eawag
aquatic research

Water Flow Diagram Quick guide

STEP 1

Process ignition

Organize a call or meeting with the mayor or the relevant stakeholders from the municipality to present the WFD and ask for a **written support statement**.
The written statement of the municipality supporting the WFD will enable the stakeholder engagements and back-up the data collection. Also discuss with the municipality who can provide what kind of data and define the system boundaries.

STEP 2

Data collection

Contact water utilities, government services and search online for data. Often, data is scarce. Don't get discouraged!

Data needed:
- Population
- Precipitation
- Area
- Water source(s)
- Drinking water treated
- Water losses
- Water for use without treatment
- Imported water
- Treated wastewater
- Inflow/Overflow sewers
- Exported water
- Recycled water

Excel

STEP 3

Draft WFD

Start early to draft your first Water Flow Diagram. It will give you a useful overview of what data is still needed.

To draft the WFD
1. Insert the data in the Excel template provided.
2. Paste the "flow code" of the Excel template into the SankeyMatic online tool and edit it online
3. Finish the layout in Adobe Illustrator or Powerpoint

STEP 4

Appropriation meeting

Call for a meeting with the relevant stakeholders where you present the draft WFD.

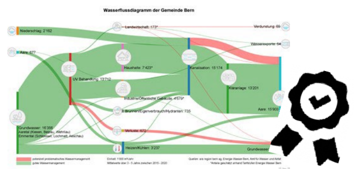
Discussion points:
- Is the diagram plausible?
- What key challenges can be identified from the diagram?
- What opportunities can be identified from the diagram?
- What are potential actions to overcome challenges and use opportunities?

STEP 5

Final WFD

Create the final WFD. Then, disseminate the diagram in a meeting with the relevant stakeholders and other activities!

- Present the result to the municipality
- Inform civil society organizations working on human rights, water and sanitation, nature protection, sustainable development, etc.
- Prepare a press release
- Define potential actions to mitigate challenges



Step 1: Process ignition

The goal of this initial step is to get the official support of the municipality in a written statement to back up the engagement with the stakeholders, data collection and other activities in the overall process.
Organize a meeting with the mayor or the relevant stakeholders from the municipality to present the WFD. The main objectives of this meeting are to...

- convince the municipality to support the WFD
- receive a written support statement to back up your activities
- discuss who can provide what data
- define the system boundaries

System boundaries

Primarily, the WFD has been developed for urbanised areas and usually, political boundaries are used as system boundaries. We recommend to take the service areas of the water utilities and public authorities into consideration when setting the system boundaries. Data is usually collected aggregated over the service area. Depending on the context, it can make sense to include suburbs of a municipality. Obviously, the studied area within the system boundaries is not isolated from its surroundings. The water flows represented in an WFD always interact with the water bodies outside the system boundaries and can influence surrounding cities in the watershed.

Documents required to generate a WFD:

- This quick guide including Appendix 1: Nodes library & quality based judgement
- Excel file for data collection “data_template.xlsx”
- PowerPoint template with template for WFD and icons “ppt_template.pptx”

Step 2: Data Collection

The data collection and compilation will take most of the time to generate a WFD! In some situations, you will encounter updated and reliable data that you can use to generate the WFD. However, often the data may be unreliable, not updated or simply not available. To start, it is best to get in touch with local authorities and utilities. Plan enough time to get in touch with them and communicate. Yearly figures [m^3/year] are used in the WFD. If available, use average values over the past years (2-4 years) instead of just one year. The following data is the minimum needed:

1. Population
2. Precipitation
3. Area in system boundaries
4. Drinking water source(s)[2]
5. Volume of drinking water treated[4] and distributed to users (segregated for users[1])
6. Water losses in the piped network (drinking water)
7. Volume of water for use without treatment (segregated for users[1] and water sources[2])
8. Volume of imported water (in bottles or piped)
9. Proportion of used water treated segregated for users[1] and treatment technologies[3]
10. Inflow and Infiltration to sewers,
11. Sewer overflow
12. Exported water (bottled, to other networks, sewered, in agricultural products)
13. Volumes of reused water: recycled water in industry, for cooling/heating, agriculture, or landscaping
14. Any other relevant information

[1] Households, Public sector, Industry/Commercial, Agriculture
[2] groundwater (incl. springs), surface water, rainwater
[3] centralized treatment (primary, secondary, tertiary), safe onsite sanitation, unsafe onsite sanitation
[4] turbidity, microbiological, advanced treatment

In the following, we present different data sources and their priorisation. Start from the top (priority 1). If a data source is not available, go one level down.

