Handbook

Poseidon – A tool to Promote and Assess Water Reuse

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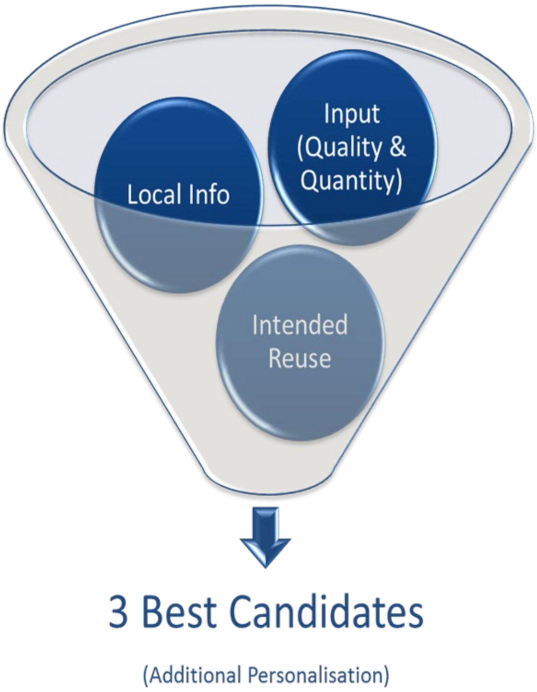
0. Glossary

Term	**Definition** *(applied to the use and understanding of Poseidon)*
Input	The wastewater that has to be treated before being reused
Unit Processes	Single water treatment technologies (primary, secondary, tertiary treatment and disinfection technologies)
Treatment Trains	Series of unit processes are combined in a so-called treatment train or treatment chain
End-use	The intended reuse of reclaimed water after its treatment with an adequate treatment train (e.g. agricultural, industrial, potable reuse or environmental recharge)
Quality class	A quality class is defined by several quality parameters included in the tool (e.g. turbidity, Biological Oxygen Demand, etc.). The quality classes included in Poseidon either represent typical water quality of wastewaters or limits based on guidelines and recommendations for reuse
Weighting	A weight can be assigned to the different evaluation criteria in order to calculate an overall treatment train score (single indicator) that considers the relative importance of different criteria based on specific cases
Distribution	Transport of wastewater and water in pipes or open channels. Depending on the elevation difference, the distribution involves pumping.
Wastewater	Water which has been polluted by human activities
Wastewater treatment	Improvement of water quality by applying a number of methods/technologies
Water reuse	Beneficial use of reclaimed water.
Greywater	Wastewater from households or office buildings (bathing, cleaning, laundry etc.) without faecal contamination, i.e. all streams except for the wastewater from toilets
Blackwater	Wastewater and sewage from toilets.
Primary treatment	Usually first step in cleaning process involving removal of solids, oils and greases by flotation, sedimentation and screening
Secondary treatment	Removal of dissolved suspended biological matter, which typically involves biological processes by microorganisms (activated sludge, membrane bioreactors, etc.)
Tertiary treatment	Cleaning to a high level of purity or/and removal of specific contaminants (e.g. heavy metals) and can include disinfection
Water reclamation	Cleaning of wastewater to a purity that can be used for specific purposes
Direct reuse	Direct use of reclaimed water for a specific purpose
Indirect reuse	Reuse of wastewater which has been previously mixed and diluted with fresh water by discharge into receiving water bodies

1. Introduction

Poseidon has been developed in the frame of the EU-project Coroado[1], which aims to develop and diffuse technologies for water recycling and reuse in Latin America by means of assessments, decision tools and implementable strategies. Coroado aims both to develop new and adapt existing concepts and produce a web-based toolbox for reuse and recycling technologies in the context of integrated water resources management. The challenge of reuse and recycling technologies projects is not the lack of treatment techniques and technologies but rather lays in the way how such schemes may be implemented in the local context.

Poseidon itself is a user-oriented, simple and fast Excel-Tool which aims to compare different wastewater treatment techniques based on their removal efficiencies, their costs and additional evaluation criteria. Furthermore, the background of the different technologies related to water reuse and the underlying theory are explained. Poseidon can be applied prior to a more detailed feasibility study in order to assess possible water reuse options and can show decision makers and other stakeholders that implementable solutions are available to comply with local requirements, as shown in Figure 1 and Figure 2.



Principle of Poseidon:

If you fill in some local information, data on the input (quality and quantity of wastewater to be treated) and the intended reuse, the tool will automatically propose the 3 best treatment trains candidates complying with your case study requirements.

Figure 1: Principle of Poseidon

[1] www.coroado-project.eu This project has received funding from the European Union's Seventh Programme for research, technological development
and demonstration under grant agreement No 2830.

2. Basic mode

Typical users: Users not used to this tool and non-experts of wastewater treatment technologies and their assessment and comparison.

Typical use: The typical intended use of this basic mode is to learn about water reuse treatment technologies and to analyze which treatment trains would comply with your case study, as shown in Figure 2**Error! Reference source not found.**.

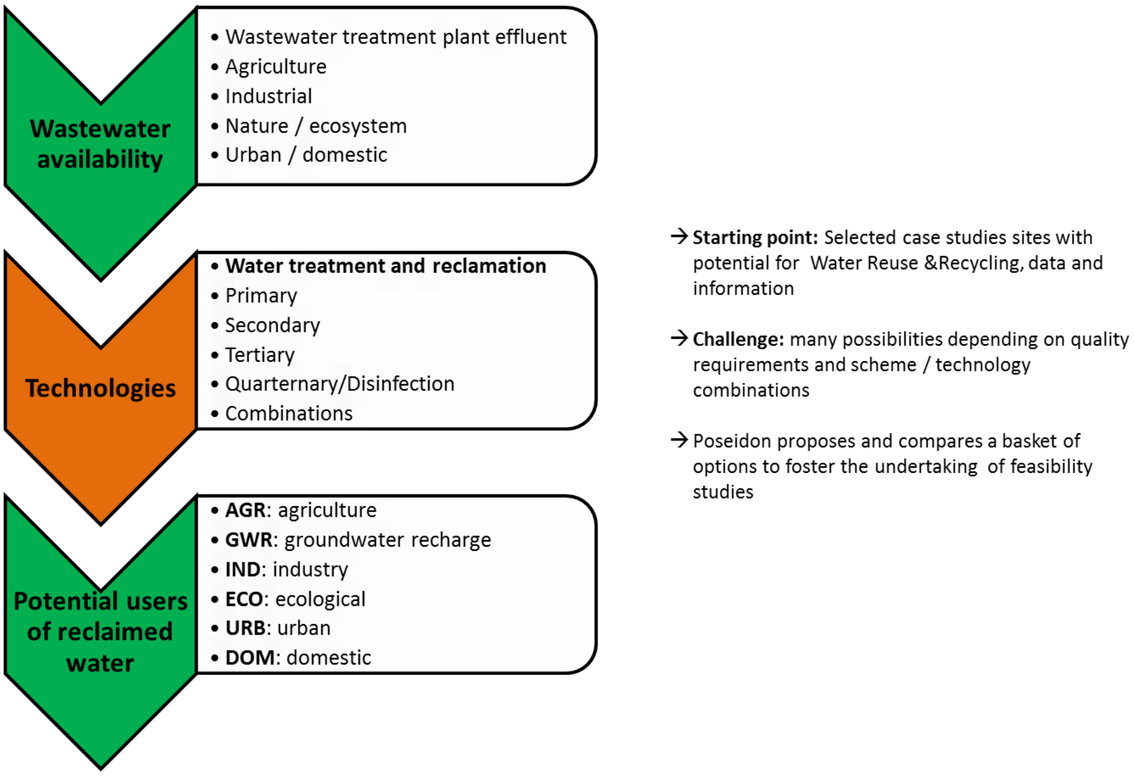


Figure 2: Main Objectives

2.1. Learn

Learn about Poseidon by clicking on the button "*1. Learn*". There are possibilities to learn more about the tool, the individual unit processes or treatment trains as well as the water quality classes and the limitations of Poseidon (see also chapter 4).

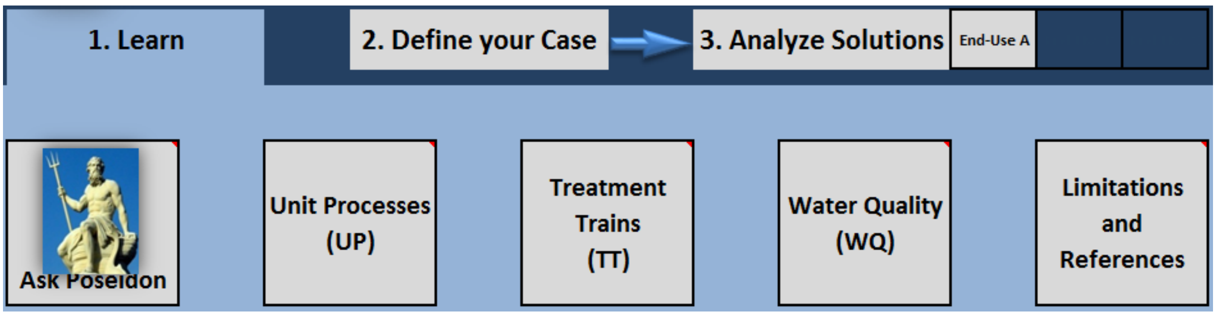
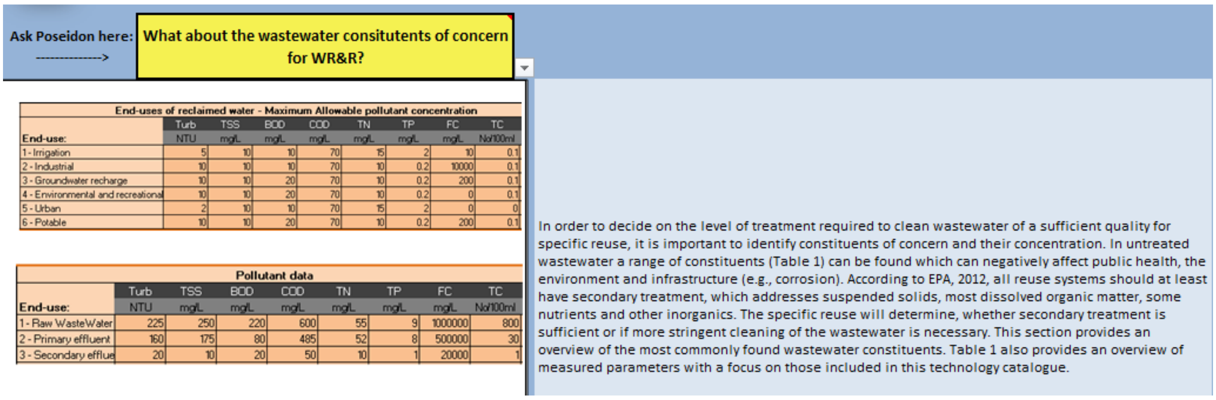


Figure 3: Learn

2.1.1. Ask Poseidon:

You will find a selection of different questions about the tool and some abbreviations you might not be familiar with. By selecting one of the questions it will automatically give you the answer in form of a picture or chart, together with a short description.



