

GEM 2.2.2

Addendum to Manual GEM 1.1.1

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July 2015 GEM 1.1.1 was released. On request of the Ministry of Economic Affairs additional refinements were added to the instrument. This document is part of the GEM manual, and describes the features that were added to GEM 2.2.2 as follow up of GEM 1.1.1:

1. Option to select emission scenarios, related to the nitrate emission limits in the Netherlands and the management of filter rinsing water
2. Option to manage individual application dates, i.e. set a certain timespan between application and discharge.

Model versions of the contributing models in GEM 2.2.2 are:

Table 1 Names and version numbers of the currently used models in GEM

Module	Version
PEARL	3.1.5
SWAP	3237
SUBSTANCE	1.2.1
TOXSWA	3.3.5
WATERSTROMEN	2.0

1. Option to select emission scenarios

The Browse Projects menu allows the user to choose an already existing project for use, editing, deletion, or to add a new project. When adding a new project the user may select a Cultivation- assessment type which can be either Soiless or Soil-bound. In GEM 2.2.2, the soiless cultivation assessment type offers a further choice of the nutrient emission reference period (either 2015 – 2017, or 2018 – 2020) and the choice whether or not the calculations should presume the reuse of filter water or not. In the latter case the filter water is presumed to be discharged to surface water. Both options are only offered when selecting a soiless cultivation scenario.

The options are shown in the project screen in the box 'Nutrient emission reference period' (Figure A1).

The effect of choosing either the 2015 – 2017 or the 2018 – 2020 reference period reflects the change in strictness of emission rules for nitrate from 2018 onward. For the earlier period 2015 – 2017 a higher overall volume of emissions is permissible. It is referred to *Scenarios Waterstreams model for GEM 2.2.2*. for further information on the emission scenarios. This document can be downloaded via www.pesticidemodel.eu/gem .

The selection of the nutrient emission reference period is done at project level. When the project contains one or more assessments, the nutrient emission reference period cannot be changed anymore.