Priority	Data source	Data accuracy
1	Water utilities, public authorities, services and agencies, large industrial users: It’s always best to start contacting these institutions.	High
2	Primary data collection: household surveys (e.g. Informal/direct/ unpiped use onsite sanitation), flow measurements	High
3	Reports: From consultants, NGOs or public authorities. Ask around and search online. Contact the author organisations for verification of the data.	Medium
4	Data or reports from comparable contexts: If data from the studied area is not available	Low
5	Default values, expert judgements or estimation: e.g. from the FAO Aquastat data base https://www.fao.org/aquastat/statistics/query/index.html?lang=en or the JMP database: https://washdata.org/data. However, the data of these database are aggregated per country.	Low

Note: If you think that there is not enough data available in your city or area you are not alone. We are aware that in many areas, the data available is scarce. The objective of the WFD is to be an easy-to-understand and easy-to-apply tool. It is not the objective to trigger costly and time-consuming data collection campaigns.
If you think that too much data is missing, we advise the following:

1. Go down the data collection hierarchy (Table 1) and consider data of comparable contexts, expert judgements, or default values. A good estimation is better than no value. Make sure you note down your assumptions. Some values can also be derived (e.g. the wastewater amount can be derived if the drinking water amount is known). Certainly, the diagram has high uncertainties if the data that is used to generate has high uncertainties. However, even an uncertain WFD can trigger a discussion and can be an important step to improve urban water management.

2. If no volumetric data is available, consider to make a WFD with %-flows. What percentage of the households have access to piped water? What percentage use untreated water? The proportions can be derived from census data. The unit of your WFD would not be [m^3/year] and needs to be adapted (e.g. “household unit”). Additionally, the column in the Excel template "m3/year" and "1000 m3/year" need to be adapted to %.

3. Consider to start with a part of the entire diagram. For example, you could start making the water flow diagram only for the private households (Figure 1). It can still be used to make statements about the urban water management of a city. In Figure 1 for example: Is the amount of water provided to the households enough to meet the human right to water? Is a large proportion not safe for consumption? Is the used water discharged appropriately?

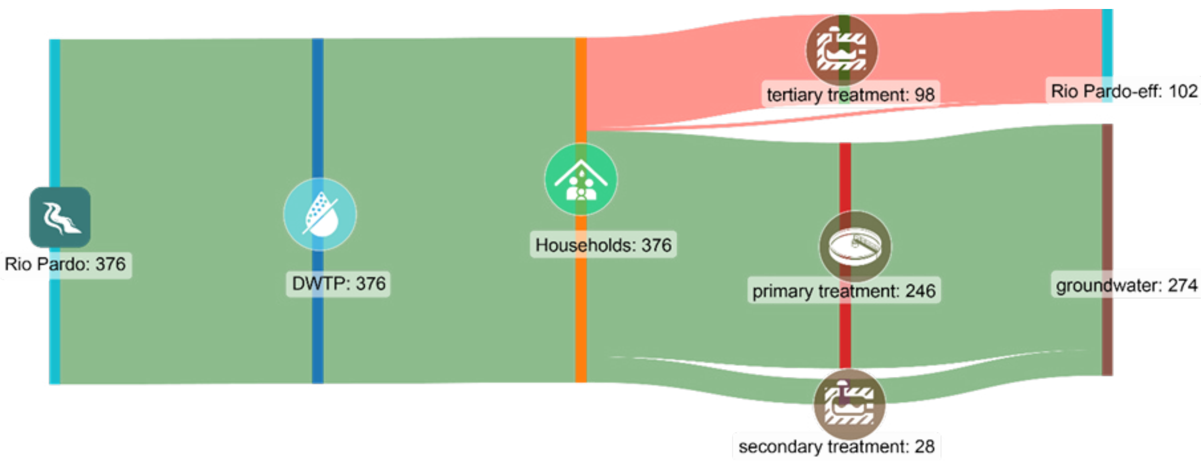


Figure 1: Partial uWFD considering the household water use only

Estimations

For some parameters it might be very difficult to find data. We suggest the following estimations:

Irrigation water
What happens to the water after irrigation? The following table provides an estimation to answer this question. Depending on different key factors specific proportions can be assumed.

