

Soil statistics for GIS users

from South Australia's polygon-based soil landscape mapping and land use potential datasets

This document provides step-by-step instructions for calculating *spatial data statistics* from South Australia's [Soil and Land Attribute](#) and [Land Use Potential](#) spatial datasets. These datasets can be viewed on [NatureMaps](#) and downloaded from [Data.SA](#). *Spatial data statistics* are a summary breakdown of the areas of different soil and land quality calculated within a particular study boundary.

It is important to follow these instructions when estimating and reporting the areas of different soil and land quality. We provide an illustrated example for calculating *spatial data statistics* using **ESRI ArcMap**, and exporting outputs to **Microsoft Excel**, for the [Flooding Susceptibility](#) mapping dataset.

Background

Soil mapping across southern SA has been undertaken using a system of map unit polygons to delineate landscape features, and linked data tables that record expert assessments for a range of soil and landscape attributes. This *Soil and Land Attribute* mapping has subsequently been used in rule-based models to estimate potential for various crops, pastures and native species, termed *Land Use Potential* models.

These datasets are structured in a way that balances the limitations of a relatively coarse scale of mapping (see box to right), while providing comprehensive information on a wide range of functionally important attributes. These data are ideally suited to identifying regional soil and land management issues and opportunities. They can provide farm property overviews, but are not suited to paddock or site-level assessments.

Each dataset contains one *Mapping Category* field plus multiple *Analysis Data* class fields. To create *spatial data statistics* from these datasets, it is necessary to use the *Analysis Data* classes.

Further information is available in the documents:

- [Soil and land attribute data descriptions](#)
- [Land use potential for agricultural crops in southern South Australia: Summary of assessment and mapping methodology](#)

What are *Mapping Categories* and *Analysis Data* classes, and why are they used?

[Regional-scale soil mapping](#) is often not able to fully capture changes in soil properties across the landscape. However, variation in *Soil and Land Attributes* and *Land Use Potential* has been recorded, enabling detailed description of map units that can contain a mix of soil and land conditions.

Mapping Categories provide a summary or simplified description of map unit contents. They are individually tailored using predefined rules to highlight features of interest. However, sometimes up to 70% of map unit data can be undescribed. For example, the most common soil type may account for as little as 30% of a map unit.

Analysis Data classes reflect the detail through which the condition, severity or quality of *Soil and Land Attributes* and *Land Use Potential* has been assessed. *Analysis Data* records multiple and varied conditions within each map unit.

Importantly, descriptions of *Mapping Categories* and *Analysis Data* classes can be different.

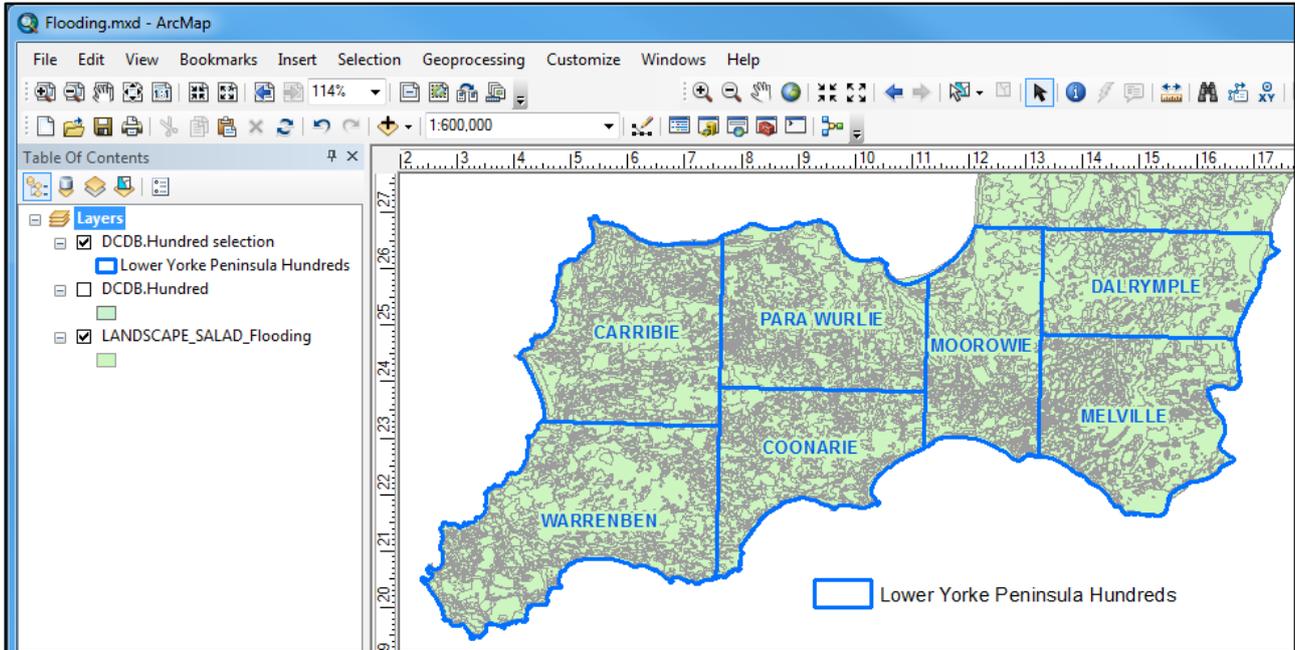
The *Analysis Data* provides the 'point of truth' for calculating areas of different soil quality or condition.