Ask Poseidon here: -------------> What about the wastewater consitutents of concern for WR&R?

End-uses of reclaimed water - Maximum Allowable pollutant concentration								
	Turb	TSS	BOD	COD	TN	TP	FC	TC
End-use:	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	No/100ml
1 - Irrigation	5	10	10	70	15	2	10	0.1
2 - Industrial	10	10	10	70	10	0.2	10000	0.1
3 - Groundwater recharge	10	10	20	70	10	0.2	200	0.1
4 - Environmental and recreational	10	10	20	70	10	0.2	0	0.1
5 - Urban	2	10	10	70	15	2	0	0
6 - Potable	10	10	20	70	10	0.2	200	0.1

Pollutant data								
	Turb	TSS	BOD	COD	TN	TP	FC	TC
End-use:	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	No/100ml
1 - Raw WasteWater	225	250	220	600	55	9	1000000	800
2 - Primary effluent	160	175	80	485	52	8	500000	30
3 - Secondary efflue	20	10	20	50	10	1	20000	1

In order to decide on the level of treatment required to clean wastewater of a sufficient quality for specific reuse, it is important to identify constituents of concern and their concentration. In untreated wastewater a range of constituents (Table 1) can be found which can negatively affect public health, the environment and infrastructure (e.g., corrosion). According to EPA, 2012, all reuse systems should at least have secondary treatment, which addresses suspended solids, most dissolved organic matter, some nutrients and other inorganics. The specific reuse will determine, whether secondary treatment is sufficient or if more stringent cleaning of the wastewater is necessary. This section provides an overview of the most commonly found wastewater constituents. Table 1 also provides an overview of measured parameters with a focus on those included in this technology catalogue.

Figure 4: Ask Poseidon

2.1.2. Unit Processes (UP):

The descriptions of the Unit Processes which are involved in this tool are presented. If you are new to the topic or if you are not sure anymore what a given unit process stands for, go to Unit Processes and there you will find all the descriptions about every single UP with some illustrating graphics.

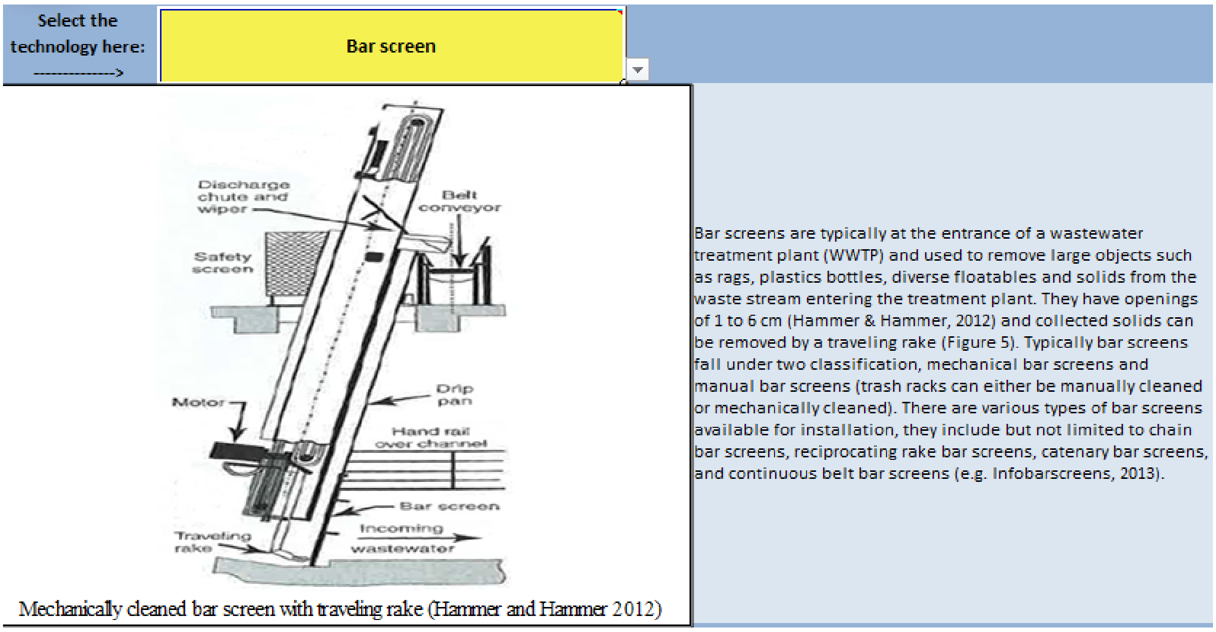


Figure 5: Unit Processes

2.1.3. Treatment Trains (TT):

Information on the catalogue of treatment trains included in the tool is presented here. Each treatment train has information on the list of unit processes, some description and sometimes a case study. Those are facilities, which are already realized and in operation. You will also find links to the reference where the given treatment trains comes from.

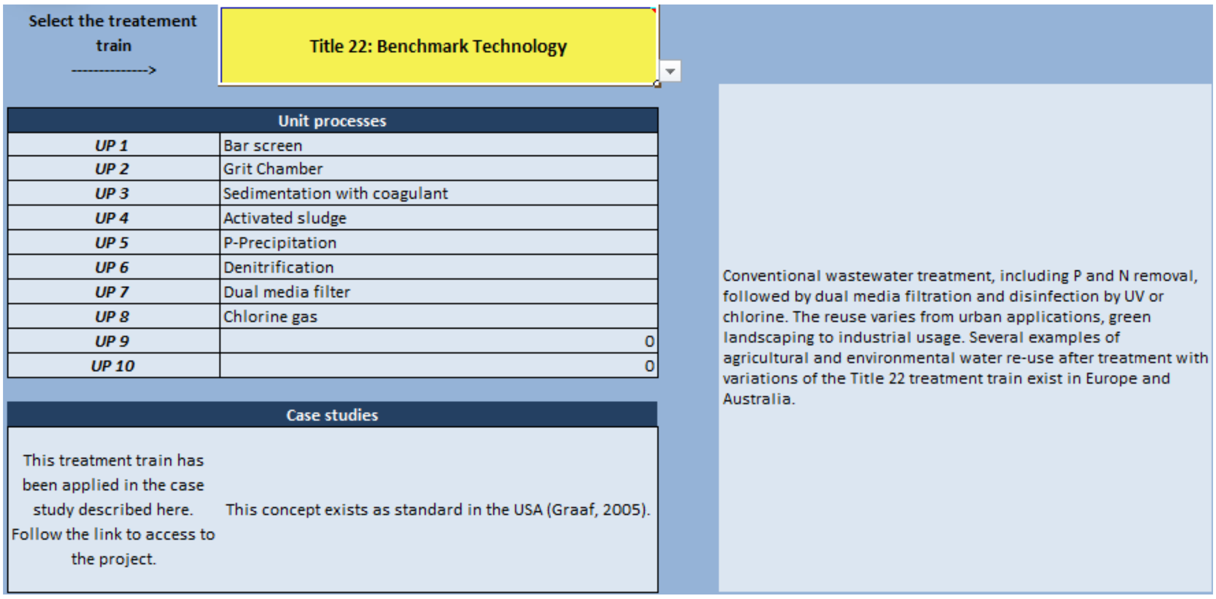


Figure 6: Treatment Trains

2.1.4. Water Quality (WQ):

You will find all the details about different water quality classes included in Poseidon. There is a short description and references as well. Water quality regulations, recommendations and requirements are a very broad and sometimes undefined topic. In addition, the compliance with requirement is another topic. For this reason, the tool proposes a catalogue of quality classes from several references (USEPA, WHO, national regulations, etc.) as indication and the user can either select one of those classes or adapt it to its own local conditions. Some references propose a range of values for selected parameters and this section allows the user to see what is used for the calculation and where those numbers come from with some additional information.

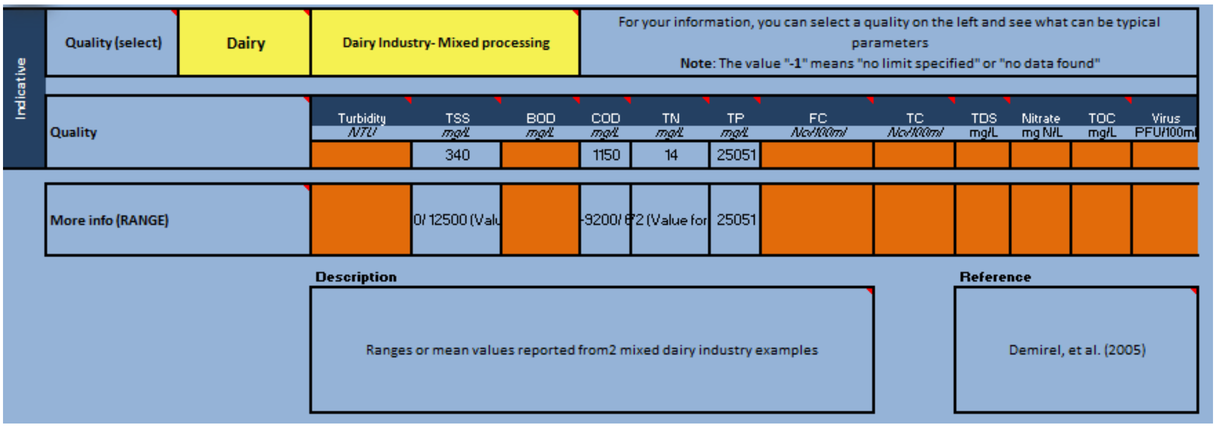


Figure 7: Water Quality

2.1.5. Limitations and References:

Main references from the data and information of the tool are listed. Poseidon is mostly based on Waternet (Dario Joksimovic, Aquarec project, 2007)[2] and Waswarplamo (Adewumi, 2011)[3]. The data have been fine-tuned a nd adapted using several references and from the data to the 4 study sites of the Coroado project. Furthermore, several workshops with experts in water treatment technologies have been organized in order to optimize and update the data included in this third version of Poseidon. Thomas Gross, Lena Breitenmoser, Thomas Wintgens, Christian Kazner, Jan Svotjka, Professor Mierzwa, Simone Verzandvoort, the whole Coroado project team, especially Professor Christos Karavitis are duly acknowledged for their inputs. The development of this tool has been partially funded by the European Commission and is also a main output of the PhD Thesis of Emmanuel Oertlé, holding the copyright on the tool.

