alle applicaties een consistente verschijningsvorm (look and feel) hebben. Dit wordt deels afgedwongen door het gebruik van een gedeelde UI bibliotheek en deels door een (nog nader vast stellen) set van ontwerpafspraken	x	DSL bibliotheek gedeeld
U145: De naamgeving van objecten, parameters, functies moet over alle applicaties heen consistent zijn. Voor dat doel moet gebruik worden gemaakt van een (nog op te stellen) totale verklarende WTI lijst van begrippen en symbolen	x	workshop; toetsen aan parameterlijst
U146: Deltares zal verantwoordelijk zijn voor het technisch beheer van de WTI tools	x	zie SLA
U146: RWS zal verantwoordelijk zijn voor het functioneel beheer van de WTI tools	x	eis aan RWS
U147: Toepassing van WTI applicaties en onderliggende bibliotheken moet voor de gebruiker altijd vrij zijn van licentie-kosten	x	workshop
U148: Beheer, beschikbaarstelling, onderhoud en ondersteuning van de WTI software door Deltares vindt plaats binnen de randvoorwaarden van de bestaande SLA tussen Deltares en de Waterdienst. WTI tools zijn in principe open source, sommige bibliotheken kunnen aangekocht zijn. Dit maakt ontwikkeling door universiteiten en bedrijven mogelijk. De moederversie zit altijd op slot en is beleidsmatig bepaald, deze is beheerd door Deltares	x	zie SLA
U149: Voor de ontwikkeling en beheer van de WTI tools is een ontwikkelprocedure uitgewerkt. De ontwikkeling en het beheer van de software zal volgens deze ontwikkelprocedure worden uitgevoerd. Ook de richtlijnen in de ontwikkelprocedure m.b.t. documentatie zal gevolgd worden	x	workshop
U150: Deltares is verantwoordelijk voor het beheer en onderhoud van alle VTV-tools en de bijbehorende documentatie. Derde partijen kunnen eventueel software-onderdelen en/of documentatie ontwikkelen. Deltares blijft echter leidend in de technische architectuur en het ontwikkelproces.	x	zie SLA
U151: Het uitbrengen van nieuwe productversies voor WTI software en onderliggende databases vindt in principe alleen plaats aan de start van nieuwe toetsronden. De levensduur van een productversie is dus minimaal de duur van een toetsronde. Tijdens de levensduur zal het echter wel noodzakelijk zijn om de onderliggende componenten te upgraden. Het zal bijvoorbeeld noodzakelijk zijn om tijdig te upgraden naar een hogere NET versie. Na een dergelijke upgrade zal om aan 1209429-001-GEO-0011, 17 oktober 2014, definitief Uitgangspunten WTI 2017 49 te tonen dat de software nog naar behoren werkt een acceptatietest worden uitgevoerd waarmee aangetoond wordt dat de werking en met de name de rekenresultaten van de software nog hetzelfde zijn als voor de upgrade	x	Is procesafspraak
U152: Het versiebeheersysteem wordt standaard gebruikt voor zowel de code, als ook de bijbehorende testen, systeemdocumentatie en gebruikersdocumentatie.	x	workshop
U153: Binnen het versiebeheersysteem bestaat per bibliotheek en per applicatie naast de productversie ook een ontwikkelversie, voor zowel de software als voor de bijbehorende systeemdocumentatie. In de productversie worden alleen foutverbeteringen aangebracht. In de ontwikkelversie (met vertakkingen voor los te testen deelontwikkelingen) wordt aangepaste of nieuwe functionaliteit of aanpassing op nieuwe technologie ingebracht. Geschikt gebleken modellen en methoden worden uiteindelijk opgenomen in de productversie voor de volgende toetsronde	x	workshop
U154: Het tijdens een toetsronde uitbrengen van eventueel noodzakelijke updates van productversies (software en/of databases) vindt plaats onder verantwoordelijkheid en regie van Rijkswaterstaat. Alle geregistreerde gebruikers moeten hier van in kennis worden gesteld. De release notes bij updates moeten duidelijk aangegeven wanneer en onder welke omstandigheden een update leidt tot andere toetsresultaten	x	release notes onderdeel van oplevering
U155: Deltares zal verantwoordelijk zijn voor het maken van de patches. RWS zal echter aangegeven wat de inhoud van de patches dient te zijn en zal tevens aangeven wat de prioriteit is van de patches	x	workshop

Description	D-Soil Model	Where or how the requirement is met:
U156: Het moet voor elke WTI applicatie mogelijk zijn om deze naar keuze lokaal op MS-Windows systemen te installeren, of op een MS-Windows netwerk server	x	zie acceptatie test
U157: Op het installatieplatform moet verder ook een DOTNET omgeving versie 4 of hoger geïnstalleerd zijn	nvt	eis aan omgeving
U158: Voor elke WTI applicatie moet worden aangetoond dat de netwerkinstallatie ook werkt binnen een Citrix omgeving	x	zie acceptatie test
U159: Het moet voor elke WTI applicatie mogelijk zijn om geïnstalleerd te worden door een deskundige eindgebruiker	x	acceptatie test rapportage, Generale repetitie
U160: De Helpdesk Water organiseert primair de 1e lijns gebruikersondersteuning voor de WTI applicaties. Deltares biedt alleen 2e lijns ondersteuning, op verzoek van de Helpdesk Water	x	eis aan omgeving
U2: Toetsen met WTI2017 is verplicht	x	eis aan omgeving
U25: Bouwstenen uit het basisinstrumentarium zijn generiek en kunnen in principe ook in andere beleids- en beheersprocessen worden gebruikt. Ook kunnen onderdelen worden gebruikt voor het toetsen van regionale en d keringen.	x	workshop
U28: Het platform voor toetsen kent (tenminste) 2 gebruikersmodi: een basismodus (formeel onderdeel) die gebruikt wordt voor het uitvoeren van de toetsing en een testmodus die gebruikt wordt voor de ontwikkeling van het instrumentarium en in een later stadium door specialisten voor geavanceerde analyses kan worden gebruikt in een toets op maat	x	workshop
U30: De verwachte voorkennis voor verantwoord gebruik van toetsinstrumentarium en voor het begrijpen van de bijbehorende documentatie is een HBO+ opleiding in de waterbouw en/of geotechniek, aangevuld met een specifieke applicatie cursus	x	Generale repetitie
U31: Van gebruiker wordt 5 jaar relevante werkervaring verwacht rondom toetsen ontwerpen en beheren van de verzameling dijken & kunstwerken of duinen & hybride keringen	x	Generale repetitie
U46: Bouwstenen moeten vervangbaar kunnen zijn (nieuwe inzichten, nieuwe kennis, kwalitatief betere versie)	x	workshop; bibliotheken
U70: Er dienen voor gedetaileerde toetsen schematiseringshandleidingen te zijn	x	zie helpdesk water
uitgangspunten par 2.3 en 3.2: Het basisinstrumentarium wordt modulair opgebouwd.	x	workshop; bibliotheken
uitgangspunten par 8.2: De gedeelde componenten binnen verschillende dijksterkte applicaties moeten worden opgenomen in bibliotheken. Het opzetten en gebruiken van deze bibliotheken reduceert de onderhoudsinspanning voor elk van de applicaties. Bovendien komen verbeteringen in de bibliotheken voor alle applicaties ter beschikking.	x	workshop; bibliotheken

C Input files

In this appendix the files which can be imported are described.
The names of the files are user defined; via the import menu an user can select the file.
The names of columns in these files are not case-sensitive.
All data, except cpt and boring, can be edited in D-Soil base.