1. Getting started in ArcMap

Open ArcMap. Add the spatial data layers which you would like *spatial data statistics* created on.

In this example, a selection of *Hundreds* has been used as the study area. Spatial data statistics will be created on the *Soil and Land Attribute: Flooding Susceptibility* (named LANDSCAPE_SALAD_Flooding.shp if downloaded from [Data.SA](#)).



Open the LANDSCAPE_SALAD_Flooding attribute table to view the shapefile fields, including the *Flooding Susceptibility Analysis Data* classes:

- **F1:** percentage of map unit which is not susceptible to flooding
- **F2:** percentage of map unit which is susceptible to flooding
- **FX:** percentage of map unit which is not applicable (e.g. urban, reservoir, etc.)

Note that the row sums across all *Analysis Data* classes equals 100% for all *Soil Landscape Map Units*.

Note: there may be multiple polygons with the same *Soil Landscape Map Unit (LANSLU)* code. Polygons with the same *LANSLU* code have the same *Flooding Susceptibility Analysis Data* classes and the same *Mapping Categories*.

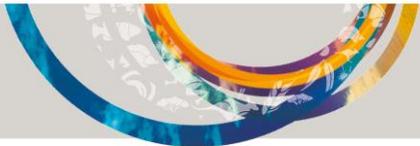
Flooding Susceptibility Mapping Category

Flooding Susceptibility Analysis Data classes

LANSLU	FLOODING	F1	F2	FX	SHAPE_Leng	SHAPE_Area
KPPFVC	A	100	0	0	9301.585096	1214481.06085
KPPAOC	A	100	0	0	38346.575131	7611070.96475
YYKWFE	A	100	0	0	12235.436922	1137629.8016
LBEETN	A	100	0	0	4039.96624	780291.6708
LBEAKC	A	100	0	0	7777.935871	995079.7316
TRLZA-	E	0	100	0	4278.124255	557798.648048
TUFWO-	E	0	100	0	6941.030741	1118802.05015
CBPWFc	A	100	0	0	3138.220404	597409.298749
CBPWM-	E	0	100	0	2585.624687	253025.22195

Soil Landscape Map Unit (LANSLU) code. One row of data for each polygon

Area (in metres²) of each Soil Landscape Map Unit polygon



For more information, refer to [Soil and land attribute data descriptions](#) for descriptions of Soil and Land Attribute Analysis Data class and Mapping Category descriptions, e.g. Flooding Susceptibility:

Analysis Data class	Susceptibility to flooding
F1	Not susceptible
F2	Susceptible
FX	Not applicable

Flooding Susceptibility Analysis Data classes and descriptions

Mapping Category	Proportion of land susceptible to flooding
A	Negligible
B	1-10%
C	10-30%
D	30-60%
E	More than 60%
X	Not applicable