2.2. Required data input - basic mode

The excel tool is versatile and can be used either in basic or personalization mode (section 3). In simple mode, the only required data are:

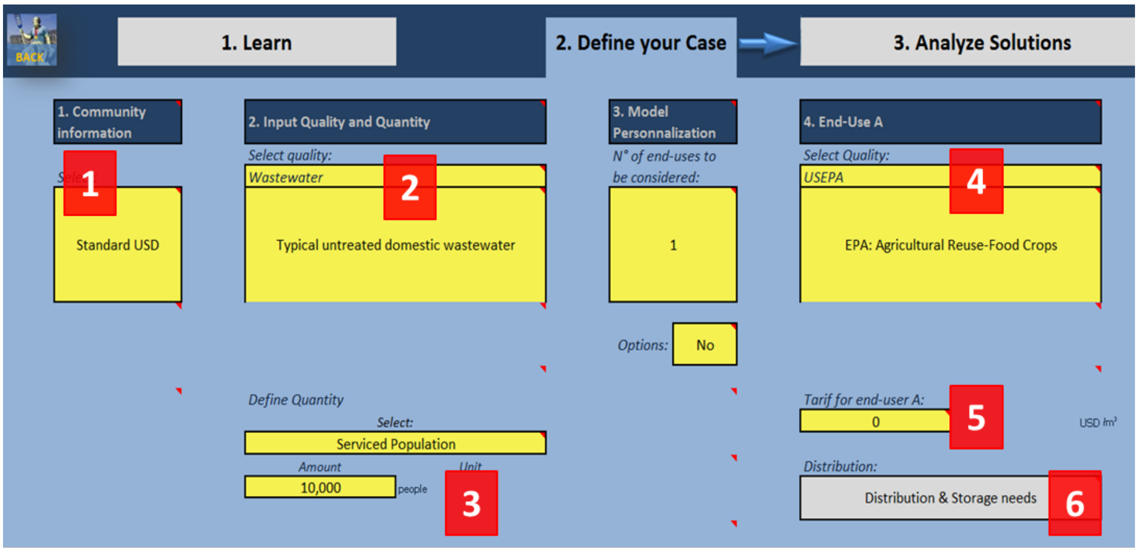


Figure 8: Data input in simple mode

1. **Community information**: what is the currency in the region you would like to apply the tool, what are labor, electricity and land costs?
2. **Input quality**: What is the quality of the water/wastewater you would like to reuse? You can either choose from a list of pre-defined quality classes or specify up to 12 quality parameters yourself.
3. **Input quantity**: What is the quantity of water/wastewater you intend to reuse?
4. **End-use quality**: What is the quality requirement for your intended end-use of the water after treatment? You can either choose from a list of pre-defined quality classes or specify up to 12 quality parameters yourself.

[2] Joksimovic, D.; Kubik, J.; Hlavinek, P.; Savic, D.; Walters, G. Development of an integrated simulation model for treatment and distribution of reclaimed water. Desalination 2006, 188, 9–20.

[3] Adewumi, J. R. A decision support system for assessing the feasibility of implementing wastewater reuse in South Africa, 2011.

5. **Tariff for end-user**: Specify the cost the reused water can be sold to the intended end-user.
6. **Distribution & storage needs**: Specify the length of the pipes required and the elevation to calculate the pumping costs. You can also specify if you need a water/wastewater storage facility.

Based on those input data, the Excel tool will calculate the performance, cost and other evaluation criteria for all the treatment trains included in the system and propose you the best candidates according to different selection and evaluation methodologies explained in sections 2.3 and 2.4.

2.3. Calculation and evaluation algorithm (informative)

In order to understand the results, the user should have a basic understanding on how the tool performs the calculations before being able to analyze the results (All those calculations are performed automatically and the user doesn't see the details while using the tool).

Poseidon contains a catalogue of unit processes (technologies) assembled into a catalogue of treatment trains (combination series of technologies). The treatment trains are based on case studies and also contain main benchmarks treatment trains and several additional examples worldwide. One example of treatment train is shown in Figure 9. In simple mode, Poseidon contains around 40 unit processes and around 50 treatment trains. There is also the possibility to add additional unit processes and to create additional treatment trains leading to an almost unlimited amount of combination. Those personalization possibilities are described in section 3

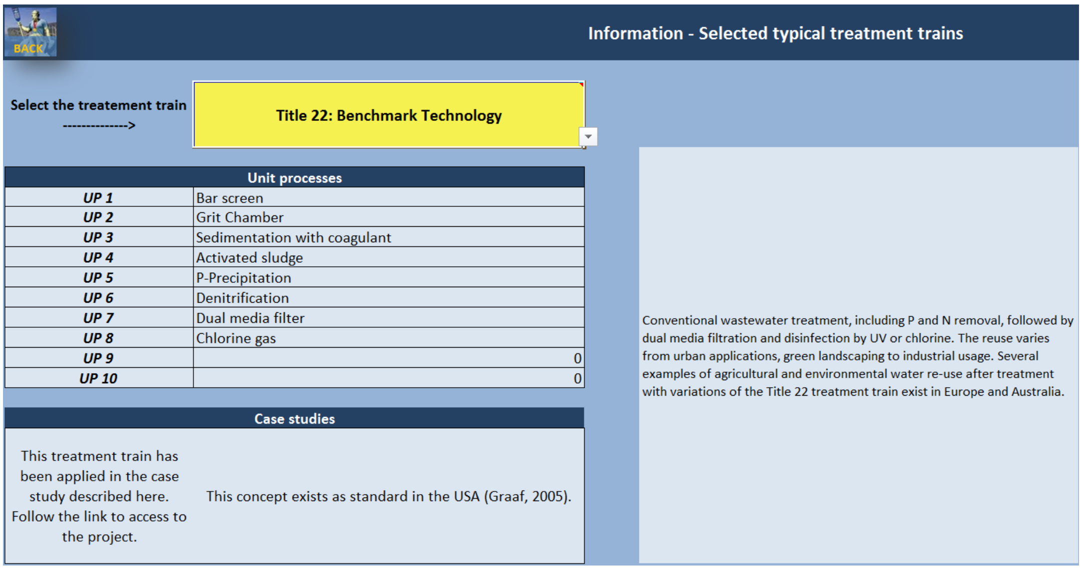


Figure 9: Title 22 benchmark technology: example of a treatment train composed of 8 unit processes

Each unit process and therefore each treatment train contain following information:

1. General description of unit process, treatment trains that can be found in the "learn" section of the tool
2. Pollutant removal percentage for each water quality parameter under minimum, average and maximum performance
3. Quantitative lifecycle costs information in order to calculate the important cost components for each case
4. Additional evaluation criteria for the technical evaluation, requirements and impacts, cost and resources. The values are between 0 and 3: (0 = nil, 1 = low, 2 = medium and 3 = high).

5. In addition to all those criteria, a normalized and aggregated single treatment train score is calculated based on the weights defined by the user (Figure 10). The values are between 0 (worse) and 3 (best).

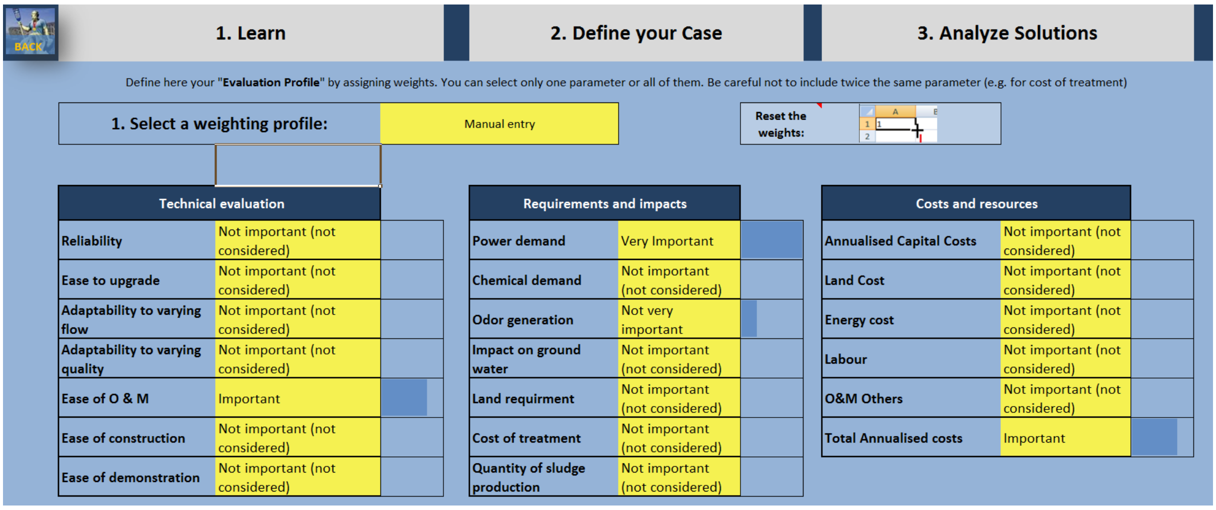


Figure 10: Weight the relative importance of different parameters in order to calculate an overall treatment train score

2.4. Elimination, ranking and evaluation process

As described in the previous section, each parameter is calculated for each treatment train included in Poseidon. Those parameters can be classified into 3 categories:

1. **Technical**: this is the calculation of the pollutant removal performance for the considered quality parameters. If a given treatment trains comply with all the water quality parameters specified for a given end-use, the treatment train is considered as compliant.[4]
2. **Economic**: these are the lifecycle treatment costs calculated quantitatively in the selected currency per cubic meter. Such a cost is calculated for each treatment train.
3. **Evaluation criteria**: those are all the additional evaluation criteria that are normalized and the values are between 0 and 3: (0 = nil, 1 = low, 2 = medium, and 3 = high). Out of those evaluation criteria, another aggregated score is calculated for every treatment train based on the assigned weights by the user, as explained in the previous section.