	Arid	Tropical	Temperate
Evapotranspiration	60%-80%	80-90%	?
Surface water	10-15%	5-10%	?
Groundwater	10-15%	5-10%	
Biomass	5-10%	5-10%	5-10%

*if it is steep, more surface runoff to surface water bodies, if it is flat more infiltration into groundwater

Toilet water
The toilet system has a large impact on the overall water consumption of a household. If different toilet systems exit among the water users, we suggest to weight differently. Households with flushed toilets use 3 times the amount of water of households with dry toilets (latrines). Households with poorly flushed toilets (anal cleansing with jar or flushing with bucket) use twice the amount of water of households with dry toilets. Consequently:

(% pit latrines) + 2*(% poorly flushed toilets) + 3*(% flushed toilets) = domestic water use On

average this would correspond to the following absolute consumption:
Flushed toilet: 150L/person/day, poorly flushed toilet: 100L/person/day, Pit latrine: 50L/person/day

Another question is how much water is used for the sanitation system and how much water is used for other purposes: consumption, washing, laundry, cooking, showering, watering, ... A basic estimation is that 50% of the water in housholds with pit latrines or poorly flushed toilets ends up in the sanitary system, while the remaining water end up in open channels, surface water, evaporates or infiltrates into the groundwater.

Step 3: Draft WFD

To easily generate an WFD, use the Excel template provided to compile the data. We recommend to start early with generating draft versions of the WFD. It helps to get an overview of missing information. To generate a complete WFD:

a. Compile the data in the Excel template
b. Copy and paste the row "flow code" to sankeymatic.com and edit it online
c. Finish the final version in an illustrator software (Powerpoint, boxy-svg.com, Adobe Illustrator) to include the provided icons to make a standard WFD

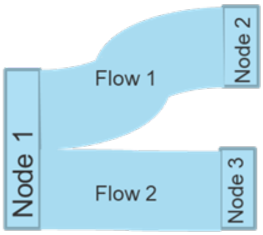


Figure 2: Flows and Nodes

For the WFD, a Sankey diagram is used. Sankey diagrams consist of nodes that are connected with flows (Figure 2). Nodes represent processes, in our case for example water use by households or central wastewater treatment. A flow connects two processes. Its thickness is proportional to the water volume that the flow represents. In the example before, how much water is conveyed to a central wastewater treatment plant from private households. In addition to the thickness, a colour code is applied to the Sankey diagram, to distinguish between "problematic" (red), "appropriate" (green), and "unknown" (grey) urban water management practices. The judgement is made based on the inflow water quality to a specific node or the node itself (e.g. losses = always "problematic"). A guide how to judge the flows is in the Annex. All possible nodes of a WFD are shown in Figure 3. They are organised in functional groups. Eventually, additional nodes need to be added that are specific to the local context. This can be done in the Excel template in the tab "nodes". Any combination of start and end nodes along the functional groups is possible, including skipping a functional group. This is for example the case, if water for irrigation is directly abstracted and used without treatment