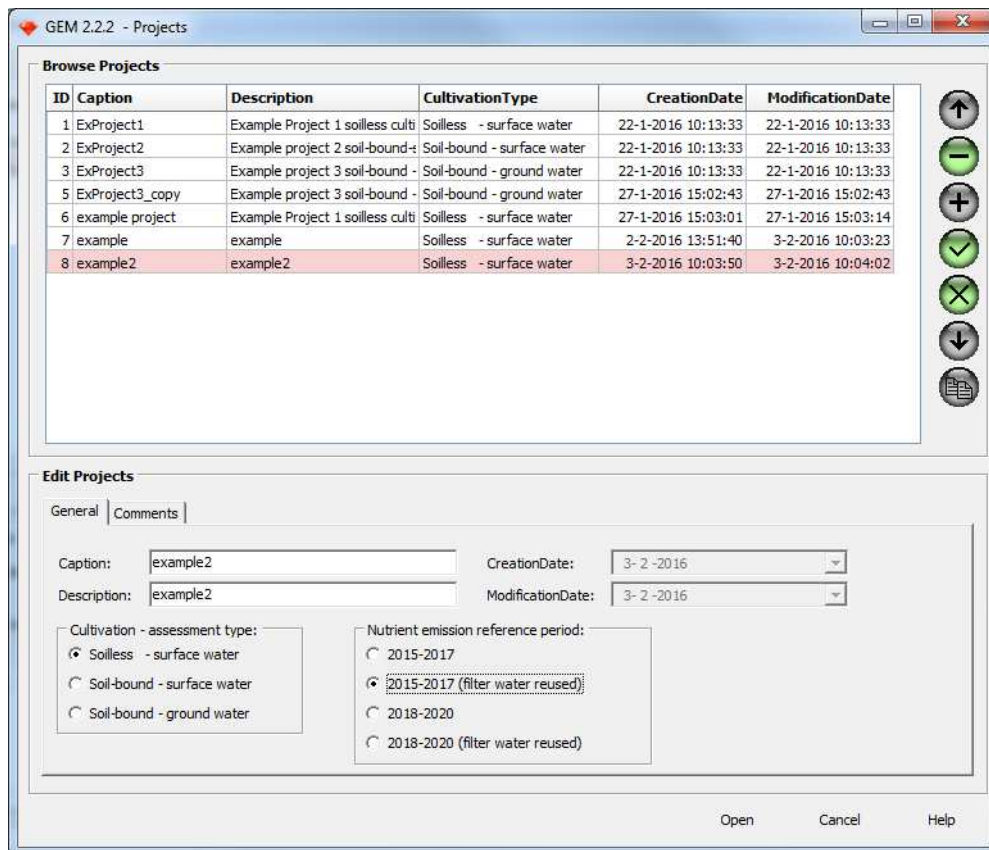


Figure A1: The projects screen, enabling the addition, removal and editing of projects. In the Edit Projects screen an option was added to select a nutrient emission reference period and to specify filter rinsing water management

2. Management of application timing

Discharge moments for growers are currently fixed: the system automatically discharges when the salt content is too high. In practice the grower may be able to manage the time between application and discharge. To allow calculating the effect of a certain timespan between application and discharge an application manager was added.

Only if the user chooses the option that calculations presume the reuse of filter water, he/she is given the choice of whether or not the application should be managed with regard to discharge. Management in this respect implies that the program will adjust the application date if the period between the specified application date and the discharge dates is shorter than allowed.

This option is selected in the lower half of the Assessment screen (Edit Assessments, Figure A2). When selected, an option to define a minimum interval between application and discharge is provided and an application screen is opened that allows access to a discharge and application viewer (Figure A3 and A4).