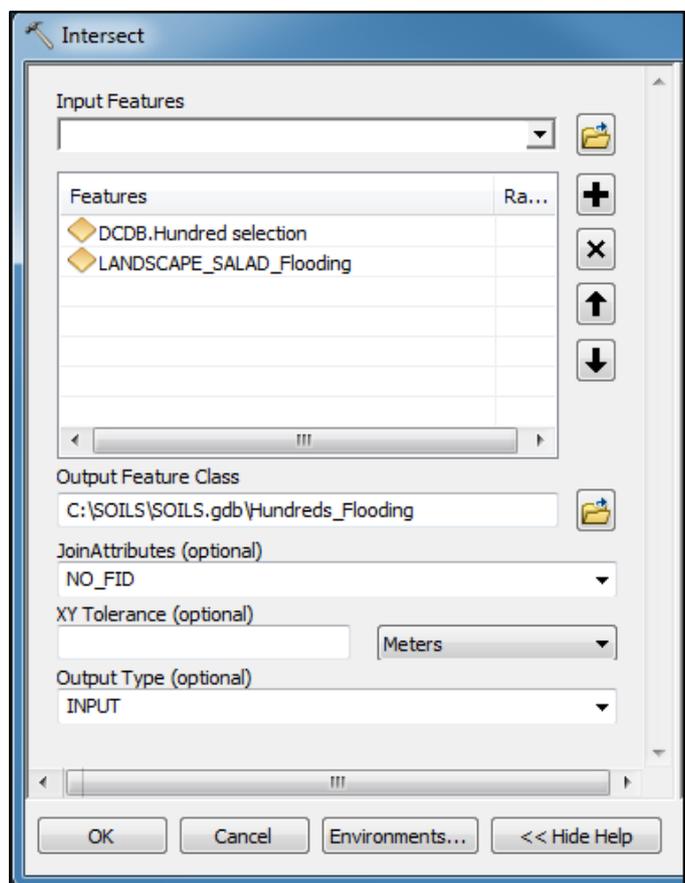
Flooding Susceptibility Mapping Categories and descriptions

2. Intersect spatial datasets

Using the ArcMap "Intersect" tool, intersect the *Hundreds* dataset with the *Flooding Susceptibility* dataset. Save the Output Feature Class (e.g. named *Hundreds_Flooding*) into a geodatabase (this will result in a "SHAPE_Area" field being created).

An ArcGIS **geodatabase** is an alternate way to store GIS information in one large file, which can contain multiple point, polygon, and/or polyline layers. Using geodatabases is a more efficient way of organizing data compared to storing multiple shapefiles in multiple folders.

Intersect is an ArcMap tool which computes a geometric intersection of the input features. Features or portions of features which overlap in all layers and/or feature classes will be written to the output feature class.