[4] Note that for each parameter, three performances are calculated (minimum, average and maximum performance), depending on the operation conditions and external factors. In the selection process, the maximum performance is considered and the user should be aware that under less well-operating treatment trains, the quality might not comply with the water quality required for the end-use.

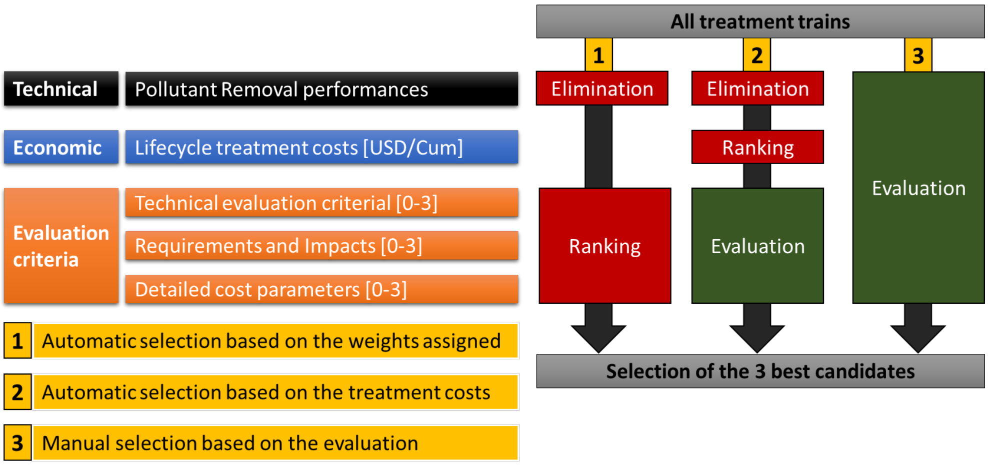


Figure 11: Evaluation algorithm proposed by the stage II assessment

Based on those three categories of parameters (technical, economic and evaluation criteria), the user can proceed to 3 main elimination, ranking and evaluation selections, as represented in Figure 11 and Figure 12:

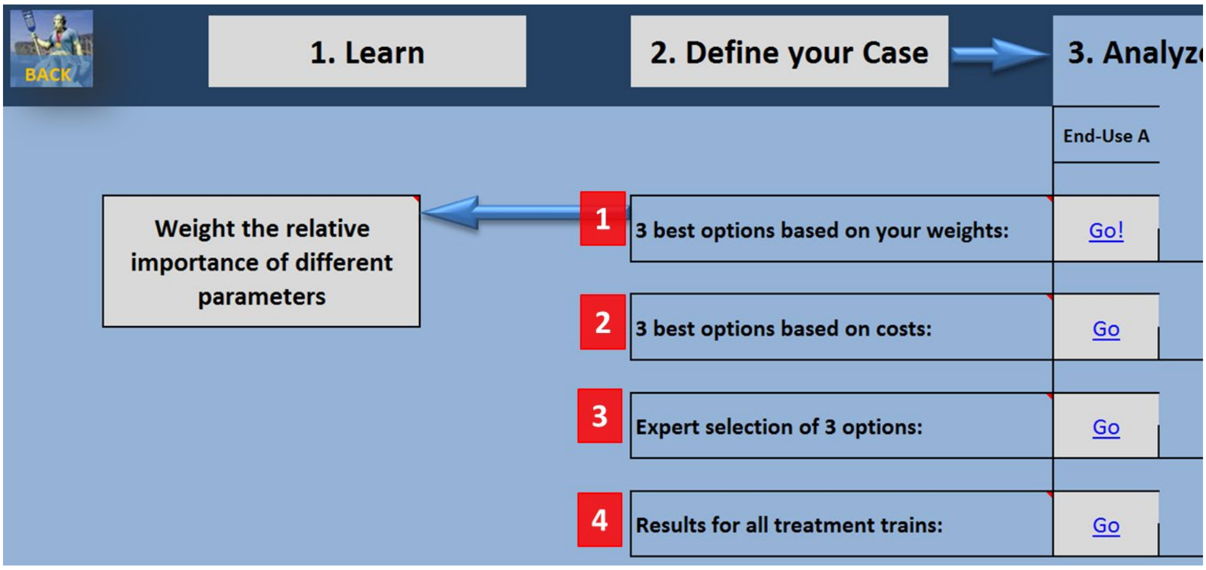


Figure 12: Analyze solution screenshot

1. **Automatic selection based on the weights assigned**: In this mode, all treatment trains not complying with the water quality required are eliminated (under maximum performance). The treatment trains complying with the quality required by the foreseen end-use are ranked according to the aggregated treatment trains single score that is based on the weights assigned by the user. The best three candidates are presented automatically.
2. **Automatic selection based on the treatment costs**: In this mode, all treatment trains not complying with the water quality required are eliminated (under maximum performance). The treatment trains complying with the quality required by the foreseen end-use are ranked according to the lifecycle treatment costs and the 3 best treatment trains are presented. In addition, the evaluation criteria are displayed but do not affect the ranking.
3. **Manual selection based on the evaluation**: In this mode, the user can choose any treatment train included in Poseidon and see the results (technical, economic and evaluation criteria).

Non-compliant treatment trains can also be selected and this mode allows total freedom for comparison.

4. **Results for all treatment trains (no selection)**: This mode number 4 doesn't have any selection but provides a table with all calculated results and allows expert analysis of every calculated parameter.

2.5. Understanding the results

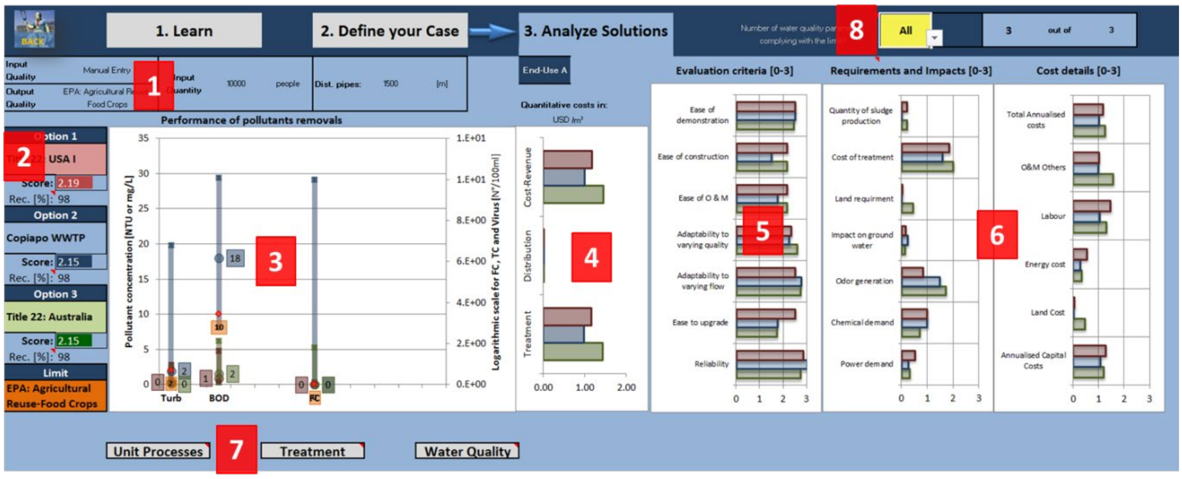


Figure 13: Example results sheet

When looking at the results, most likely the user will start to analyze the graphic shown in Figure 13. On this sheet, a range of information is displayed and can be classified into 8 points (highlighted in red):

1. Recapitulation of the data input (input quality and quantity, output quality, distribution)
2. The 3 best options are displayed in three colors (red, blue, green). For each option, the name of the treatment train is displayed with the overall treatment train score based on the assigned weights and the recovery percentage. The limit chosen for the output quality required is indicated in orange.
3. The chart displays the pollutant removal performances under minimum, average and maximal performance. The limit is indicated in orange. One can see how well perform the three options and should be aware that depending on the performance of the treatment train, it might not comply with the required quality. There are two scales, one on the right for most quality parameters in [NTU] (turbidity) or [mg/l], and logarithmic for Fecal Coliform, Total Coliform and Virus, in [n°/100ml].
4. The quantitative costs are presented in the selected currency per cubic meter. Cost-Revenue is the cost of treatment and distribution minus the foreseen selling cost to the end-user. If this value is negative, the option would generate money. The quantitative costs are calculated with the lifecycle cost methodology and include everything (OPEX, CAPEX, interest rate, electricity cost, useful life, etc.).
5. The independent evaluation criteria results are displayed. The values are between 0 and 3: (0 = nil, 1 = low, 2 = medium and 3 = high). For the evaluation criteria, a high value is considered as positive for the calculation of the overall treatment train score based on the weights (displayed under the option name, point 2).

6. The results for requirements, impacts and costs and are displayed. The values are between 0 and 3: (0 = nil, 1 = low, 2 = medium and 3 = high). For those criteria, a high value is considered as negative for the calculation of the overall treatment train score based on the weights (displayed under the option name, point 2).
7. The three buttons are links to the "Learn" component. Depending on the option proposed, the user can look in the database to see the details of each treatment train, unit process and water quality class.
8. In case no treatment train complies with the water quality required, the user can choose how many water quality parameters should comply with the requirements (e.g. 2 out of 3)

In addition, some results are presented in a table form at the bottom of the sheet. The user can also look at the table including all results of all treatment trains, as shown in Figure 14.