C.1 Materials

There is only one MSoilbase-file: <filename>.mdb. This material database can be edited with MSoilbase.exe. It contains the materials and their parameters.
Materials from existing profiles will be imported with the profile import;

- 1D profiles: material names
- 2D profiles: material names and (deterministic) material parameters

Materials and the parameters can also be edited in D-Soil Model.

C.2 2D profiles

D-Geo Stability files, *.sti / *.geo, can be imported in D-Soil Model when it is generated with D-Geo Stability 16.1.2.1.
*.geo contains the geometry.
*.sti contains the geometry and soil parameters.

C.3 1D profiles

The soilprofile file is a table in csv format with the following columns.

Column name	Type	Unit	Required	Description
soilprofile_id[1]	StringId	-	yes	Name of Soil Profile
soil_name[1]	StringId	-	yes	Reference to soil (in soilmaterials.mdb).
soil_color[2]	StringId	-	no	Color used in the cross section. Bisque is default or in case of typo.[3]
soil_type[2]	StringId	-	no	This column is obsolete. This parameter has to be set in the soil database, but even then it is not used anymore to define aquifer layers. There is now a new parameter “IsAquifer” to define aquifers. Possible options: - Clay - Loam - Gravel - Peat - Sand (default or in case of typo)
top_level[1]	Float	m	yes	Level of top of layer.
max-d	Float	m	no	Optional SOS parameter holding the maximum value for the top of the layer.
min-d	Float	m	no	Optional SOS parameter holding the minimum value for the top of the

Column name	Type	Unit	Required	Description
				layer.
remark	StringId	-	no	Optional SOS parameter to be used for remarks on max-d and min-d or other specifics for the layer.

[1]When importing a csv file with missing or incorrect headers for these required data, the file is not imported and a message is given “Een of meer kolomnamen onbekend – <column name>”

[2]When importing a csv file with missing or incorrect headers for these required data (example: soiltype instead of soil_type) a message is given:” Een of meer kolomnamen onbekend – <column name>”. And the column is filled with the default values (Zand for soil_type and Bisque for soil_color)

[3] Possible colors:

AliceBlue	DarkOliveGreen	Indigo	MediumPurple	Purple
AntiqueWhite	DarkOrange	Ivory	MediumSeaGreen	Red
Aqua	DarkOrchid	Khaki	MediumSlateBlue	RosyBrown
Aquamarine	DarkRed	Lavender	MediumSpringGreen	RoyalBlue
Azure	DarkSalmon	LavenderBlush	MediumTurquoise	SaddleBrown
Beige	DarkSeaGreen	LawnGreen	MediumVioletRed	Salmon
Bisque (default)	DarkSlateBlue	LemonChiffon	MidnightBlue	SandyBrown
Black	DarkSlateGray	LightBlue	MintCream	SeaGreen
BlanchedAlmond	DarkTurquoise	LightCoral	MistyRose	SeaShell
Blue	DarkViolet	LightCyan	Moccasin	Sienna
BlueViolet	DeepPink	LightGoldenrodYellow	NavajoWhite	Silver
Brown	DeepSkyBlue	LightGreen	Navy	SkyBlue
BurlyWood	DimGray	LightGray	OldLace	SlateBlue
CadetBlue	DodgerBlue	LightPink	Olive	SlateGray
Chartreuse	Firebrick	LightSalmon	OliveDrab	Snow
Chocolate	FloralWhite	LightSeaGreen	Orange	SpringGreen
Coral	ForestGreen	LightSkyBlue	OrangeRed	SteelBlue
CornflowerBlue	Fuchsia	LightSlateGray	Orchid	Tan
Cornsilk	Gainsboro	LightSteelBlue	PaleGoldenrod	Teal
Crimson	GhostWhite	LightYellow	PaleGreen	Thistle
Cyan	Gold	Lime	PaleTurquoise	Tomato
DarkBlue	Goldenrod	LimeGreen	PaleVioletRed	Turquoise
DarkCyan	Gray	Linen	PapayaWhip	Violet
DarkGoldenrod	Green	Magenta	PeachPuff	Wheat
DarkGray	GreenYellow	Maroon	Peru	White
DarkGreen	Honeydew	MediumAquamarine	Pink	WhiteSmoke
DarkKhaki	HotPink	MediumBlue	Plum	Yellow
DarkMagenta	IndianRed	MediumOrchid	PowderBlue	YellowG

The soil_name, soil_type and soil_color are placed in the material table in D-Soil Model.
Of the combination of these three are not consequent, the first combination is presented in D-Soil Model.
Example:

soilprofile_id	top_level	soil_name	soil_type	soil_color

Segment_36006_1D1	3	H_Ro_z&k	Clay	Chocolate
Segment_36006_1D1	2.25	H_Rg_zg	Clay	Gold
Segment_36006_1D1	-3.5	H_Ro_z&k	Sand	Chocolate
Segment_36006_1D1	-4.5	*P_Rg_zm*	*Sand*	*PaleGreen*
Segment_36006_1D1	-13	P_Ova_sd	Sand	Peru
Segment_36006_1D1	-17	*P_Rg_zm*	*Sand*	*Peru*
Segment_36006_1D1	-25	P_Rg_zg	Sand	Linen

H_Ro_z&k will be presented as 'Clay'.
P_Rg_zm will be presented as 'PaleGreen'

C.4 Segments

The segments consists of two files; a *.csv and a *.shape file.