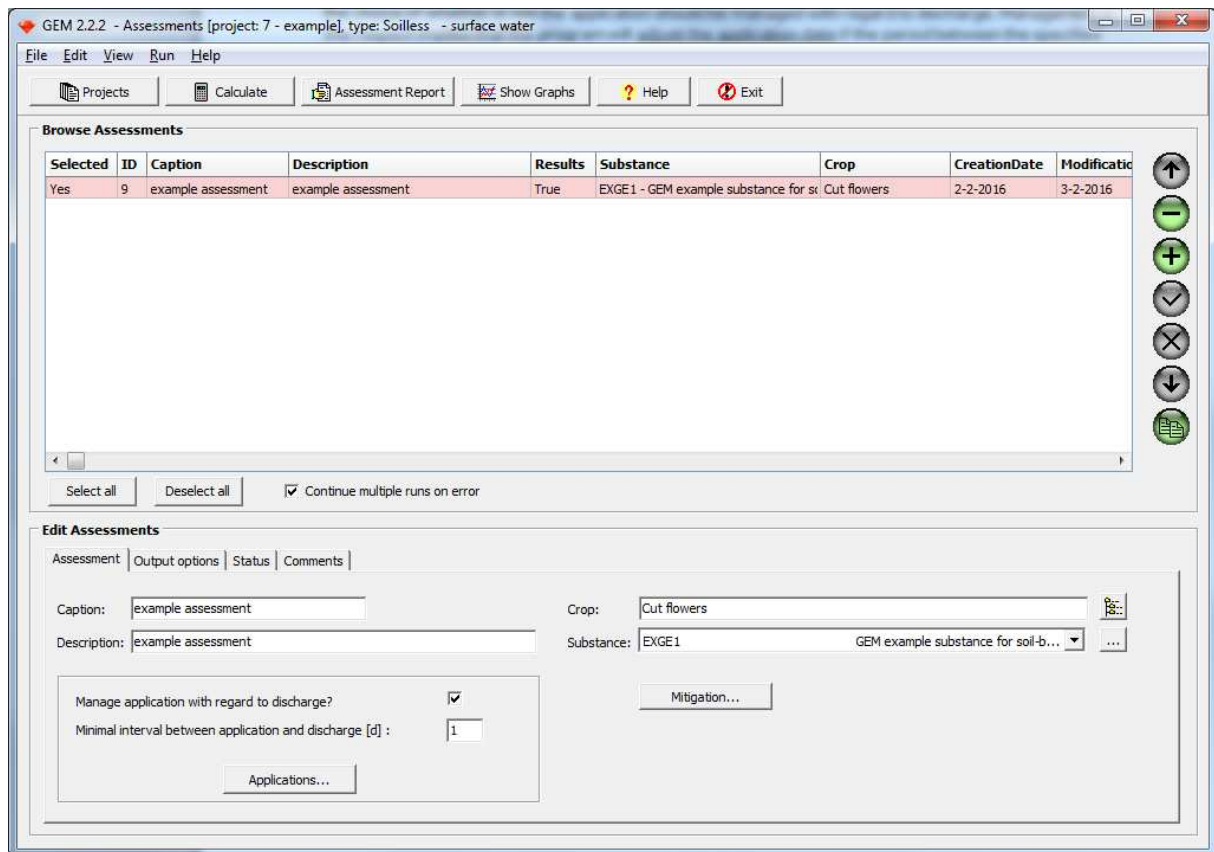


Figure A2: The assessments screen for an assessment with enabled management of application dates

After the user has specified the minimum number of days that preferably should occur between an application and the next subsequent discharge event, the user will be asked to specify a target application date in the 'applications' screen which opens when the Application button on the assessments screen is opened. If the user, without realising it, chooses an application date which is too closely followed by a discharge date, GEM will automatically search for the nearest application date which fulfils the requirement of having the specified number of days prior to a discharge event. For this reason, the user is given the possibility to enter the maximum number of days that the program may automatically adjust the application date in order to create sufficient time between application and discharge. The acceptable change in application date is specified as the number of days that the application date may be moved to an earlier or to a later date.

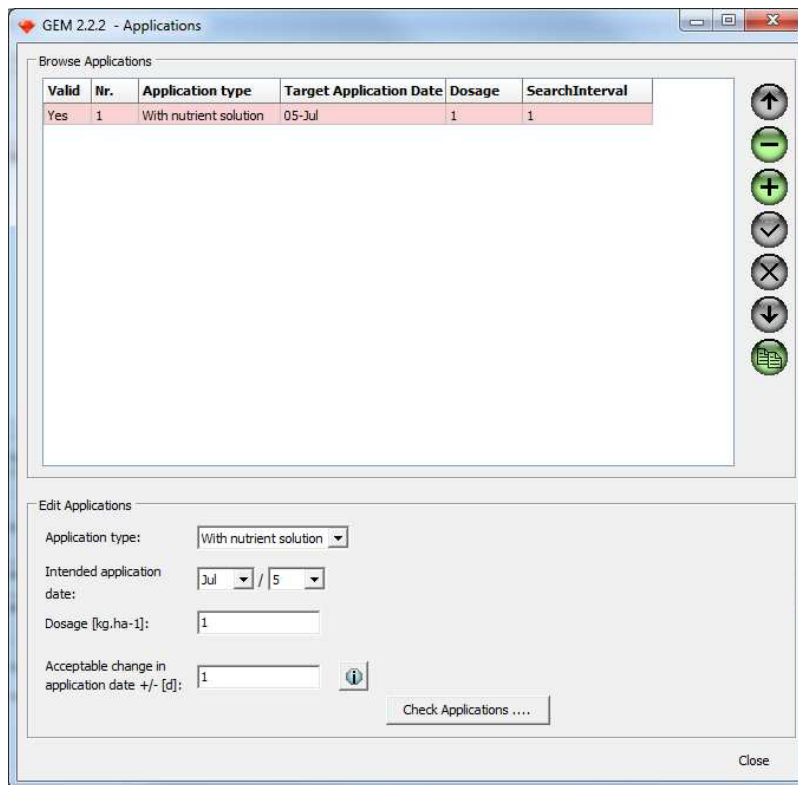


Figure A3: The applications screen, enabling addition, removal and editing of individual applications. A new option has been added to define an interval within which GEM may search for suitable application dates.

GEM checks first if an application is possible one day earlier than the target date, else it checks the day after the target date. This is continued until the limits of the search interval are achieved.