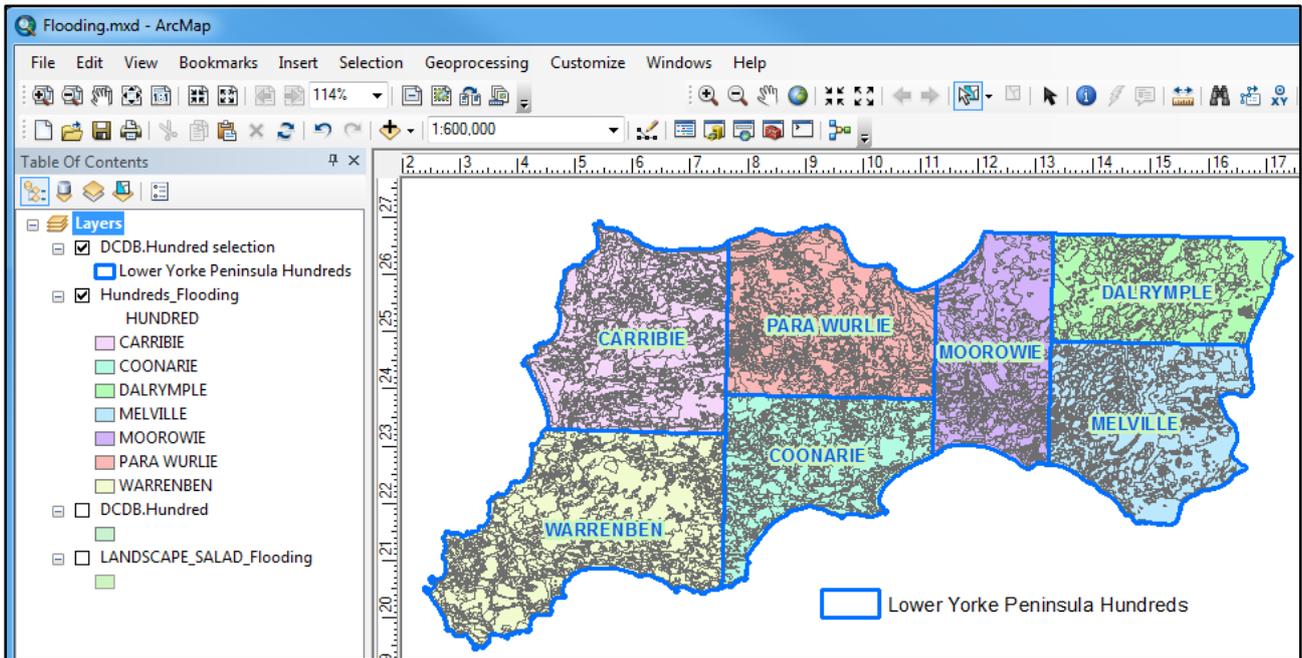


Note: if you also require *spatial data statistics* broken up into areas which are vegetated and areas not vegetated, it is more appropriate to use the ArcMap "Union" tool instead of the "Intersect" tool.

Scenario: Say you are locating areas susceptible to wind erosion for land management purposes, and most areas of high wind erosion potential are already covered by native vegetation. In this case, you may choose to exclude vegetated areas from your calculations.



The output feature class, which contains all the fields of both the *Hundreds* and *Flooding Susceptibility* layers, has been clipped to the extent of the selection of *Hundreds* and *Flooding Susceptibility* datasets. Only overlapping areas are retained.



3. Frequency of study area fields

Using the ArcMap *Frequency* tool, create a frequency of the following *Frequency Fields*:

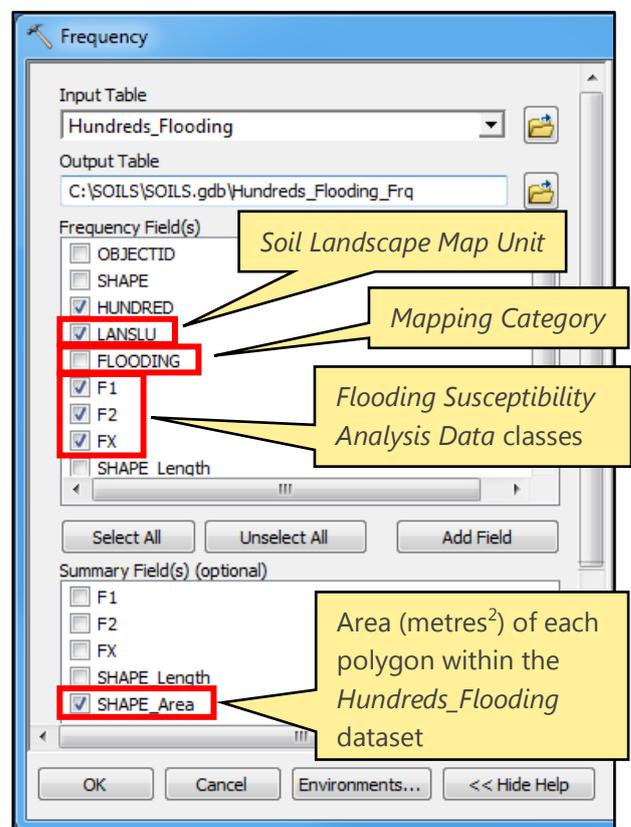
- **HUNDRED** (from the study area)
- **LANSLU** (*Soil Landscape Map Unit*)
- *Flooding Susceptibility Analysis Data* classes:
 - **F1**
 - **F2**
 - **FX**

Summary Field:

- **SHAPE_Area** (creates a summary (sum) of numerical values).

Save the frequency file (e.g. *Hundreds_Flooding_Frq* table) into the geodatabase.

Frequency is an ArcMap tool which reads a table which contains a set of fields and creates a new table containing unique field values and the number of occurrences of each unique field value, and, when specified, sums the total values of *Summary Fields*.