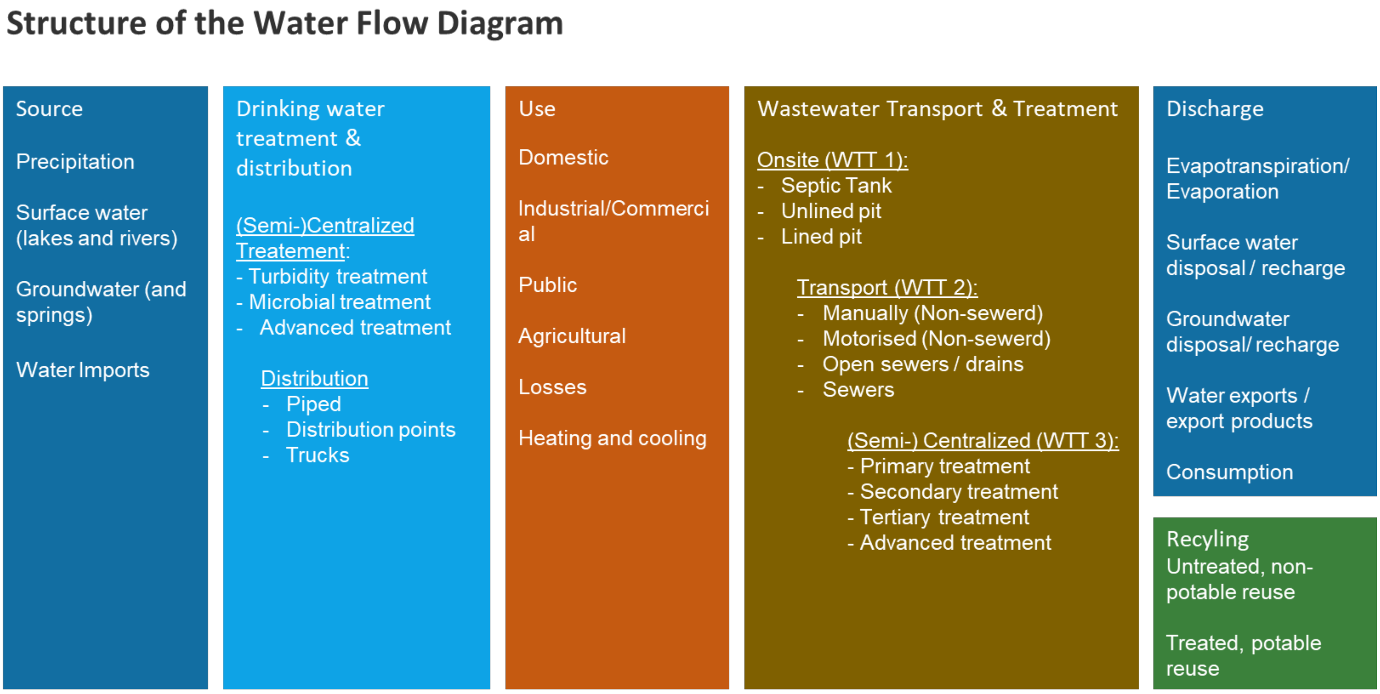


Figure 3: The WFD is structured in these 6 functional groups. Every functional group can have several nodes. E.g. in the funtional group «source» one possible node is «groundwater». The nodes are connected by flows and together they build the Sankey diagram

a) Compile the data in the Excel template

https://youtu.be/gSqWPBf2jAk

Open the Excel Template “data_template.xls”.

On the first tab “Read_me” you can find a short description of the Excel file. You can also select the language in the yellow cell.

Compile the data collected [m^3/year] in the excel template.

1. Open the excel file in Tab “inventory”
2. Enter every flow section separately.
    a. Choose the origin and target node of the flow you want to enter in columns A-I. E.g., if you want to fill in the amount of water abstracted from groundwater and treated in an advanced drinking water treatment plant, select “groundwater” from the source column (A), and “advanced treatment” in the Drinking water treatment column (B). Every column represents one segment of flow between two nodes with one origin and one target.

<u>NOTE:</u> If you want to add context specific nodes you can do this in the tab "nodes"

    b. Insert the volume of the flow in m^3/year in column “m^3/year”. It is automatically transformed into Mio m^3/year (column K).
    c. Insert the quality of the flow (see Box 1) and the quality-based judgement of the flow in the dedicated columns. For the judgement, refer to the Annex.
    d. Insert the quality of data of the flow in column “Data Accuracy”. There are 3 possible categories: High, medium, low. Refer to Table 1 for the judgement.

In column “flow code”, an automated code will be generated for every flow that is needed for generating the Sankey diagram.

b) Generate Sankey diagram in Sankeymatic.com

https://youtu.be/_7YPPfC2Tz8

The following steps describe the procedure to generate the Sankey diagram with the flows, their volumes and colour code using the online tool Sankeymatic.com.

1. Copy the column “flow_code” (P) in the Excel file. Mark all the entries in that column and press “Ctrl+C”.
2. Go to the website: https://sankeymatic.com/build/
3. Delete the code in the “Input” box and paste your code (press “Ctrl+V”).
4. Press the button “Show” next to the “Input” box. Now you have the first draft of a Sankey diagram for the water flows of your city!
5. Adjust the diagram
    a. Box “Nodes”: Choose “a single color” and set it to dark blue
    b. Box “Labels & Units”: Set “highlight” to 0. Position: Place the first labels “after the node” and place labels on the other side starting at “7” (Total - 1).
    c. Box “Layout Options”: Tick “place all flow origins at the left edge” and “place all flow endpoints at the right edge”.
    d. “Diagram size & Background”: Adjust the width to approximately 1'000 and set the background to transparent
    e. Move the nodes to have a tidy and intuitive diagram. Rearrange the order of the source and discharge nodes that “groundwater” is at the bottom, “surface water” in the middle and “rainwater”/”evapotranspiration” at the top.
    f. Untick the box: “Made with SankeyMATIC” below the diagram

https://youtu.be/G0M44ut5_oU

c i) Finalize the WFD in PowerPoint (video)

The easiest way forward is to download a PNG image of the Sankey diagram on Sankeymatic.com and import it into the provided Powerpoint template.