If, despite allowing an automatic adjustment of the application date, the program is not able to find an application date sufficiently far away from subsequent discharge events, the user is warned by a text box on the right side of the screen, with text in red stating 'No solution found for one or more of your target application dates. You may try an alternative application target date and/or search interval.'

Regardless whether suitable application dates were found, with or without automatic adjustment of the dates by the program, the user can visualize the application dates by pressing the 'Check applications' button. The resulting diagram will depict discharge dates and suitable (where necessary: adjusted) application dates.

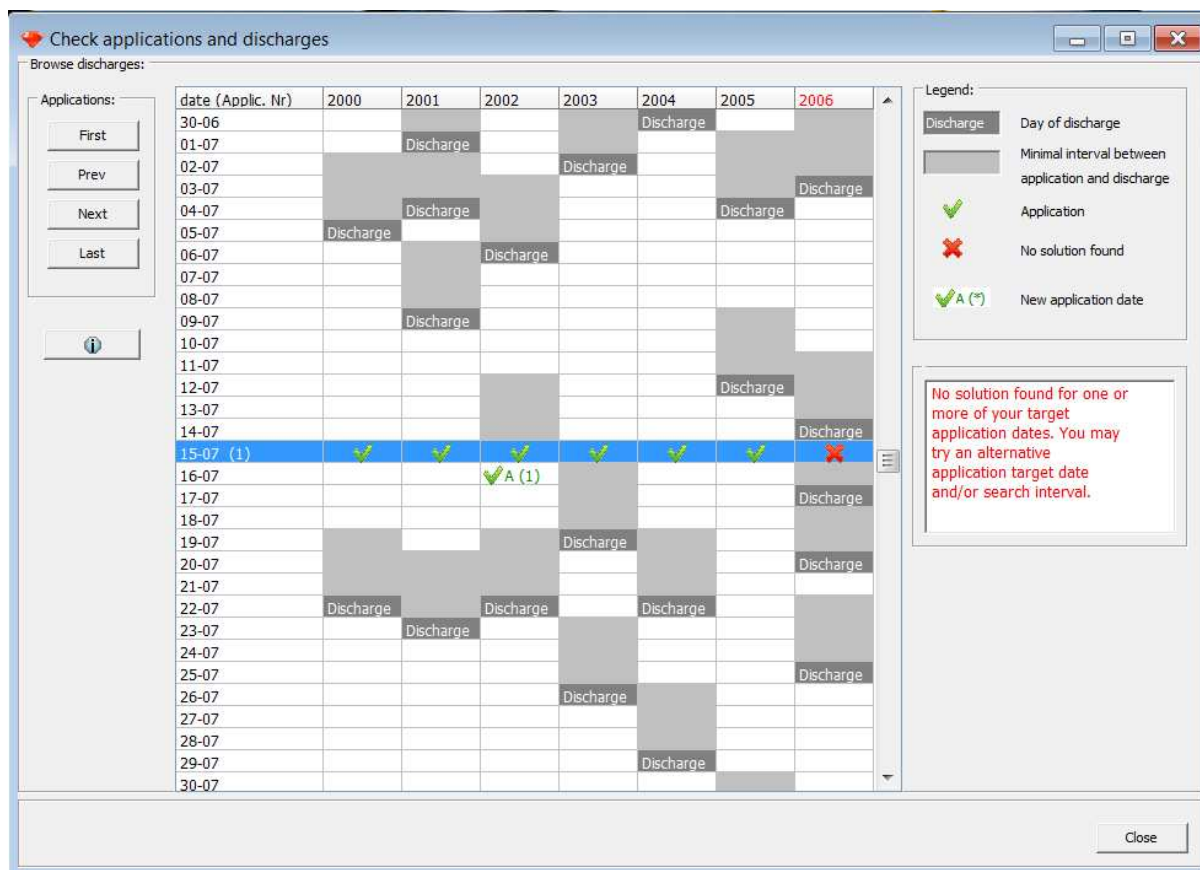


Figure A4: An example of automatically adjusted application dates. For the case presented no solution was found within the required time between application and timing and the search interval.