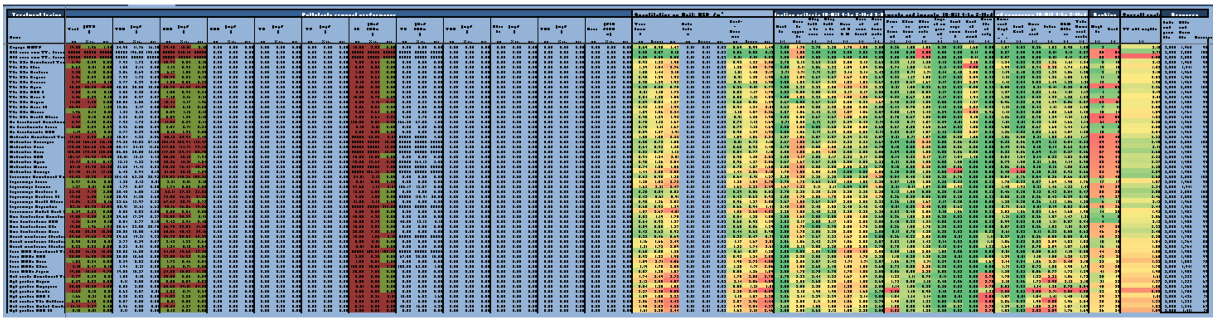


Figure 14: Results for all treatment trains displayed in a table

Meaning of the color coding:

In the first 12 columns (factors about the water quality) red is negative and green is positive. If it is green, the reclaimed water is compliant with the selected water quality requirement for the end use. If red, it is not compliant. The rest of the columns show criteria such as quantitative costs, evaluation, requirements and impacts and costs and resources. The colors go from green (the best) to yellow (medium) up to red (bad) and represent a ranking for each column.

3. Personalization features

It is possible to personalize Poseidon in order to match certain needs. For example, it is possible to change and create community information profiles, define quality classes for the water, consider up to three end uses for the treated water, create own treatment trains or unit processes and define or calculate storage and distribution costs.

3.1. Additional features - Personalization

In the personalization mode, the same analysis can be conducted but several additional features are offered:

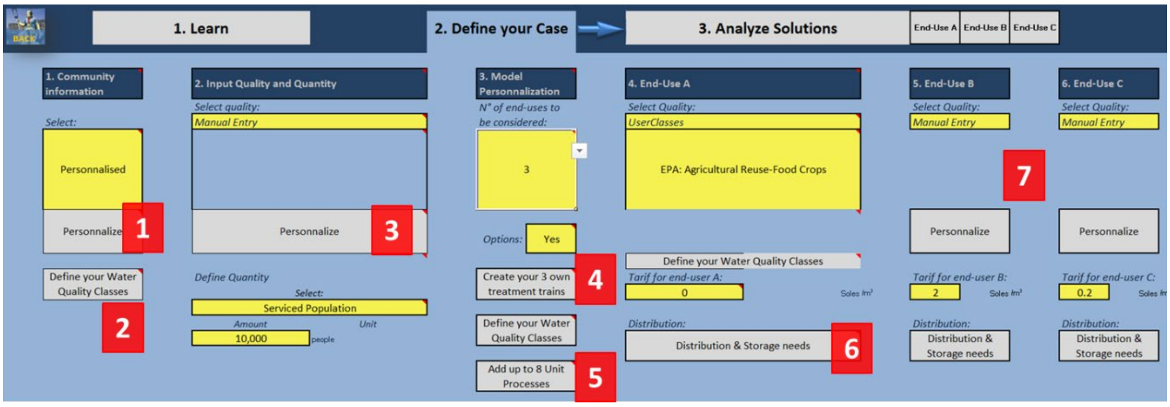


Figure 15: Data input Personalization

1. **Personalize Community information**: You can define in details different cost components, what is the interest and discount rate, etc.
2. **Define your water quality classes A-E**: Here you can define yourself quality classes A-E by specifying the different quality parameters for each class. The defined quality class can then be selected as input data if you choose the quality category *"User Classes"*.
3. **Personalize water quality:** You can personalize the water quality for each parameter.
4. **Create your own treatment trains:** It is possible to create your own three treatment trains by assembling up to 10 unit processes from the database included in the Excel tool. The created treatment trains will be considered for the analysis.
5. **Add up to 8 unit processes:** You can add up to 8 additional unit processes (e.g. UASB) to the database. Note that this is an intensive process as for each new unit processes, a large amount of data is required (pollutant removal performances, costs, evaluation criteria, etc.)
6. **Distribution and Storage needs:** It is possible to change the pipe design criteria by changing the average flow velocity.
7. **End-uses B and C**: You can specify quality and distribution data for two additional end uses and therefore compare up to three different types of intended reuse for on input and compare them accordingly.

3.2. Procedure to define community information profiles

This option allows the specification of community information mainly related to costs. The user can specify currencies with the exchange rate to USD 2006 (basis for the calculation). Apply following procedure to add new community information:

- Select *Define your case*.
- Choose from point 1 *Community information* the option *Personalized*. A new field *Personalize* appears.
- Click on this new box redirects the user to a new sheet, where all the fields in yellow can be updated.
- The last row with the title *Personalized* can be completed with own currency information.
- Go back to the page *Define your case* by selecting the box *Back to community selection*.

Standard USD	Currency [CUR]	Exchange rate to USD 2006 [CUR/USD2006]	Land cost [CUR/ha]	Electricity cost [CUR/kWh]	Personal cost [CUR/person-hour]	Discount rate	Piping	Controls & Instrumentation	Site electrical	Site development	Site works	Engineering	Contingency
Standard Community based on USD 2006.	USD	1	10000	0.05	20	8%	8%	8%	9%	8%	6%	12%	15%
Argentina - A-Peso	**Currency**	**Exchange rate to USD 2006**	**Land cost**	**Electricity cost**	**Personal cost**	**Discount rate**	**Piping**	**Controls & Instrumentation**	**Site electrical**	**Site development**	**Site works**	**Engineering**	**Contingency**
Argentina - A-Peso	ARS	3.07	46,006.55	0.15	61.34	8%	8%	8%	9%	8%	6%	12%	15%
Argentina - USD	**Currency**	**Exchange rate to USD 2006**	**Land cost**	**Electricity cost**	**Personal cost**	**Discount rate**	**Piping**	**Controls & Instrumentation**	**Site electrical**	**Site development**	**Site works**	**Engineering**	**Contingency**
Argentina - USD	USD	1.00	15,000.00	0.05	20.00	8%	8%	8%	9%	8%	6%	12%	15%
Chile - C-PESO	**Currency**	**Exchange rate to USD 2006**	**Land cost**	**Electricity cost**	**Personal cost**	**Discount rate**	**Piping**	**Controls & Instrumentation**	**Site electrical**	**Site development**	**Site works**	**Engineering**	**Contingency**
Chile - C-PESO	CLP	525.51	5,255,052.85	76.20	10,510.11	8%	8%	8%	9%	8%	6%	12%	15%
Chile - USD	**Currency**	**Exchange rate to USD 2006**	**Land cost**	**Electricity cost**	**Personal cost**	**Discount rate**	**Piping**	**Controls & Instrumentation**	**Site electrical**	**Site development**	**Site works**	**Engineering**	**Contingency**
Chile - USD	USD	1.00	10,000.00	0.15	20.00	8%	8%	8%	9%	8%	6%	12%	15%
Brazil - REALS	**Currency**	**Exchange rate to USD 2006**	**Land cost**	**Electricity cost**	**Personal cost**	**Discount rate**	**Piping**	**Controls & Instrumentation**	**Site electrical**	**Site development**	**Site works**	**Engineering**	**Contingency**
Brazil - REALS	BRL	2.41	28,888.98	0.29	48.13	8%	8%	8%	9%	8%	6%	12%	15%
Brazil - USD	**Currency**	**Exchange rate to USD 2006**	**Land cost**	**Electricity cost**	**Personal cost**	**Discount rate**	**Piping**	**Controls & Instrumentation**	**Site electrical**	**Site development**	**Site works**	**Engineering**	**Contingency**
Brazil - USD	USD	1.00	12,004.00	0.12	20.00	8%	8%	8%	9%	8%	6%	12%	15%
Mexico - M-PESO	**Currency**	**Exchange rate to USD 2006**	**Land cost**	**Electricity cost**	**Personal cost**	**Discount rate**	**Piping**	**Controls & Instrumentation**	**Site electrical**	**Site development**	**Site works**	**Engineering**	**Contingency**
Mexico - M-PESO	MXN	10.76625793	107662.5793	1.356548499	215.3251586	8%	8%	8%	9%	8%	6%	12%	15%
Mexico - USD	**Currency**	**Exchange rate to USD 2006**	**Land cost**	**Electricity cost**	**Personal cost**	**Discount rate**	**Piping**	**Controls & Instrumentation**	**Site electrical**	**Site development**	**Site works**	**Engineering**	**Contingency**
Mexico - USD	USD	1.00	10,000.00	0.13	20.00	8%	8%	8%	9%	8%	6%	12%	15%
Personnalised	**Currency**	**Exchange rate to USD 2006**	**Land cost**	**Electricity cost**	**Personal cost**	**Discount rate**	**Piping**	**Controls & Instrumentation**	**Site electrical**	**Site development**	**Site works**	**Engineering**	**Contingency**
Peru	Soles												

Figure 16: Community information - specify the different parameters

3.3. Define your water quality classes A-E

Data entry - Create your own water quality classes (A-E)

Indicative			
Quality (select)	Argentina	ARG - Water for agricultural Irrigation(non-food crops)	For your information, you can select a quality on the left and see what can be typical parameters **Note**: The value "**-1**" means "no limit specified" or "no data found"

Quality	Turb	TSS	BOD	COD	TN	TP	FC	TC	TDS	Nitrate	TOC	Virus
	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	No/100ml	No/100ml	mg/L	mg N/L	mg/L	PFU/100ml
		50	30		30	5			500	30		

Define here your own quality classes A-E

Class A	Turb	TSS	BOD	COD	TN	TP	FC	TC	TDS	Nitrate	TOC	Virus
Water quality **very low** (it cannot be reused for any purpose neither discharged and needs treatment);	500	500	440	1200	110	18	2000000	1600	1600	150	30	200
Class B	Turb	TSS	BOD	COD	TN	TP	FC	TC	TDS	Nitrate	TOC	Virus
Water quality is **low** (it cannot be reused for any purpose but can be discharged according to the national regulations);	10	100	100	200	-1	-1	-1	25	-1	-1	-1	-1
Class C	Turb	TSS	BOD	COD	TN	TP	FC	TC	TDS	Nitrate	TOC	Virus
Water quality is **medium** (it could be reused for restricted agricultural - food crops not consumed uncooked - and/or industrial purposes);	10	30	30	-1	10	-1	200	23	-1	-1	-1	-1
Class D	Turb	TSS	BOD	COD	TN	TP	FC	TC	TDS	Nitrate	TOC	Virus
Water quality is **good** (it could be reused for agriculture and other non-potable uses in industry or in the urban network);	-1	20	20	150	-1	-1	-1	1000	30	50	-1	-1
Class E	Turb	TSS	BOD	COD	TN	TP	FC	TC	TDS	Nitrate	TOC	Virus

Figure 17: water quality classes A-E

3.4. Procedure to Personalize water quality

Also add a figure with the numbers in red that fit the list of points after:

It is possible to define the exact parameter values of your influent water instead of choosing a category of wastewater with defined values.