1. Go to “Export" and click on "Save as .PNG image” to download the PNG image.
2. Import the PNG image in the Powerpoint template and insert the icons in the correct positions
3. Adapt the title, legend, unit and year(s) represented, data sources and basic information about the city (population, area, population density).

c ii) Finalize the WFD using an SVG illustrator

If you want to have more flexibility, use an SVG illustrator to finalize the WFD. You can easily change the position of the flows, nodes and labels and insert titles and descriptions of the WFD. Possible SDG editors are Adobe Illustrator, Powerpoint 365, online tool boxy-svg.com) Here we describe the process with the free online tool Boxy-svg.com.

1. Download the diagram in SankeyMatic as a .SVG file
2. Open the browser Microsoft Edge or Google Chrome and go to boxy-svg.com/app. Press File/ Open from disk... and open the SVG file that you downloaded.
3. Use the icons provided in the PowerPoint presentation and place it on the associated nodes.
4. If needed, adapt the position of the labels and/or flows and nodes.
5. Insert a title, a legend, unit and year(s) represented, data sources and basic information about the city (population, area, population density).

Box 1: Description of different flow qualities

Flow Qualities:

0:	uncontaminated (typically drinking water)
path:	pathogenic contamination: contaminated with pathogens (typically surface water)
biochem:	biochemical contamination: contaminated with pathogens and biodegradable chemicals such as nutrients or organic matter (typically grey and black water)
chem:	chemical contamination: contaminated with non-biodegradable and hazardous chemicals such as geogenic contamination, persistant organics, etc. (typically industrial wastewater/geogenically contaminated groundwater)
unknown	There is no information about the water quality

Step 4: Appropriation meeting with stakeholders

Before you start disseminating the WFD of your city, it is very important that you allow a feedback round with the stakeholders that provided the data. Invite them to a appropriation meeting, in which you present the diagram, give every stakeholder the opportunity to give a feedback and discuss potential actions.

Relevant questions:

- Is the diagram plausible?
- What data points should be discussed/verified?
- What key challenges can be identified from the diagram?
- What opportunities can be identified from the diagram?
- What are potential activities to overcome challenges and use opportunities?

If the stakeholders agree on the WFD, you can continue with the discussion about the dissemination of results. If major revisions need to be done, go back to generate a revised WFD and consult the stakeholders before publishing it.
An example of a final WFD is presented in Figure 4.