Any user-chosen application date too close to a discharge, which cannot be adjusted by the program within the constraints of the 'acceptable change in application date' to allow an application anyway, will be marked in red (see July 15th 2006 in the example given above).

If the requirements for the minimal interval between application and discharge date are not met, no calculations can be performed!

If under these circumstances the author selects the invalid assessment anyway, and tries to perform a calculation, either the 'Finished' textbox will pop up immediately or after all selected assessment have been calculated, without any calculations being performed (provided that the 'Continue multiple runs on error' has been enabled). The corresponding error is shown in the Status tab on the Assessment screen.

3 Changes in the input and assessment report

If the user wishes to check whether user specified dates were adjusted by the program, he/she may do so by either visually inspecting the applications in the application scheme (an example is given in Figure A4), or alternatively through inspection of the Substances input file (View --> Input files --> SUBSTANCE, section 4: Management section). See also Figure A5.

The same list of actual application dates is also available through the Assessment Report of the assessment, provided that results are available, i.e. the calculations for the assessment have been performed (Annex B).

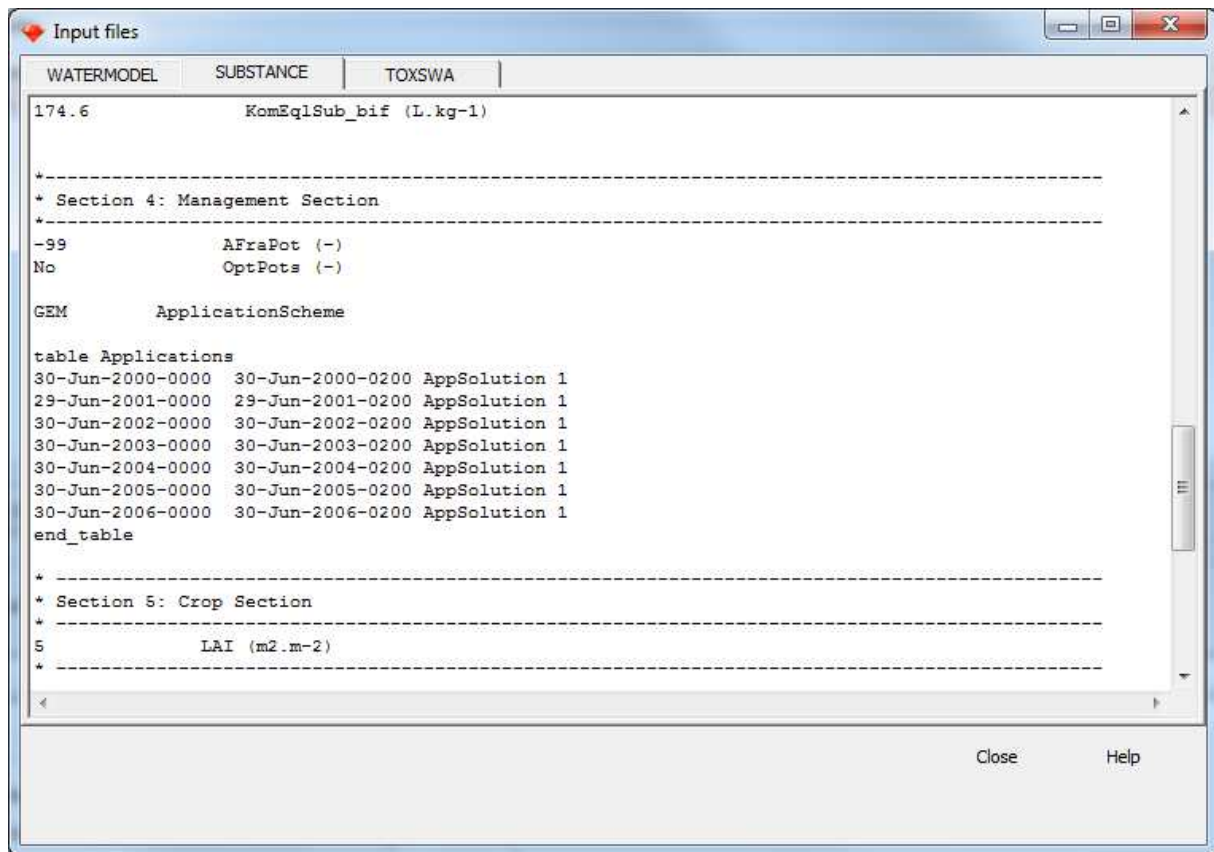


Figure A5. Screenshot of Application Scheme as defined in the Substance Emission Model input file. The use of the application manager resulted in a justified application date in 2001, i.e. the date was adjusted from June 30 to June 29.