Quality (enter data here if you selected "Manual Entry")	Turb	TSS	BOD	COD	TN	TP	FC	TC	TDS	Nitrate	TOC	Virus
	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	No/100ml	No/100ml	mg/L	mg N/L	mg/L	PFU/100ml

Figure 18: Define your own water quality classes

Following procedure has to be undergone:

1. Select Define your case.
2. Choose from point 2 Input Quality and Quantity the option Manual Entry. A new field Personalize appears.
3. Clicking on this field opens a new sheet in which the influent wastewater parameters can be entered. Pay attention to match the given units.
4. If one parameter is not defined, enter the value "-1".
5. Go back to the Define your case page by selecting the box *"Back to define your case Study"*.

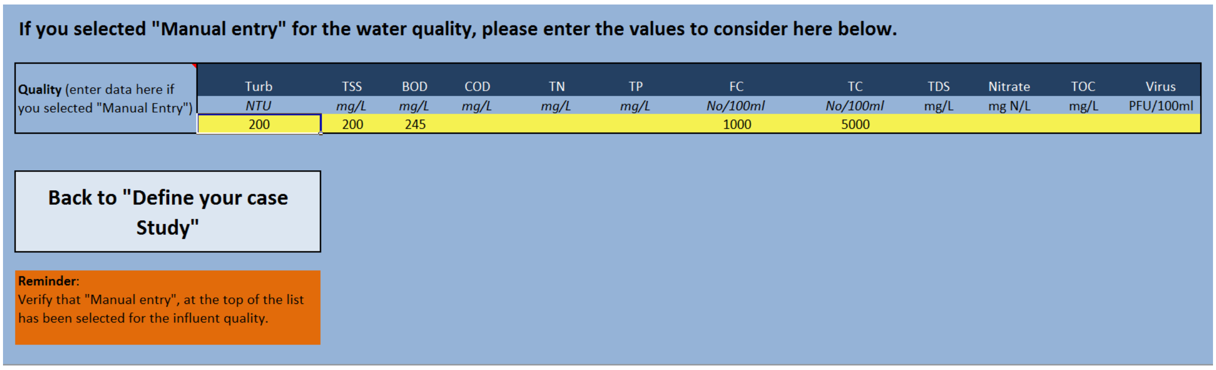


Figure 19: Own water quality class - data input

3.5. Procedure to create own treatment trains

Poseidon proposes a catalogue of treatment trains, composed of combinations of single unit processes representing typical wastewater treatment plant. It is nevertheless possible to combine the different unit processes in a new, more case-fitting treatment train.

Figure 20: Create your own treatment trains

Select the Excel-sheet 2.3.

1. Change the name of the treatment train in the first yellow box (*Edit your own TT, here: only bar screen*).
2. Describe your own treatment train by selecting the correspondent unit processes beginning on top with *Unit Process 1*. To do so, select the yellow box right to the unit process. A shortlist can now be open. Select the appropriate unit process from this list and continue with the following step in your treatment train as described.
3. Enter up to 10 unit processes. If not all possibilities are used, leave the last unit processes in the possibility *"NONE"*. The *Number of Unit Processes* allows a control: The number of entered unit

processes should match the one given in the light grey field below your treatment train. Never insert *"NONE"* between two unit processes.

4. To describe the newly created treatment train, use the yellow box *"Description of own treatment train 1"*.

It is possible to create up to three treatment trains in that way that will be considered in the evaluation and ranking processes.

3.6. Procedure to create additional unit processes

Up to 8 additional unit processes can be created and used for the creation of your own treatment trains. To add personalized unit processes, follow the procedure below:

Own Unit Process 1	Name:	test 1	Description:		Recovery [%]	90

Turb			TSS			BOD			COD			TN			TP		
min	% av.	max	min	% av.	max	min	% av.	max	min	% av.	max	min	% av.	max	min	% av.	max
FC			**TC**			**Conductivity**			**Nitrate**			**TOC**			**Virus**		
min	% av.	max	min	% av.	max	min	% av.	max	min	% av.	max	min	% av.	max	min	% av.	max

Figure 21: Create additional unit process

1. Select the Excel-sheet 2.5.
2. Change the name of the unit process in the yellow field *test 1.*
3. Add a short description of the unit process in the yellow field right to the denomination.
4. Specify the overall pollutant removal efficiency. Provide information about the different parameters such as turbidity, total suspended solids etc. as well as their range (minimum, average, maximum).
   Note: If not all data are available, it is important to indicate valued for pollutant removal performance at least for the maximum performance as this is the value used in the calculation.
5. Enter values on the evaluation indicators and on the costs (it has to be sensible and relative to the evaluation criteria of the other unit processes included in the catalogue).
6. Enter information related to costs for at least two different flows

It is possible to create up to eight unit processes in that way. Each of these can be either used as a standalone wastewater treatment or integrated in a treatment train as described in chapter 3.5.

3.7. Procedure to define distribution and storage needs

Wastewater has to be collected, treated and stored and in the end redistributed. The distribution and storage costs are not to be underestimated. To take them into consideration, follow the procedure:

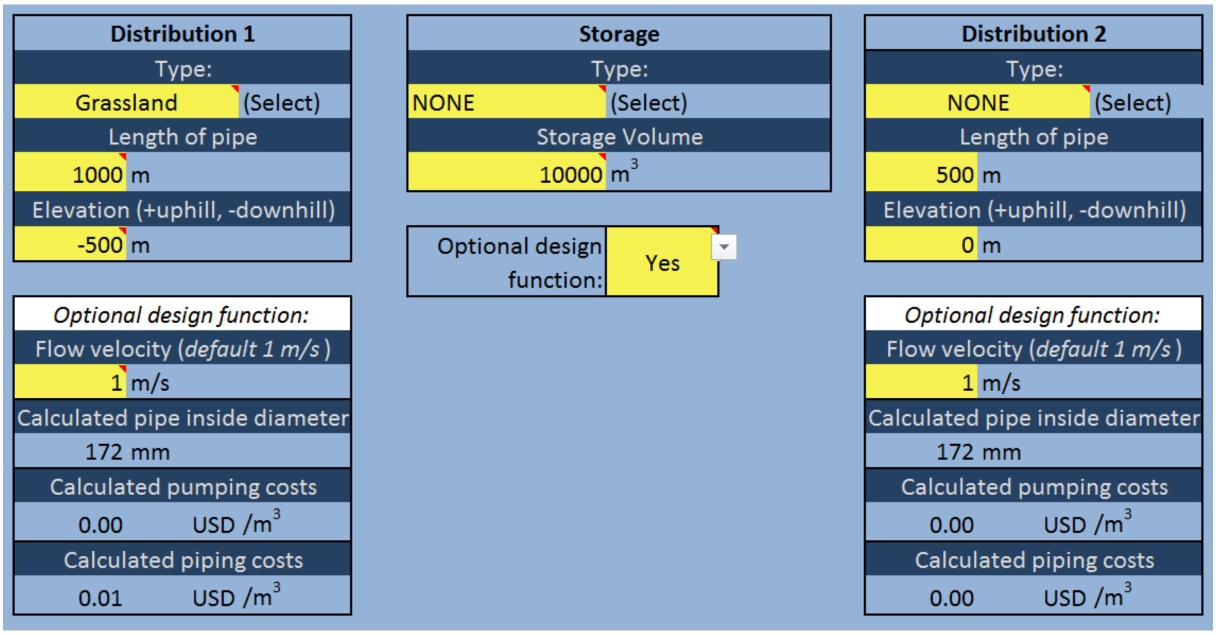


Figure 22: Define distribution and storage needs

3.8. Procedure to consider more end uses

If the treated wastewater could be used in more than one application field, it is possible to consider up to three different end-uses. This function is useful if a potential wastewater could be reused exemplarily for agriculture and industrial reuse. The tool can propose adapted treatment trains for both options considering the same influent. To do so, follow the procedure below.

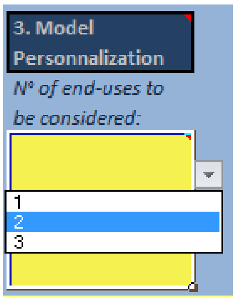


Figure 23: N° of end-uses

1. Select Define your case.
2. Choose from point 3 Model Personalization the option 2 or 3 according to the desired number of end-uses for the wastewater.
3. More fields are added according to the chosen number of end-uses. The end-uses are differentiated in A, B or C (if three end-uses have been selected).
4. As the tariff and the distribution can vary from one end-use to another, enter the according values in the corresponding fields.

4. Typical examples

4.1. Example 1: two potential water reuse scenarios for the untreated wastewater from a city

A village in Europe with typical domestic untreated wastewater from 5,000 inhabitants is considered. You would like to analyze how to treat this water for two scenarios and find the best 3 options based on costs of treatment.

Scenario 1: Reuse for aquaculture

Scenario 2: Reuse for industrial cooling in an industry

The foreseen wastewater treatment plant will be at an altitude of 1'000m above sea level. The foreseen agriculture area is 1 km away in a rural area and has an altitude of 500m above sea level. The industry is 100m away from the foreseen wastewater treatment plant.