*.csv file:

Name	Type	Unit	Required	Description
segment_id	StringId	-	Yes	Name of segment
soilprofile_id	StringId	-	No	Reference to 1D-Soil profile
probability	Float	%	yes	Chance of occurrence of profile (value between 0.0 and 100.0)
calculation_type	StringId	-	yes	- Piping - Stability

*.shape file:
The table view of the WTI-SOS shape file presents a dijkring number, the length of the segment, a segment id and a unique segment number (=segment_id from csv file):

DIJKRNR1	LENGTH	Segment	Segmentnr
9	3352.3996	17	9017
9	4663.8887	11	9011
9	4824.1161	1	9001
9	3842.2141	2	9002
9	4120.1497	3	9003
9	3394.6365	4	9004

Any other shape file can be imported as segment shape file, as long as one column contains segment_id which are matching with the segment_id from the segment csv file.
The name of the column is free; mapping of the segment_id is done in a dialogue box during import.

C.5 Surface line and characteristic points

A specification of a surface line and corresponding characteristic points are used to create 2D profiles from 1D profiles or adjust 2D profiles with a new surface line.

Surface line

The surface line file is a csv-file containing an ID of the location in the first column, in the following columns the X- and Y coordinates (in RD-coordinates) and the Z value (height in m NAP). The coordinates have to be consecutive in a line.

Example:

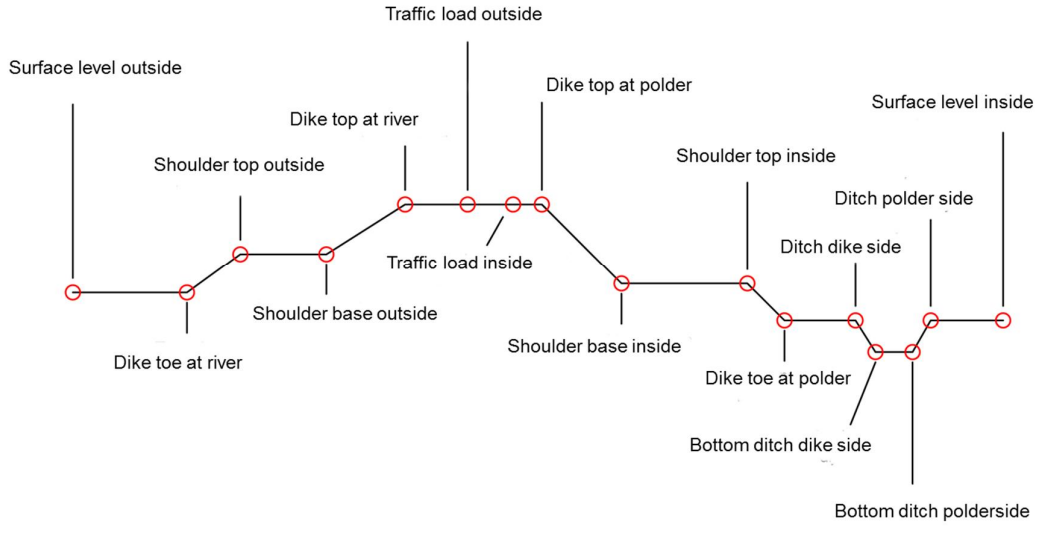
LOCATIONID	X1	Y1	Z1	Xn	Yn	Zn				
AD640M00	160146	424333.5	6.763	160145.8	424332.6	7.082	160145.6	424331.6	7.492	etc
AD642M50	159891.6	424372.9	6.319	159891.5	424371.9	6.328	159891.4	424370.9	6.333	etc
AD645M00	159641.7	424402.4	6.128	159641.6	424401.4	6.17	159641.5	424400.4	6.183	etc
AD647M30	159374	424357.3	0.841	159374.1	424356.3	1.11	159374.2	424355.3	1.165	etc
Enz.										

Name	Type	Unit	Required	Description
Profile name	StringId	-	yes	Name of surface line
X1	Float	m	yes	X coordinate 1-st point
Y1	Float	m	yes	Y coordinate 1-st point
Z1	Float	m	yes	Z coordinate 1-st point
.....				
Xn	Float	m	yes	X coordinate n-th point
Yn	Float	m	yes	Y coordinate n-th point
Zn	Float	m	yes	Z coordinate n-th point

Characteristic points

Characteristic points are certain points on the surface line which enables to combine surface lines and are used for the waternet creator of the stability kernel.

The characteristic points file is a csv-file containing an ID of the location in the first column, in the following columns the X- and Y coordinates (in RD-coordinates) and the Z value (height in m NAP) of the characteristic points. For combining the surface line with the corresponding characteristic points the locationID (Key id) in both files must be equal.



Example:

LOCATIONID	X_Maaiveld binnenwaarts	Y_Maaiveld binnenwaarts	Z_Maaiveld binnenwaarts	X_Insteek sloot polderzijde	Y_Insteek sloot polderzijde	Z_Insteek sloot polderzijde	X_Slootbodem polderzijde	Y_Slootbodem polderzijde	Z_Slootbodem polderzijde	Enz.
AD720M00	153999.5	422183.9	3.588	153938.1	422198.1	3.462	153935.2	422198.8	2.769	
AD722M50	153945.8	421957.2	3.33	153881.9	421961	3.204	153878.9	421961.1	2.633	
AD724M90	153887.2	421695.5	2.77	153828.9	421710	2.878	153828	421710.2	2.832	
AD727M50	153816.8	421456.3	2.75	153763.3	421469.4	2.759	153759.5	421470.4	2.332	
AD730M00	153755.5	421213.4	3.101	153710	421224.8	2.787	153709	421225.1	2.75	

Enz.

The sequence of the columns is fixed.

Name	Type	Unit	Required	Description
Profile name	StringId	-	yes	Reference to surface line (in surfacelines.csv)
X_Maaiveld buitenwaarts	Float	m	yes	Coordinates of surface level outside
Y_Maaiveld buitenwaarts	Float	m	yes	
Z_Maaiveld buitenwaarts	Float	m NAP	yes	
X_Teen dijk buitenwaarts	Float	m	Yes	Coordinates of dike toe at river
Y_Teen dijk buitenwaarts	Float	m	Yes	
Z_Teen dijk buitenwaarts	Float	m NAP	Yes	
X_Kruin buitenberm	Float	m	no[4]	Coordinates of shoulder top outside
Y_Kruin buitenberm	Float	m	no	
Z_Kruin buitenberm	Float	m NAP	no	
X_Insteek buitenberm	Float	m	no	Coordinates of shoulder base outside
Y_Insteek buitenberm	Float	m	no	
Z_Insteek buitenberm	Float	m NAP	no	
X_Kruin buitentalud	Float	m	yes	Coordinates of dike top at river
Y_Kruin buitentalud	Float	m	yes	
Z_Kruin buitentalud	Float	m NAP	yes	
X_Verkeersbelasting kant buitenwaarts	Float	m	no	Coordinates of traffic load outside
Y_Verkeersbelasting kant buitenwaarts	Float	m	no	
Z_Verkeersbelasting kant buitenwaarts	Float	m NAP	no	
X_Verkeersbelasting kant binnenwaarts	Float	m	no	Coordinates of traffic load inside
Y_Verkeersbelasting kant binnenwaarts	Float	m	no	
Z_Verkeersbelasting kant	Float	m NAP	no	