The inspection of the selected Nutrient emission period can be done similarly via View --> Input files --> WATERMODEL. Figure A6 shows an example in which the reference period 2015-17 is selected and filter water is reused. The crop selected has rose as a reference crop. All file names and corresponding nitrate emission periods are listed in Annex A. The selected input file name of the WATERSTREAM model is additionally provided in the assessment report.



Figure A6. Screenshot of the input file of the WATERSTREAM model. The input file name refers to the combination of reference crop- emission period and whether or not the filter water is reused.

Annex A input file names of WATERSTREAM model related to Nutrient Emission Reference Period

Input file name	Reference crop	Nutrient emission period	Filter water management
Ficus_2015-17	figus	2015-2017	discharged
Ficus_2018-20	figus	2018-2020	discharged
Ficus_2015-17_reuse_filter_water	figus	2015-2017	reused
Ficus_2018-20_reuse_filter_water	figus	2018-2020	reused
Rose_2015-17	rose	2015-2017	discharged
Rose_2018-20	rose	2018-2020	discharged
Rose_2015-17_reuse_filter_water	rose	2015-2017	reused
Rose_2018-20_reuse_filter_water	rose	2018-2020	reused
Tomato_2015-17	tomato	2015-2017	discharged
Tomato_2018-20	tomato	2018-2020	discharged
Tomato_2015-17_reuse_filter_water	tomato	2015-2017	reused
Tomato_2018-20_reuse_filter_water	tomato	2018-2020	reused
Pepper_2015-17	sweet pepper	2015-2017	discharged
Pepper_2018-20	sweet pepper	2018-2020	discharged
Pepper_2015-17_reuse_filter_water	sweet pepper	2015-2017	reused
Pepper_2018-20_reuse_filter_water	sweet pepper	2018-2020	reused

Annex B Assessment report (changes as compared to GEM 1.1.1 are highlighted)

Assessment report: GEM 2.2.2

General assessment information

Report generated on : 3-2-2016 9:57:16
Project ID : 7
Assessment ID and Caption : 9 example assessment, (example assessment)
Cultivation - assessment type : Soilless - surface water
Nutrient emission reference period : 2015-2017 (filter water reused)
Substance code : EXGE1
Substance name : GEM example substance for soil-bound SW and soilless
Selected Crop from the DTG list : Cut flowers
Minimal interval between application and discharges : 1 days

Application scheme:

Nr	Application type	Target application date	Dosage (kg/ha)	Depth (m)	Fraction intercepted (-)
1	With nutrient solution	5-7-2001	1.00	NA	NA

Model versions

GEM version : 2.2.2
Build date : 25-Jan-2016
Database version : 2
SPIN version : SPIN (Substances Plug IN) 2.2
WATERSTREAMSMODEL version : 2.0
(also referred to as WATERMODEL)
SUBSTANCE EMISSION model version : v 1.2.1
TOXSWA version : 3.3.5
PEARL version : 3.2.2
SWAP version : 3237
Copy rights : Alterra, RIVM, PBL and Wageningen UR Greenhouse Horticulture

Soilless specific

Pots : No

Substance name End-of-pipe removal fraction

Summary output of model: WATERSTREAMS MODEL (also referred to as WATERMODEL)