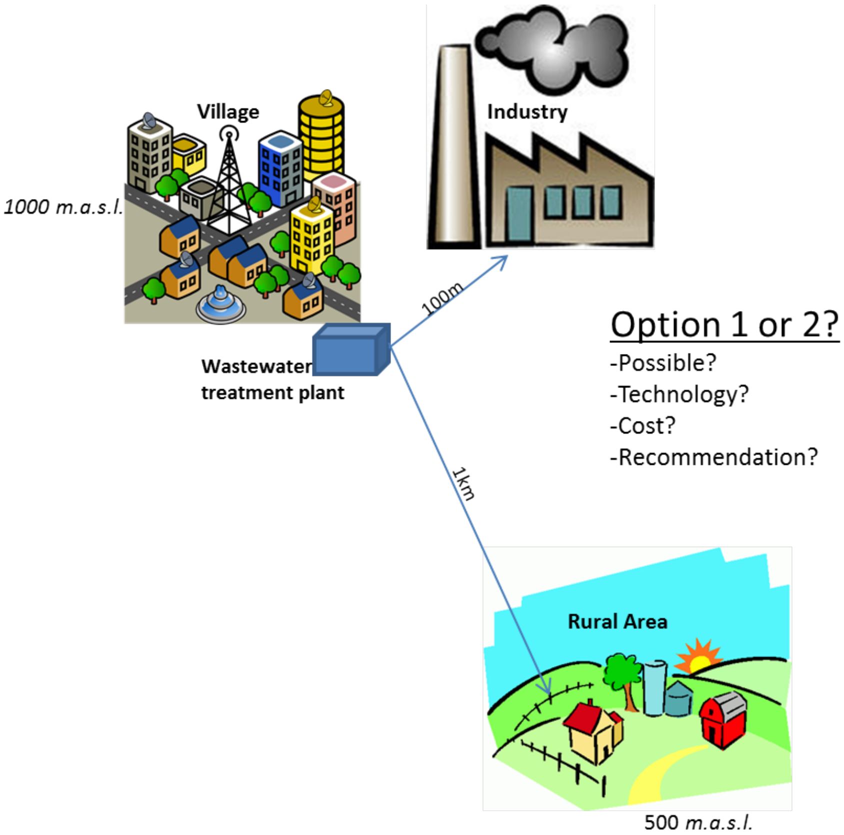


Figure 24: Visualization Example Task

Answer the following questions:

- Are there suitable treatment trains for reuses 1 and/or 2?
- Which are the best 3 options based on the costs?
- What are the costs of treatment for those options?
- What are the costs of distribution for option 1?

4.1.1. Suggested Procedure

This is how the tool looks like at the beginning:

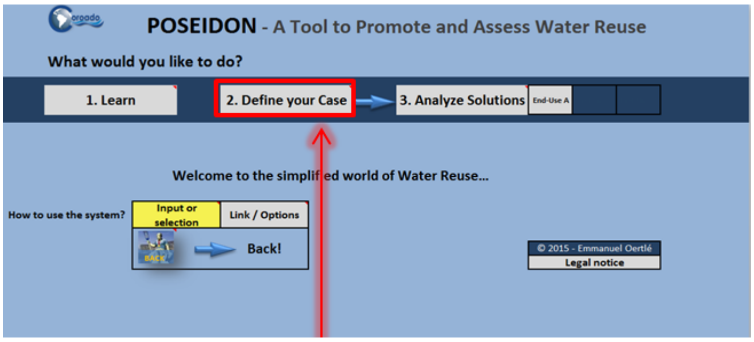


Figure 25: Beginning

First click on the button *"Define your Case"*

Let's start to fill in information:

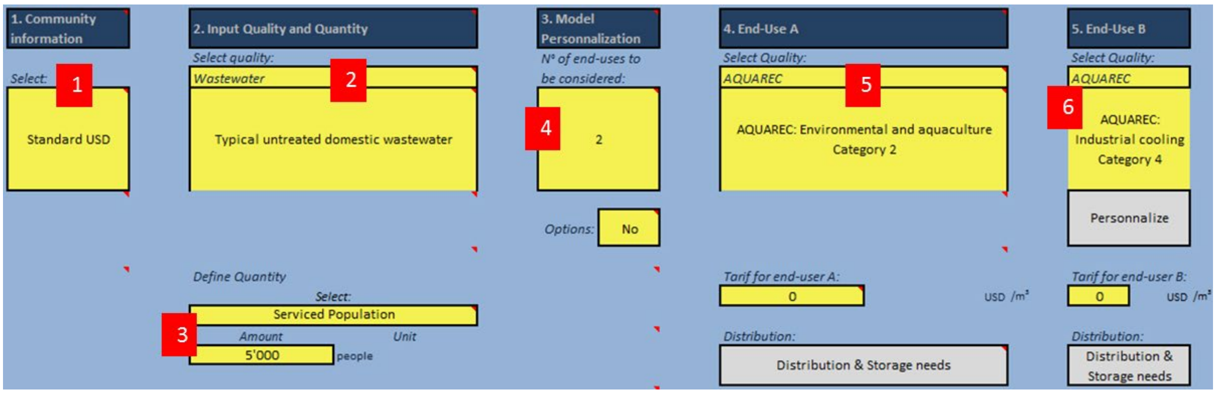


Figure 26: Filling in the information's

1. First select Standard USD.
2. Select Wastewater on the top and just under it select "Typical untreated domestic wastewater".
3. Select Serviced Population and on the bottom type in 5,000 for the inhabitants.
4. In N° of end-uses to be considered you have to fill in 2, because we have 2 different scenarios in this task.
5. Here you choose AQUAREC on the top and just under it you choose AQUAREC: Environmental and aquaculture Category 2.
6. Select AQUAREC on the top as well, but under it choose AQUAREC: industrial cooling Category 4.

To fill in the information's for the 1st scenario click the button *"Distribution & Storage needs"*

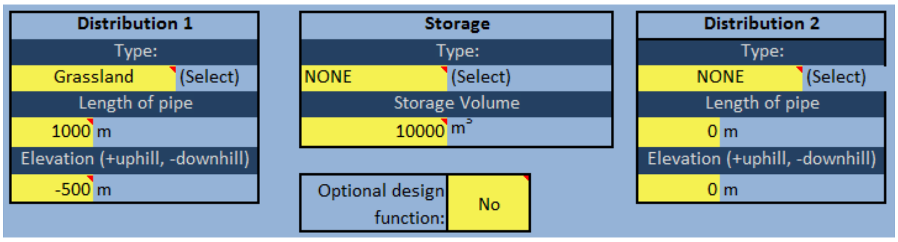


Figure 27: Distribution & Storage needs

Now fill in the needed data. Do the same for the other scenario just click on the same button as before, but under the *"5.End-Use B"*

4.1.2. Suggested procedure - Analyze the results

To analyze your solutions click on the button *"3. Analyze Solutions"*

You will see this window:

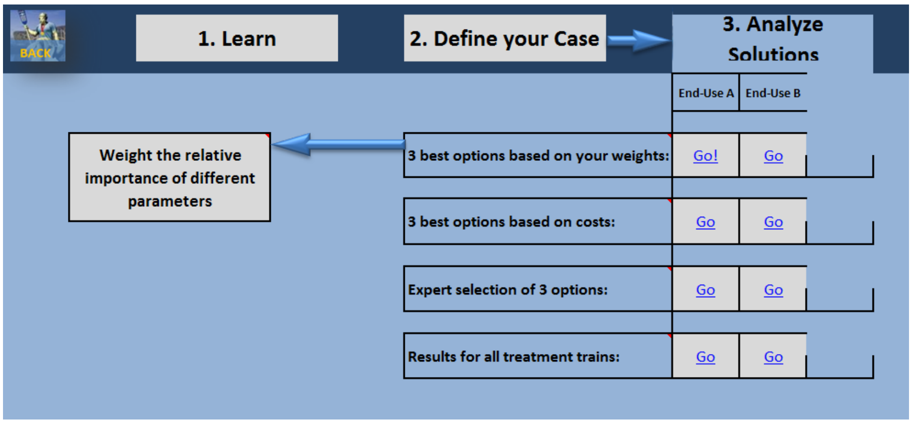


Figure 28: 3. Analyze Solutions

If click on *"3. Analyze Solutions"* You can select one of the following buttons and you will see your results:

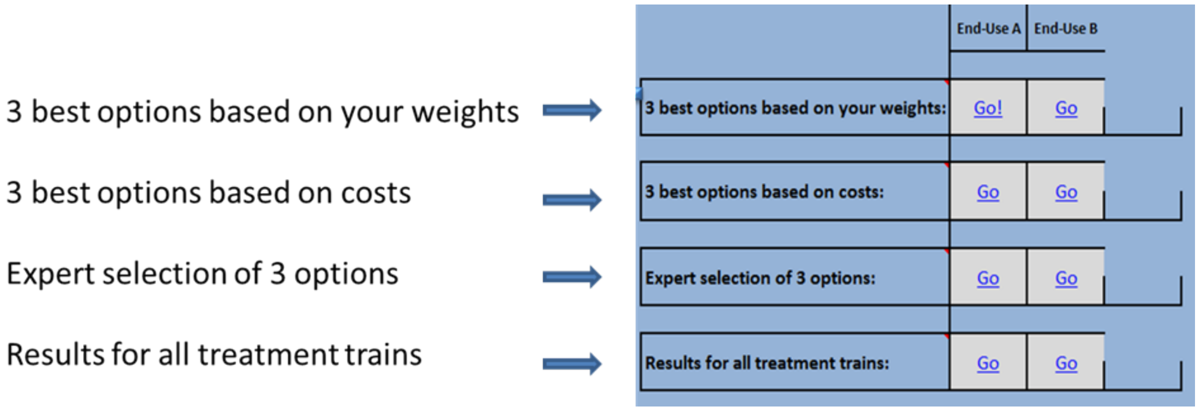


Figure 29: Different options in 3. Analyze Solutions

For example if you click here:

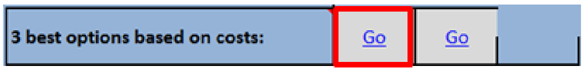


Figure 30: 3 best options based on coasts

You will see the 3 best options based on coasts for the 1st scenario. If you click the *"Go"* on the right side you will see the same just adapted to the 2nd scenario.