[4] • *When a characteristic item is absent at one location, but present in others, the value of -1 is given for X,Y en Z. Absence is possible for sloot (ditch), berm and verkeersbelasting (traffic load).*

Name	Type	Unit	Required	Description
binnenwaarts				
X_Kruin binnentalud	Float	m	yes	Coordinates of dike top at polder
Y_Kruin binnentalud	Float	m	yes	
Z_Kruin binnentalud	Float	m NAP	yes	
X_Insteek binnenberm	Float	m	no	Coordinates of shoulder base inside
Y_Insteek binnenberm	Float	m	no	
Z_Insteek binnenberm	Float	m NAP	no	
X_Kruin binnenberm	Float	m	no	Coordinates of shoulder top inside
Y_Kruin binnenberm	Float	m	no	
Z_Kruin binnenberm	Float	m NAP	no	
X_Teen dijk binnenwaarts	Float	m	yes	Coordinates of dike toe at polder
Y_Teen dijk binnenwaarts	Float	m	yes	
Z_Teen dijk binnenwaarts	Float	m NAP	yes	
X_Insteek sloot dijkzijde	Float	m	no	Coordinates of ditch dike side
Y_Insteek_sloot dijkzijde	Float	m	no	
Z_Insteek sloot dijkzijde	Float	m NAP	no	
X_Slootbodem dijkzijde	Float	m	no	Coordinates of bottom ditch dike side
Y_Slootbodem dijkzijde	Float	m	no	
Z_Slootbodem dijkzijde	Float	m NAP	no	
X_Slootbodem polderzijde	Float	m	no	Coordinates of bottom
Y_Slootbodem polderzijde	Float	m	no	
Z_Slootbodem polderzijde	Float	m NAP	no	
X_Insteek sloot polderzijde	Float	m	no	Coordinates of ditch polder side
Y_Insteek sloot polderzijde	Float	m	no	
Z_Insteek sloot polderzijde	Float	m NAP	no	
X_Maaiveld binnenwaarts	Float	m	yes	Coordinates of surface level inside
Y_Maaiveld binnenwaarts	Float	m	yes	
Z_Maaiveld binnenwaarts	Float	m NAP	yes	

C.6 GEF files

*.GEF files can be imported when file is conform CUR reports [8 for borings] [9 for cpt] and vertical reference is in m NAP (#ZID: 31000=NAP).
Only *.GEF files with X, Y-coordinates in Rijks Driehoekstelsel (#XYID: 31000=RD) can be plotted on the map.

C.7 Shapefiles

Any other geo-referred data can be imported to be shown in the map window. Only requirement is the used coordinate system: Rijks Driehoekstelsel (RDnew).

Soil parameters

In following tables the material parameters are arranged per failure mechanism; Macrostabiliteit, Piping and Zettingsvloeiing. The filt
show the parameters of all three failuremechanisms.
Explanation of columns:

WTI-ID	Id in parameterlist [10]
Determinist/stochast	A number of parameters can be entered as determinist and as stochast. When parameter is stochast t extra column, starting with (S). The columns are not connected to each other via calculations.
Default value	Default values in D-Soil Model are mostly NaN; Not a number. Default value of stochasts: lognormal d with 'Gemiddelde' and 'Afwijking': NaN
Min. value	Kernels can demand minimum and maximum values. Since D-Soil Model can provide data for several k minimum and maximum values in D-Soil Model are the outer boundaries of the kernel values.
Max. value	see Min. value.

Soil parameters for filter Macrostabiliteit:

WTI-ID (STBI-..)	**Parameter**	**Display unit**	**Description**	**Name in D-Soil Model**	**Determinist /stochast**	**Default value /distribution / variation**	**Min. value**
n.a.	n.a.	n.a.	Soilname	Naam	n.a.	Undetermined	n.a.
n.a.	n.a.	ARGB-code	Color	Kleur	n.a.	White	n.a.
n.a.	n.a.	n.a.	Type	Grondtype	n.a.	Sand	n.a.
n.a.	n.a.	n.a.	Description	Beschrijving	n.a.	empty	n.a.
M04	γ_{unsat}	[kN/m^3]	Unit weight of soil above phreatic level	Onverzadigd gewicht	D/S	NaN/logn/0	0.001

WTI-ID (STBI-..)	**Parameter**	**Display unit**	**Description**	**Name in D-Soil Model**	**Determinist /stochast**	**Default value /distribution / variation**	**Min. value**
M03	γ_{sat}	[kN/m^3]	Unit weight of soil below phreatic level	Verzadigd gewicht	D/S	NaN/logn/0	0.001
n.a.	Shear strength model	n.a.	Shear strength model (choice between **C-Phi and Su-calculated**)	Schuifsterkte model	D/S	C-Phi	n.a.
M05	*c'*	[kN/m^2]	Cohesion	Cohesie	D/S	NaN/logn/0	0
M06	φ'	[˚]	Friction angle of shearing resistance	Wrijvingshoek	D/S	NaN/logn/0	0
M14	*S*	[-]	Undrained shear strength ratio (normally consolidated)	Schuifsterkte ratio	D/S	NaN/logn/0	0
M15	*m*	[-]	Strength increase exponent	Sterkte toename exp	D/S	NaN/logn/0	0
n.a.	*Use POP*	n.a.	Checkbox to chose between POP and yield stress. 'Use POP' = TRUE: POP editable. 'Use POP' = FALSE : POP non-editable (=default).	Gebruik POP	n.a.	FALSE	n.a.
n.a.	*POP*	[kN/m^2]	Pre overburden pressure	POP	D/S	NaN/logn/0	0

Materialparameters for Piping:

WTI-ID (STPH-..)	**Parameter**	**Display Unit**	**Description**	**Name in D-Soil Model**	**Determinist/ stochast**	**Default value /distribution / variation**	**Minimum value**
n.a.	n.a.	n.a.	Soilname	Naam	n.a.	Undetermined	n.a.
n.a.	n.a.	ARGB-code	Color	Kleur	n.a.	White	n.a.
n.a.	n.a.	n.a.	Type	Grondtype	n.a.	Sand	n.a.
n.a.	n.a.	n.a.	Description	Beschrijving	n.a.	empty	n.a.
M07	PipingLayer.AbovePhreaticLevel	[kN/m^3]	Unit weight above phreatic level	Onverzadigd gewicht	D/S	NaN/logn/0	0
M08	PipingLayer.BelowPhreaticLevel	[kN/m^3]	Unit weight below phreatic level	Verzadigd gewicht	D/S	NaN/logn/0	0
M13	D70	[µm]	70% fractile of the aquifers grain size distribution	D70	D/S	NaN/logn/0	1E-8
M15	DarcyPermeability	[m/s]	Permeability (Darcy)	Doorlatend-heid	D/S	NaN/logn/0	0

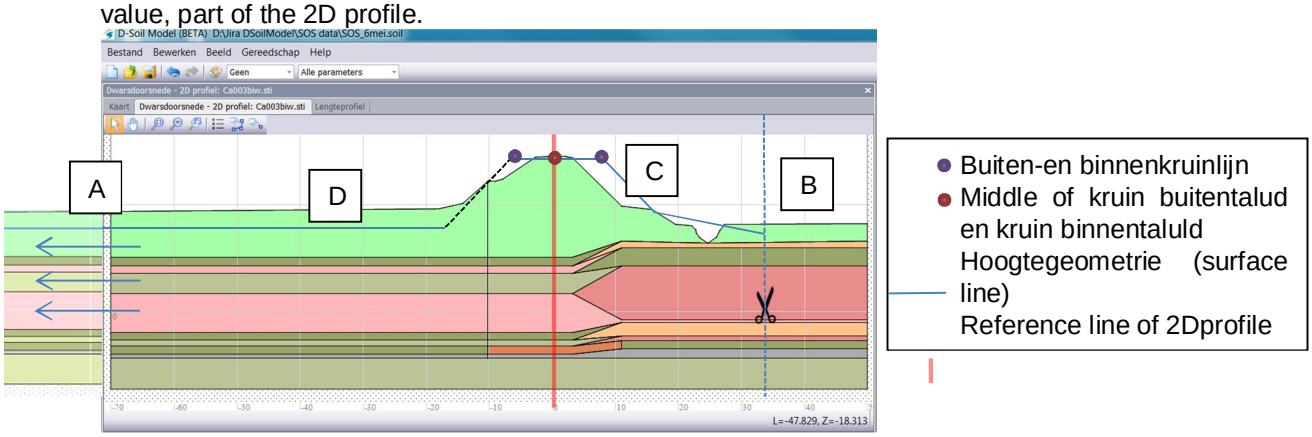
Soil parameters for Zettingsvloeiing:

WTI-ID (zettings-vloeiing-..)	**Parameter**	**Display unit**	**Description**	**Name in D-Soil Model**	**Determinist/stochast**	**Default value**	**Minimum value**	**Maximum value**
n.a.	n.a.	n.a.	Soilname	Naam	n.a.	Undetermined	n.a.	n.a.
n.a.	n.a.	ARGB-code	Color	Kleur	n.a.	White	n.a.	n.a.
n.a.	*Soil type*	n.a.	Type	Grondtype	n.a.	Sand	n.a.	n.a.
n.a.	n.a.	n.a.	Description	Beschrijving	n.a.	NaN	n.a.	n.a.
	s_2	[-]	Value of s at maximum contraction	s2	D	NaN	1.1	1.4
M09	*D15*	[µm]	Fine grain size	D15	D	NaN	30	2000
M08	*D50*	[µm]	Median grain size	D50	D	NaN	30	2000
	φ'	[°]	Friction angle of shearing resistance	Wrijvingshoek	D	NaN	0	89
	n	[-]	Porosity	Porositeit	D	NaN	0.3	0.6
	n_{min}	[-]	Minimum porosity	Min. porositeit	D	NaN	0.3	0.6
	n_{max}	[-]	Maximum porosity	Max. porositeit	D	NaN	0.3	0.6
	$\varepsilon_{vol;dm0}$	[-]	Value of Eps $_{vol;dm}$ at mean effective stress p_0	Epsvoldm0	D	NaN	0.0003	0.03
	K_{s0}	[kN/m^2]	Value of Ks at average stress p0'	Ks0	D	NaN	10000	140000
	γ_{sand}	[kN/m^3]	Unit weight of grains	Gamma korrel	D	NaN	20	30
	m	[-]	Parameter describing f(s), defined in equation: f(s) = A s^m – B s^r / (s_{max} – s)	m	D	NaN	1.5	3

WTI-ID (zettings-vloeiing-..)	Parameter	Display unit	Description	Name in D-Soil Model	Determinist/stochast	Default value	Minimum value	Maximum value
	u	[-]	Parameter describing the influence of p' on Ks defined in equation: Ks = Ks0 (p' / p0')^{u}	u	D	NaN	0.5	1.5
	v	[-]	Parameter describing the influence of p'$_{CON}$ on ε_{voldm}, defined in equation: $\varepsilon_{vol;dm} = \varepsilon vol;dm0\ (p_{CON}' / p0')^{v}$	v	D	NaN	0.5	1.5
	r	[-]	Parameter describing f(s), defined in equation: f(s) = A s^{m} – B s^{r} / (s_{max} – s)	r	D	NaN	7	7

E Combination of surface line and 2D profile

The combination of a surface line and a 2D profile is possible by adding a reference line to the 2D profile. This reference line and the middle of the characteristic points 'kruin buitentalud' and 'kruin binnentalud' are mapped upon each other. The reference line is a x-value, part of the 2D profile.



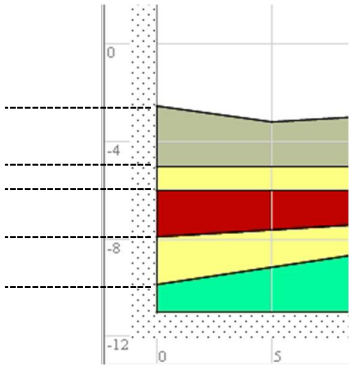
Combination of surface line and 2D profile

The combination follows the rules:

- Middle between 'kruin buitentalud' en 'kruin binnentaluld' at the surface line is mapped on the reference line of the 2D profile (x-values are equal);
- When the surface line is longer than the 2D profile (situation A in figure); the 2D profile is enlarged to boundary of surface line.
- When the surface line is smaller than the 2D profile (situation B in figure); the 2D profile is cut off to boundary of surface line.
- When surface line is heigher than 2D profile (situation C in figure); the 'space' between surface line and 2D profile is filled with 'opvulmateriaal', to be defined by user.
- when surface line is lower than 2D profile (situation D in figure); this area of the 2D profile is removed.