Basin capacity [m3/ha]: 500
Greenhouse area [ha]: 1
Max Na concentration [mmol/l]: 4
Na uptake [factor of concentration]: 0.001
Illumination [micromol/m2/s]: 200
Na rain water [mmol/l]: 0.327
Na osmosis water [mmol/l]: 0.327
Na tap water [mmol/l]: 1.5
Na ground water [mmol/l]: 0.5
Na surface water [mmol/l]: 1.5
Surface water priority: 5
Tapwater priority: 3
Ground water priority: 4
Basin priority: 1
Drainperc [%]: 50
System leakage [%]: 1.5
Percentage condens recycled [%]: 80
Osmosis used: True
Osmosis capacity [m3/ha/day]: 60
Daynum osmosis start: 91

Daynum osmosis stop: 237

Summary output of model: SUBSTANCE

```
-----
* SUBSTANCE EMISSION MODEL REPORT: Header
*
* Results from the SUBSTANCE EMISSION MODEL (c) Alterra, WUR Greenhouse Horticulture and RIVM
* SUBSTANCE EMISSION MODEL kernel version : v1.2.1
* SUBSTANCE EMISSION MODEL created on : 13-1-2016
*
* SUBSTANCE EMISSION MODEL was called from : Greenhouse_Emission_Model_1.0
* Working directory : D:\UserData\GEM2\Projects\7\9\SUBSTANCE
* Run ID : 9
* Input file generated on : 03-Feb-2016 09:32:14
*
-----
*
* Waterflux file: rose_2015-17_reuse_filter_water
*
-----
* Number of substances : 1
* Parent substance : EXGE1
* Application scheme : GEM
*
* End of SUBSTANCE EMISSION MODEL REPORT: Header

* SUBSTANCE EMISSION MODEL REPORT: GEM
*
* Start date : 01-Jan-2000
* End date : 01-Jan-2007
*
-----
*
* NumApp 7
*


| Nr | Start of application | End of application   | Dosage (kg ha-1) | application type                   |
|----|----------------------|----------------------|------------------|------------------------------------|
| 1  | 05-Jul-2000 00:00:00 | 05-Jul-2000 02:00:00 | 1.0000           | application with nutrient solution |
| 2  | 05-Jul-2001 00:00:00 | 05-Jul-2001 02:00:00 | 1.0000           | application with nutrient solution |
| 3  | 05-Jul-2002 00:00:00 | 05-Jul-2002 02:00:00 | 1.0000           | application with nutrient solution |
| 4  | 04-Jul-2003 00:00:00 | 04-Jul-2003 02:00:00 | 1.0000           | application with nutrient solution |
| 5  | 05-Jul-2004 00:00:00 | 05-Jul-2004 02:00:00 | 1.0000           | application with nutrient solution |
| 6  | 04-Jul-2005 00:00:00 | 04-Jul-2005 02:00:00 | 1.0000           | application with nutrient solution |
| 7  | 05-Jul-2006 00:00:00 | 05-Jul-2006 02:00:00 | 1.0000           | application with nutrient solution |


*
* Substance 1 EXGE1
* Substance properties:
* Molar mass (g.mol-1) : 255.7
* Saturated vapour pressure (Pa) : 0.4E-09; measured at (C) 20.0
* Solubility in water (mg.L-1) : 0.6E+03; measured at (C) 20.0
* Half-life in tanks (d) : 1000.0; measured at (C) 25.0
* Selectivity factor for pesticide uptake (-) : 0.4
* coef. for equilibrium sorption on organic matter (L.kg-1) : 131.0
*
* Important mass fluxes (kg ha-1) of substance EXGE1
*
-----


| yr   | Identifier      | Applied   | Transformed | Uptake    | Discharged to surface water |
|------|-----------------|-----------|-------------|-----------|-----------------------------|
| 2000 | BalMasWat_EXGE1 | 0.100E+01 | 0.590E-02   | 0.744E+00 | 0.199E+00                   |
| 2001 | BalMasWat_EXGE1 | 0.100E+01 | 0.598E-02   | 0.726E+00 | 0.217E+00                   |
| 2002 | BalMasWat_EXGE1 | 0.100E+01 | 0.593E-02   | 0.753E+00 | 0.189E+00                   |