Open the *Hundreds_Flooding_Frq* table to view the fields:

HUNDRED	LANSLU	F1	F2	FX	SHAPE_Area
CARRIBIE	CBEYdg	100	0	0	1410624.53
CARRIBIE	CCHYEI	100	0	0	2516263.35
CARRIBIE	HWBWU-	0	100	0	913915.05
CARRIBIE	CCHYal1	100	0	0	74286.12
CARRIBIE	HWBWGE	100	0	0	1132463.94
CARRIBIE	CBEYdLs	100	0	0	1601364.37
CARRIBIE	CCHYal1	100	0	0	3322249.63
CARRIBIE	CBEYEU _s	100	0	0	5666946.94
CARRIBIE	CBEYEU	100	0	0	1209223.53
CARRIBIE	CBEYAB1	100	0	0	201669.85
CARRIBIE	CBEYAO	100	0	0	543289.93
CARRIBIE	CCHYdL	100	0	0	331596.57

Sum of areas (metres²) of each *Soil Landscape Map Unit* contained within each *Hundred* of the study area

Note: the output frequency table is a sum of the areas (in metres²) of all *Soil Landscape Map Units* (LANSLU code), with their unique *Flooding Susceptibility Analysis Data* class percentage values, within each *Hundred* of the study area

4. Calculate Analysis Data fields

Multiply the *Analysis Data* percent values by the area (metres²) of each *Soil Landscape Map Unit* (LANSLU) to calculate the total area of each *Analysis Data* class for each *Soil Landscape Map Unit*, for each *Hundred*:

- Open the *Hundreds_Flooding_Frq* table in ArcMap
- Select the "F1" column
- Right mouse click and select the "Field Calculator" option
- Calculate the entire column with:
 $F1 = [F1] * [SHAPE_Area] / 100$ (i.e. the area not susceptible to flooding for each map unit)

HUNDRED	LANSLU	F1	F2	FX	SHAPE_Area
CARRIBIE	CBEMbYb	100			
CARRIBIE	CBEMbYC	100			
CARRIBIE	CBEWAB	100			
CARRIBIE	CBEWGa	70			
CARRIBIE	CBEWGc	100			
CARRIBIE	CBEWGC	100			
CARRIBIE	CBEWGd	100			
CARRIBIE	CBEWGD	100			
CARRIBIE	CBEWGe	100			
CARRIBIE	CBEWGE	100			
CARRIBIE	CBEWGK	100			
CARRIBIE	CBEWGT	100			

Repeat this process, selecting and calculating the remaining *Analysis Data* class columns, i.e.:

- $F2 = [F2] * [SHAPE_Area] / 100$ (i.e. the area susceptible to flooding for each map unit)
- $FX = [FX] * [SHAPE_Area] / 100$ (i.e. the area not applicable for each map unit)

This will result in each *Analysis Data* class percent value being replaced / populated with areas in metres².

Note: to convert area units from metres² further divide each *Analysis Data* class column by:

- 10,000 (or 10⁴) to calculate hectares
- 1,000,000 (or 10⁶) to calculate km²



5. Sum total areas for study area

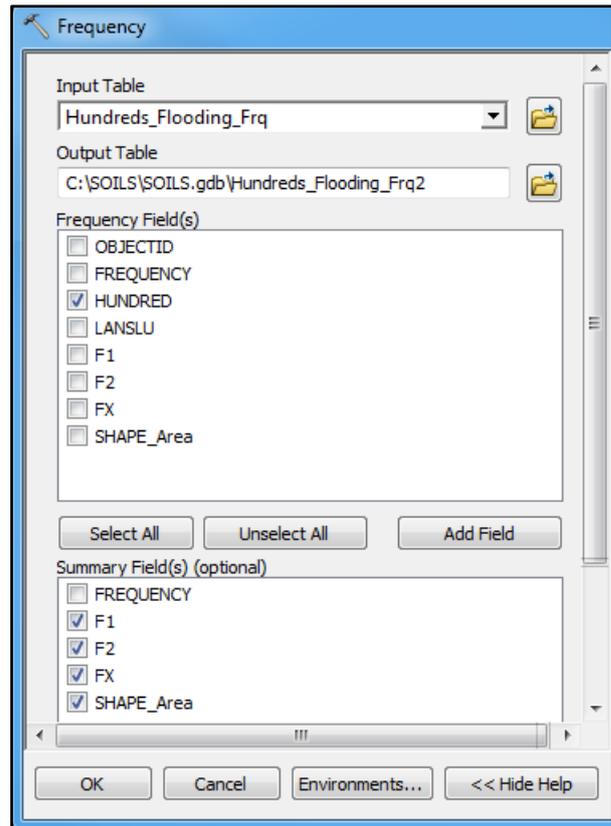
Once you have calculated each *Analysis Data* class field from a percent value to an area value, create a frequency of the *Hundreds_Flooding_Frq* table to sum the total area of each *Flooding Susceptibility Analysis Data* class for each *HUNDRED* of the study area into a new table e.g. *Hundreds_Flooding_Frq2*.