Extra rule for situation A:

- When 2D profile contains non-horizontal layer boundaries, the Z-value at the boundary is maintained:



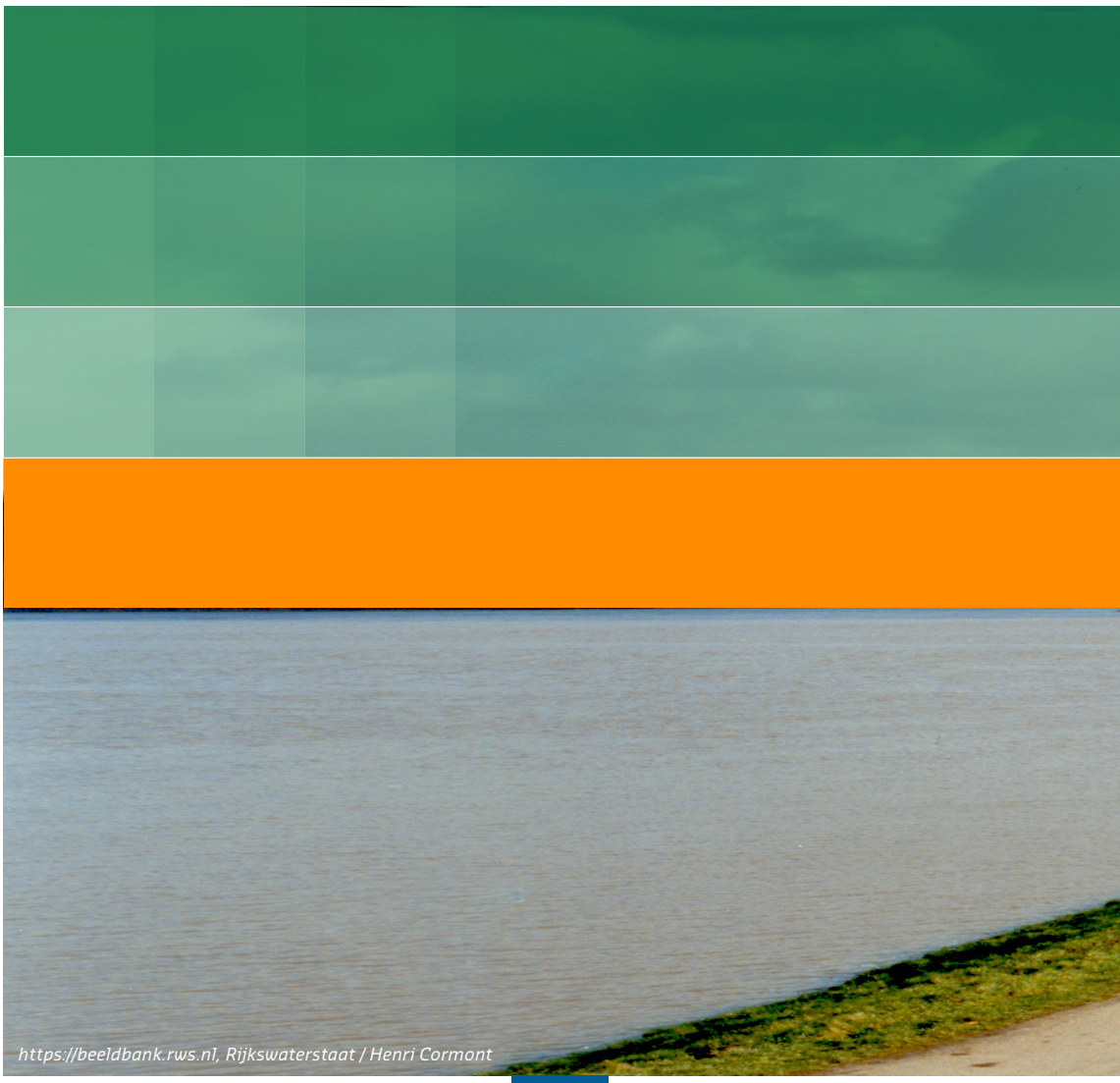
F Description functional requirements

Eis ID	*Eis omschrijving*
REQ 3	Format of import data.
REQ 3.1	Format of import data. The required import files are: geo-file, sti file and mdb file from D-GeoStability; for subsoil schematizations (2D profiles) and strength parameters. • csv files; description of the segments and 1Dsoil profiles. shape files; location of segments, 2D) profiles, CPT's, borings.
REQ 3.2	REQ 3.2 Import and view all SOS data. The user must be able to get an overview of all available SOS subsoil schematizations. A user must be able to import all SOS segments and browse through them. The user must get a good visual overview of all available scenarios of soil profiles.
REQ 3.3	Select relevant SOS information for project. Only the relevant part of the SOS database needs to be read. The user defines the relevant area, a reference line, or the user specifies the segments from a list. Only the SOS data relevant data is imported into the O-Soil Model project.
REQ 3.4	Import relevant reference data. Also data which is not passed through to Ringtoets should be showed in order to make good subsoil schematizations. The following items need to be shown in a relevant window: Surface lines, Characteristic points, Outside water level, PL lines, Polder water level. Note: A surface line with characteristic points and the actual polder water level can be imported and placed above a relevant 20 cross section. Surface lines will be combined with all possible subsoil scenarios in Ringtoets. They will not be available as a separate object in O-Soil Model. Also, the outer water level and other PL lines can be viewed for reference in the cross sections of the 20 profile.
REQ 4(.1)	All existing M-SoilBase functionality must be present in D-Soil Model
REQ 5	The application gathers the (stochastic) subsoil schematizations input and parameters for the following kernels: • WTI macro stability kernel, WTI piping kernel, WTI flow slide kernel. D-Soil Model can save this output into one file.
REQ 5.1	In order to supply the kernels with the right input, the application supports the schematisation, storage and management of the subsoil schematisation for the failure mechanism macrostability. A subsoil schematisationf or a macrostability mechanism consists of: One or more soil segments (polylines). Per soil segment per mechanism one (stochastic)soil profile schematisation. Per (stochastic) soil profile schematisation one or more 1D and/or 2D soil profiles scenarios with a probability of appearance and profile properties (e.g. preconsolidationpressure) if applicable. Per 1D or 2D soil profile scenario one or more soil layers with layer properties (e.g. aquifer yes/no) if applicable. • Per soil layer one soil material with soil material properties. • Surface line profiles related to the soil segment, if applicable . All inputs are defined in the technical design document of the macrosstability kernel.
REQ 5.2	Supply the subsoil schematization and –parameters for the WTI piping kernel. A subsoil schematization for piping consists of the same type of dataset as the data for the macro stability kernel. Within a segment, each surface line must be combined with all available stochastic subsoil scenarios to form all piping input scenarios. All piping inputs are defined in the technical design document of the piping kernel. [6].
REQ 5.3	Supply the subsoil schematization and -parameters for the WTI flow slide kernel. A subsoil schematization for flow slide consists of the same type of dataset as the data for the macro stability kernel. Within a segment, each surface line must be combined with all available stochastic subsoil scenarios to form all flow slide input scenarios. All flow slide inputs are defined in the technical design document of the flow slide kernel. [7].
REQ 5.4	Each kernel has a list of variables defined in its own technical design [5, 6 and 7]. Each of these variables that have to do with subsoil information must be provided by D-Soil Model. In addition of these mechanism related variables, all general soil related properties need to be stored as well [8].
REQ 6	For each failure mechanism the subsoil is described in soil seqrnents" consisting of one of more scenario(s) of a soil profile" with a probability of appearance. These soil profiles are described in either 10 or 20 layer schematization. A soil segment can have a combination of 10 and 20 soil profiles. Each layer is described with at least all the parameters needed for the relevant failure mechanism. This output is gathered in one file, which can be directly imported in Ringtoets.
REQ 6.1	Stochastic characterization of the variables. A stochastic variable has a distribution. All stochastic variables can be stored as a mean value with a distribution.
REQ 6.2	Automatically derive the stochastic parameters from a set lab data (e.g.field or labdata) for a given distribution. For example the mean and standard deviation for a lognormal distribution fo ra given set labdata.
REQ 6.3	Separate segments for each failure mechanism. The SOS segment boundaries can be different, depending upon the failure mechanism. Each mechanism has its own segment boundaries.