| 2003 | BalMasWat_EXGE1 | 0.100E+01 | 0.566E-02   | 0.711E+00 | 0.234E+00                   |
| 2004 | BalMasWat_EXGE1 | 0.100E+01 | 0.604E-02   | 0.820E+00 | 0.117E+00                   |
| 2005 | BalMasWat_EXGE1 | 0.100E+01 | 0.604E-02   | 0.770E+00 | 0.170E+00                   |
| 2006 | BalMasWat_EXGE1 | 0.100E+01 | 0.657E-02   | 0.784E+00 | 0.154E+00                   |


*
* END OF SUBSTANCE EMISSION MODEL REPORT: GEM
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* -----
* -----
* The run time was 3 minutes and 55 seconds

Summary output of model: TOXSWA
-----
* TOXSWA REPORT: Header
* Results from the TOXSWA model (c) Alterra
* GEM version : 2.2.2
* TOXSWA model version : 3.3.5
* TOXSWA created on : 19-Jan-2016
*
* Working directory : D:\UserData\GEM2\Projects\7\9\TOXSWA
* Run ID : 9
* Input file generated on : 03-02-2016
* -----
*
* Scenario : Netherlands
* Meteo Station : DeBilt
* Substance : EXGE1
* Flow Type : Variable
* Water Body Type : greenhouse_ditch
* Simulation Period : 01-Jan-2000 to 31-Dec-2006
* -----
*
* End of TOXSWA REPORT: Header

* TOXSWA REPORT: Substance properties and substance loadings
*
* Summary for the following substances
*
* Substance 1: EXGE1
* Molar mass (g.mol-1) : 255.7
* Saturated vapour pressure (Pa) : 0.400E-09 measured at (C) : 20.0
* Water solubility (mg.L-1) : 0.613E+03 measured at (C) : 20.0
* Half-life in water (d) : 7.00 measured at (C) : 20.0
* Half-life in sediment (d) : 1000.00 measured at (C) : 20.0
* Kom susp.solids (coef. for sorption on organic matter) (L.kg-1) : 131.00
* Freundlich exponent (-) : 0.90
* Kom sediment (coef. for sorption on organic matter) (L.kg-1) : 131.00
* Freundlich exponent (-) : 0.90
* Kmp (coef. for sorption on macrophytes-dry weight) (L.kg-1) : 0.00
*
* End of TOXSWA REPORT: Substance properties and substance loadings

* TOXSWA REPORT: Target percentiles water layer
* Start date simulation : 01-Jan-2000
* End date simulation : 31-Dec-2006
*
* Time window for selecting the maximum concentration:
* Evaluation period
* Start End
01-Jan 31-Dec

* Percentile summary for substance EXGE1
* -----
* Period Date of Maximum substance
* number maximum concentration in water
* (ug/L)
* -----
1 01-Aug-2000 669.8
2 07-Jul-2001 3358.2
3 06-Jul-2002 1681.4
4 05-Jul-2003 2058.6
5 16-Jul-2004 1703.4

```

6 24-Jul-2005 906.6
7 14-Jul-2006 1917.0
* The 50 percentile peak concentration of EXGE1 is 1703.4 ug/L

* End of TOXSWA REPORT: Target percentiles water layer

* TOXSWA REPORT: Time weighted average exposure concentrations (TWA) water layer selected year

* Targets:

* TWA7 TWA period: 7.0 d Time window Start date: 01-Jan End date: 31-Dec
* TWA21 TWA period: 21.0 d Time window Start date: 01-Jan End date: 31-Dec

* Target	TWA period	Maximum TWA	TWA
*		Start	(ug/L)
*	-----	-----	-----

* Results for substance: EXGE1

TWA7	7.00	16-Jul-2004	260.0
TWA21	21.00	16-Jul-2004-07h30	120.9

*

* End of TOXSWA REPORT: Time weighted average exposure concentrations (TWA) water layer selected year

* TOXSWA REPORT: Project_Summary

* Report_type Percentile
* Run_Id 9
* Location Netherlands
* Meteo_station DeBilt
* Substance EXGE1
* Result_EXGE1 1703.4 ug/L

* End of TOXSWA REPORT: Project_Summary