Using the ArcMap *Frequency* tool, create a frequency of the following *Frequency Field* (study area):

- **HUNDRED**

And the *Flooding Susceptibility Analysis Data* classes and area as the *Summary Fields* (sums of the previously created frequency file)

- **F1**
- **F2**
- **FX**
- **SHAPE_Area**



6. Export table to Microsoft Excel

The resultant frequency table can be converted to a Microsoft Excel table using the ArcToolbox "Table to Excel" conversion tool.

The subsequent Microsoft Excel table is a frequency list of each *HUNDRED* in the study area, with the total area values (in metres²) of each *Flooding Susceptibility Analysis Data* class.

Edit the Microsoft Excel table to your requirements, by adding *Analysis Data* class descriptions to the table, or recalculating the metres² into hectares or kilometres² (see previous page).

Note: Do not display *Analysis Data* areas in decimal points. This gives the indication that the data is at a high resolution, which it is not. Note that it is preferable to display the data in either hectares or kilometres².

Sum of F1, F2 and FX

7. Check the final table

It is important to check that an error has not been made with your calculations. As a check, sum the "F1", "F2" and "FX" values for the study area. These must add up to the sum of *SHAPE_Area* for the study area, or an error has been made in your calculations. The checking process can be undertaken in either ArcMap or Excel.

HUNDRED	F1 Hectares	F2 Hectares	FX Hectares	Total Hectares
CARRIBIE	34,812	1,092	0	35,904
COONARIE	25,987	637	23	26,647
DALRYMPLE	23,557	1,732	100	25,390
MELVILLE	28,240	3,304	83	31,627
MOOROWIE	23,033	3,344	0	26,376
PARA WURLIE	32,344	1,004	0	33,348
WARRENBEN	40,858	3,418	0	44,276



8. Further information

Soil and Land Attributes:

Refer to the [Soil and land attribute data descriptions](#) information sheet for:

- fact sheet links
- state map links
- spatial data download links
- metadata links
- *Mapping Data* classes and descriptions
- *Analysis Data* class descriptions, which can be appended to the *spatial data statistics* Microsoft Excel table

Land Use Potential:

Refer to the [Land use potential for agricultural crops in southern South Australia: Summary of assessment and mapping methodology](#) technical note for:

- state map links
- spatial data download links
- metadata link
- descriptions of Land Use Potential Analysis Data classes (below)

Note: *Land Use Potential spatial data statistics* can be created using the same process outlined here, but instead use *Analysis Data Classes*, as listed in the following table.

<i>Analysis Data class</i>	Land Use Potential	General definitions of Land Use Potential classes
Class 1	High	Proportion of land with high productive potential and requiring no more than standard management practices to sustain productivity.
Class 2	Moderately high	Proportion of land with moderately high productive potential and / or requiring specific, but widely accepted and used, management practices to sustain productivity.
Class 3	Moderate	Proportion of land with moderate productive potential and / or requiring specialized management practices to sustain productivity.
Class 4	Moderately low	Proportion of land with marginal productive potential and / or requiring very highly specialized management skills to sustain productivity.
Class 5	Low	Proportion of land with low productive potential and /or permanent limitations which effectively preclude its use (includes not applicable, no data)
Class X	Not applicable	Not applicable areas, e.g. urban, reservoirs

Other links

- View data on [NatureMaps](#) (→ Soils)
- Read more about [soil attribute mapping](#)
- Read more about [land use potential](#)
- Contact [Mapland](#)

Download spatial data from Data.SA

- [Soil and land attributes](#)
- [Land use potential](#)

Download from Enviro Data SA:

- [Assessing Agricultural Lands](#) (Maschmedt 2002)
- Soils of Southern SA book [Part 1](#) and [Part 2](#)



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