Eis ID	*Eis omschrijving*
REQ 6.4	Definition of the location of the 1D profile for Piping and DFlowSlide. 2D profiles exist for piping and flow slide analyses. The current kernels can only handle 1D schematizations. The D-Soil Model user must be able to define the location of the 1D profile per 2D profile per mechanism.
REQ 6.5	The application must support profile properties. Profile properties are information which is related and can be allocated to a soil profile. Thus far, the yield stress (Pre-consolidation stress) is the only profile property being used.
REQ 6.6	The application must support layer properties. Layer properties are information which is related and can be allocated to a soil layer. Thus far, the "is aquifer" property is the only available layer property. In future, leak agelength sor dampingfactors may also be transferred to layer properties.
REQ 7	Stochastic schematization of subsoil. All the parameters of above described schematization can consist of stochastic variables or "as is" value (characteristic value or design value). All stochastic variables can be stored as a mean value with distribution parameters and the distribution type.
REQ 7.1	Stochastic subsoil modelling consists of soil segments (lines), each with soilprofiles with a probability of appearance. Per failure mechanism the segments are defined. This stochastic subsoil modelling is presented in D-Soil Model.
REQ 7.2	Allocation of CPT's and boreholes on a map and to a segment. Imported CPT's and borings are shown on a map and can be matched to a segment. The application must support the allocation of soil profile scenarios to a soil segment. A soil profile scenario consists of a 1D or 2D soil profile with a probability of appearance.
REQ 7.3	Overview of all available borings and CPT's in a segment/crosssection. All available ground investigation information in a section can be scrolled through and preferably dragged/dropped into a SOS scenario for viewing purposes.
REQ 7.4	Overview of all available SOS scenario's in a segment. All available SOS scenarios per segment per mechanism must be presented. Preferably, available CPT's and borings can be matched with one SOS scenario.
REQ 8	View the building blocks of the subsoil schematization
REQ 8.1	A reference line can be imported form a GIS. This reference line can, for example, be used for the projection of soil investigation in longitudinal direction or to import SOS data in a relevant section.
REQ 8.2	Table view for soil parameters The application must support the several views to show (parts of) the subsoil schematisation. Table view to show all the information in a tabular format. The soil materials properties will only be shown in table view (not in graphical views). Property view to show details (information)of the selected object and if applicable the relation with other information(objects).
REQ 8.3	Map view for soi areas The application will support in map view the division of the soil areas (polygons) in which the soil profile scenarios can be allocated to. Graphical map view (in RD) with a detailed topographic map in the background to refer the spatial information of the subsoil schematisation. Since this means the implementation of (advanced) GIS functionality, soil segments (polylines) instead of soil areas are acceptable if future development towards soil areas maintain open. A soil segment or soil area is allocated to one of the failure mechanisms and cannot overlap other segments or areas with the same mechanism.
REQ 8.4	Profile view to modify soil profiles .The application must support in profile view the drawing and modification of 10 and 20 soil profiles. 10 and 20 soil profile can be viewed in map view in case the location of the soil profile is available in RD (point or line). Modification of the location must be able in future development of the application. The application must support in profile view the drawing and modification of 10 and 20 soil profiles. Visualize the surface lines with their characteristic points. The application must give an overview in scenarios view of the soil profile scenarios for a soil area or segment. Since this might mean a major change in the software architecture an overview of the soil profile scenarios in another way than a scenarios view is acceptable if future development towards scenarios view maintain open.
REQ 8.5	Automatically project boreholes and CPT onto a cross section. Borehole and CPT can be allocated automatically to one or more soil profiles if it lies within a certain (user defined) distance of this cross section. If the location in RD is known the borehole or CPT is plotted perpendicular to the 20 profile if the borehole or CPT is within a user defined distance. This distance is set per cross section and is default 100 meter. The CPT/boring and the soilprofile are plotted on the same vertical referencelevel (e.g. NAP) and scale
REQ 8.6	Segments have an ID that the user can relate to. This ID must be presented in mapview
REQ 8.7	Show all soil investigation with labels in mapview The name of the boring or CTP must be visible to the user in mapview
REQ 8.8	Visualize the surface lines with their characteristic points. A user must be able to view surface lines and characteristic points on top of a 10 and/ or 20 cross section.
REQ 8.9	Select boreholes and CPT's onto a cross section. If automatic plotting (RE08.5) is not possible, the borehole or CPT can be dragged by the user to the right location in the 20 profile. The height reference of a borehole or CPT is assumed to be the same as in the soil profile and plotted in the height reference of the 20 profile