On the left side you see now the three best options. These are examples of projects in other countries which are already in service.

Figure 31: Table with results

4.1.3. Questions & Answers:

1. Are there suitable treatment trains for reuses 1 and/or 2?	Yes, there are a lot of suitable treatments for reuses for both of the scenarios.
2. Which are the best 3 options based on the costs?	1st scenario (reuse for aquaculture): Option1: Title 22: Belgium Option2: Soil treatment: Israel Option3: Soil treatment: Benchmark 2nd scenario (reuse for industrial cooling in an industry): Option1: Title 22: Belgium Option2: Soil treatment: Israel Option3: Soil treatment: Benchmark
3. What are the costs of treatment for those options?	Click on *"3 best options based on costs"* and you will see the costs of treatment in the table (*in this case in USD/m^3, you can choose other currencies*). Belgium: 1.00 [USD/m^3] Israel: 1.37 [USD/m^3] Benchmark: 1.40 [USD/m^3]
4. What are the costs of distribution for option 1?	Click on the same button as in question 3: Distribution costs are 0.02 [USD/m^3]

Remark and analysis: For this case, it appears that the treatment train Title 22 Belgium complies with both intended reuse and offer best costs of treatments. There are some additional treatment trains that would be cheaper but that apparently wouldn't comply with the water quality requirements indicated. If a treatment train based on Title 22: Belgium would be implemented in this fictive European village, it would comply with both scenarios (industrial and agricultural reuse) and it could be a good option to consider both reuses with a single treatment. The industry would probably also pay for the reclaimed water and it would make sense to initiate some more detailed design and feasibility studies for this case.

4.2. Example 2: comparison of different treatment trains

Compare 3 treatment trains for the treatment of typical untreated domestic wastewater from 5,000 inhabitants. Consider the following three treatment trains:

1. Treatment train 1: Title 22 Benchmark technology
2. Treatment train 2: Bar screen, Grit chamber, Sedimentation with coagulant, Activated sludge, chlorine gas
3. Treatment train 3: Maturation pond, Maturation pond, chlorine dioxide

4.2.1. Suggested procedure

To fill in all the information's go first to *"2. Define your Case"*

There you can fill in the 5000 inhabitants as you have done it in task 1

For the next step you click on *"Create your own 3 treatment trains"*

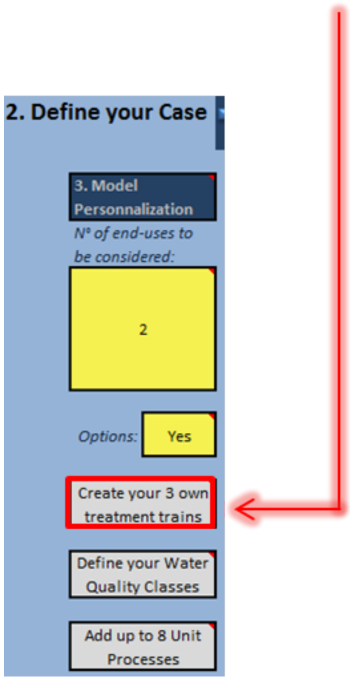


Figure 32: Create your own 3 treatment trains

Now fill in all the data; you have to create two new treatment trains, because the 1st treatment train *"Title 22 Benchmark technology"* we have to fill in somewhere else. You can call the 2nd treatment train *"TT2"* and de 3rd *"TT3"*.

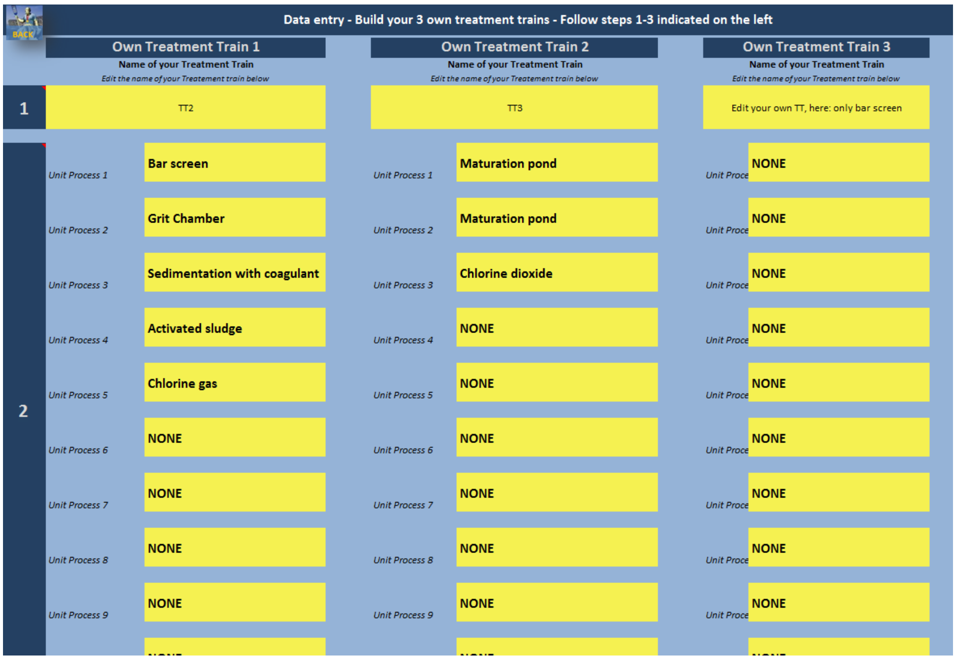


Figure 33: Data entry for your own 3 treatment trains

Now you go back and click on *"3. Analyze Solutions"*

There you click on *"Go"* by the "*Expert selection of 3 options*"

You will come to the page with your results, once you are there you have to change the treatment trains on the left side in the middle and fill in the needed 3 treatment trains:

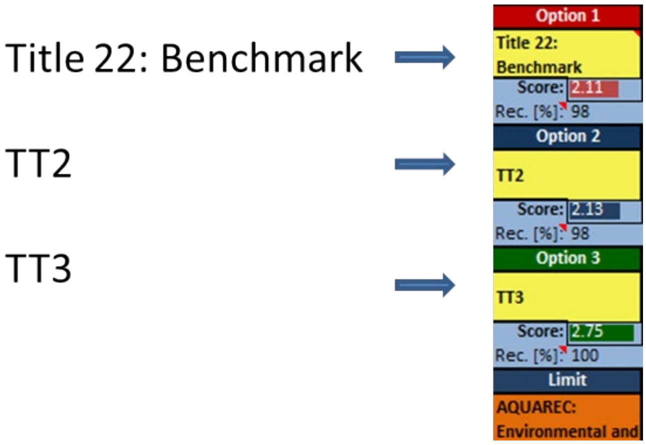
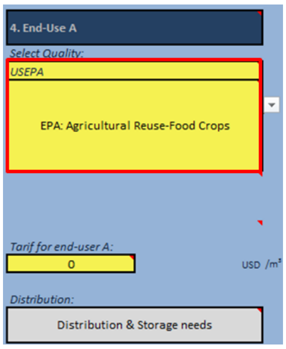


Figure 34: Title 22 Benchmark, TT2, TT3

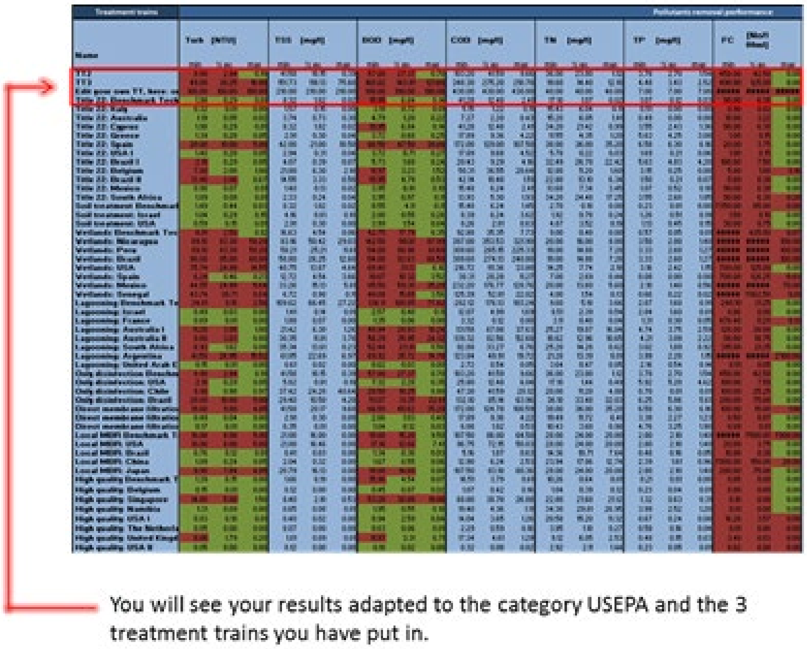
4.2.2. Questions & Answers

1. Are the 3 treatment trains compliant with EPA agricultural reuse - food crop quality class?

For the first task go to *"2. Define your Case"* and select in 4. End-Use A *"USEPA"* and under *"USEPA"* you choose *"Agricultural Reuse - Food Crops"* quality class:



Than you go to *"3. Analyze Solutions"* and click on the *"GO"* on *"Results for all Treatment Trains"*



If the results are green it is compliant, if they are red it is not compliant.

2. What are the treatment costs of the three treatment trains?

   Select *"Expert selection of 3 options"* in *"Analyze solutions"* there you will find the cost of treatment for your three treatment trains.

3. What would you recommend?

   Here TT2 and TT3 would be cheaper, but Title 22 Benchmark works better if you look in the table. So I would choose the solution which they built in Title 22 Benchmark

5. Conclusions

Poseidon is a tool to promote and asses water reuse. Different parameters can be personalized and adapted to every single user. The values given by Poseidon should not be considered as absolute values but only as indicators. The accuracy is not guaranteed. The given results show different possibilities to adapt or enhance the treatment of wastewater, but only the implementation in "real life" with adapted monitoring of the treatment can result in accurate values for a given treatment plant.