Eis ID	*Eis omschrijving*
REQ 8.10	The application must give an overview in scenarios view of the soil profile scenarios for a soil area or segment. Since this might mean a major change in the software architecture an overview of the soil profile scenarios in another way than a scenarios view is acceptable if future development towards scenarios view maintains open. This scenarios view is not yet required in this version of the application if an overview of the scenarios per soil area or segments is provided in another manner (see also REO 5.1). En zie plaatje in Functional design document.
REQ 8.11	View files in file-related software. a. CPT's and borings in GEF format can be shown in an external program like GefPlotTool by doubleclicking the names in D-Soil Model. b. Open *.sti in DGeoStability by doubleclicking the name in D-Soil Model.
REQ 8.12	In map view, relevant background information must be shown. Standard relevant information is AHN information and information from a (later to be specified) WMS server.
REQ 8.13	Show SOS scenario's in 20 profiles. All relevant SOS scenario's (the ones from the same segment) must be visible in a 20 profile at the same reference level. The user will use this additional information to make sure the 20 subsoil schematization fits the SOS segments.
REQ 8.14	Draw SOS profiles in one segment on the same height for comparison. When plotting SOS profiles next to one another, they must be plotted relative to a same reference level (e.g. NAP) and scale for simple comparison. The minimum and maximum value of the layers must also be shown.
REQ 8.15	Show ground investigation simultaneously to REO 8.14 at the same reference level. When plotting soil investigations (CPT's and borings) on a reference line next to one another, they must be plotted relative to a same reference level (e.g. NAP) for simple comparison.
REQ 8.16	Synchronization between different views. The user can switch between different kind of views of the data by clicking on the name. E.g. clicking on segment A in the table window, also selects this segment on the map and the properties of this segment are shown on the map. Applicable for names of: Soilsegments, soilprofiles, material, layer, CPT, boring, surface lines
REQ 8.17	Visibility of yield stress Yield stresses are plotted in the 2D profile as points with optional labels (label =Spanningswaarde).
REQ 9	Edit and generate the building blocks of the subsoil schematization The user is able to edit all the building blocks. The user is responsible for the edits, D-Soil Model gives validations messages when applicable (e.g. minimum and maximum values). The user is supported by the application with tools.
REQ 9.1	The soil materials can be named or renamed and the material properties can be created and modified in table view. Modification of the soil materials automatically updates the soil materials in the regarding soil layers. The material properties can be filtered on failure mechanism and calculationmodel if applicable.
REQ 9.2	The probably of appearance of one SOS scenario can be changed. The user is responsible for letting these scenarios add up to 100 percent. The interface should be such that the user can check this easily.
REQ 9.3	An existing 1D profile can be changed into a 2D profile so that the user can make changes in the cross section. A reference surface line needs to be drawn in this profile. Default width 100m.
REQ 9.4	A user can make changes in a cross section is a similar way he can do in DGeoStability.
REQ 9.5	Have reference points to draw surface lines on 2D profiles. Surface lines and characteristic points must be plotted onto a 2D profile.As a referencepoint, the x-value of the outer crest line will be used. This means that, for each 2D profile, the location of the initial outer crest characteristic point must be stored. The user can move the reference point If no width of the cross section is known, the default is set to 100 meters. Other mapping methods are in consideration for more reliable mapping.
REQ 9.6	Soil interpretationools are available in D-Soil Model so that testing data (e.g. CPT's) can directly be transformed into information that is relevant to the user (e.g.1D profileor strength parameter). For example the parameters required for undrained analyses like the POP or OCR and m can be automatically derived from CPT.
REQ 9.7	The application must support the user to draw two dimensional soil layering.
REQ 9.8	The application must support the allocation of a soil material to a soil layer in one or more soil profiles.
REQ 9.9	Define layer as aquifer or aquitard. A soil layer in a soil profile can be defined in profile view as an aquifer. All other layers are considered to be an aquitard..This is a layer property.
REQ 9.10	Enter yield stresses for macrostability. The pre-consolidation pressure can be entered as a profile property and as soil material property. If the pre-consolidation pressure is a profile property it can be entered as point in profileview. The yield stresses must be shown to the user in a visual manner.
REQ 9.11	Copy/pastesegments for one failure mechanism to the next. Different failure mechanisms can have different section lengths. Often,though they will be the same. A user must be able to copy a segment from one mechanism to another mechanism.
REQ 9.12	Modify the location of de borehole or CPT in the 2D profile. A CPT or borehole can be dragged to another location in the profile view. This will never alter the depth of the CPT or borehole, nor will it affect the "real" world position of the CPT or borehole.
REQ 9.13	Logging of all changes to the database Each cross section will have a text field where the user can enter all relevant changes made to the input data.

Eis ID	*Eis omschrijving*
REQ 9.14	Minimal validity check on the data. Minimal validation for the right values within given boundaries
REQ 9.15	Extensive validity check on the data for Ringtoets. Complete validation for a Ringtoets analyses where the user can ask if the data is complete to perform the analysis (as a WTI add-on).Validation is possible per failure mechanism.
REQ 9.16	Define n and gamma per material parameter for determination of stochastic or design values. Parameters to define the nature of the soil tests regarding one material need to be stored to be able to calculate stochastic values.
REQ 9.17	All test to derive parameterscan be stored. This way, an extra test can be added and the relevant parameters can be updated.
REQ 9.18	Add another 1D profile to an existing 2D profile (a). The user must be able to build a 2D schematization based on multiple 1D profiles (b). A newly selected 1D profile is then valid in a predefined range. Different material properties underneath and next to an embankment can be selected. The surface line and dike material (including the internal geometry of the dike) can also be edited.
REQ 9.19	Draw a new subsoil configuration. The user must be able to configure a new subsoil schematization from scratch.
REQ 9.20	Incorporate settlements underneath an embankment. The user must be able to define settlements (input cm settlement as input) underneath the embankment.
REQ 9.21	On a longitudinal cross section, the user is to be able to Visualize minimum and maximum of layer boundaries from the SOS data. For each 1D SOS scenario, the user must see the expected value of each layer boundary, together with the minimum and maximum value of the layer boundary.
REQ 9.22	Longitudinal cut based on dike material If information regarding the dike core is known ,the user must be able to cut a segment into smaller bits, locally specifying dike material, berm material or material besides the embankment.
REQ 9.23	On a longitudinal cross section, the user is to be able to Import soil areas and segments. The application can import soil areas (as a nice to have) and segments (must have) as shapefiles (polygons or polylines).
REQ 9.24	On a longitudinal cross section, the user is to be able to Table import/export. All the tables in D-Soil Model (tables in table window, yield stresses, Sigmatau curves etc.) must have an export as well as an import functionality (for table or column(s)).



https://beeldbank.rws.nl, Rijkswaterstaat / Henri Cormont

Rijkswaterstaat
Ministry of Infrastructure and the Environment

Deltares

Enabling Delta Life

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