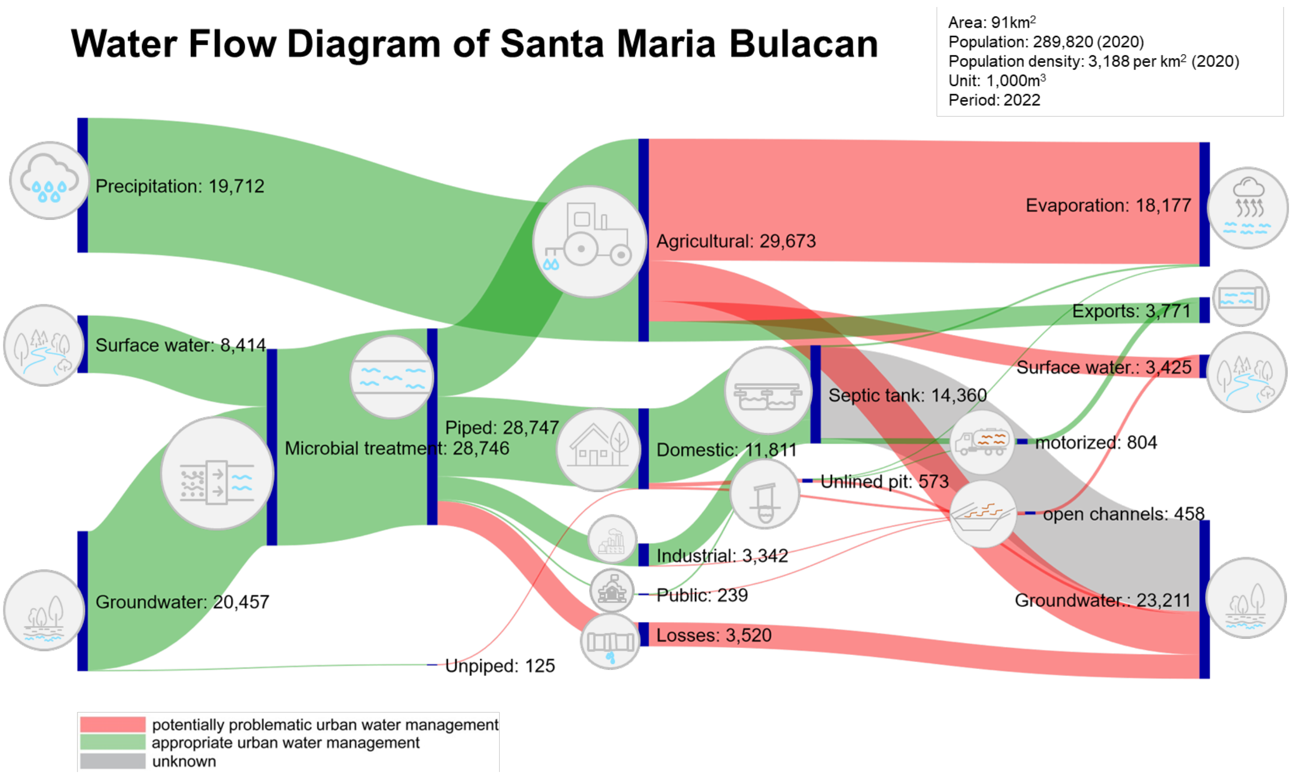


Figure 4: Example of a final WFD including the squares of the renewable water

Step 5: Final WFD and dissemination of results

Dissemination of your results with effective activities is key in order to trigger action. Involve all the stakeholders in a discussion about possible dissemination activities. The effectiveness and suitability of dissemination activities heavily depends on the local context and must be adapted to it.

Here we present a number of ideas for dissemination activities:

- Enter into dialogue with the mayor or municipality, the main users, and public services
- Inform civil society organizations working on human rights, water and sanitation, nature protection, sustainable development, etc.
- Prepare a press release
- Ask utilities to publish the diagram in their annual reports, website, etc

Last but not least, please share the diagram also with Eawag (regula.meierhofer@eawag.ch). This helps us to improve the WFD, increase the data availability of urban water management and build a community of practice for more sustainable urban water management.

Video from previous case studies

Rio Pardo de Minas

Bern

Applying the WFD process in Rio Pardo:

In partnership with:

***Appendix*: Nodes library & quality judgement**

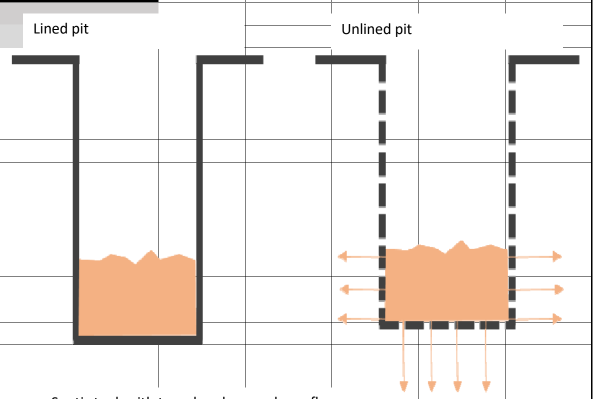
Node	Definition	input water quality	Judgement of input to node	examples for inputs	output water quality	examples for outputs					
					Note: The quality is not judged here, it is judged as "input" of the next node. "Default" refers to the most probable case under the assumption of fully working infrastructure. If there is an uncertainty of the peformance this leads to an uncertainty of the output quality which can be captured by "?" unknown.						
Source		**In**			**Out**						
Precipitaiton (rain and runoff)	Water that originates directly from precipitation or stormwater runoff, and is stored in e.g. rain water harvesting tanks, dams or less enginered reservoirs.	-	**n.a.**		**0 (default)**	**Rain/snow directly from the sky**					
Surface water (lakes and rivers)	Water, that originates from surface water bodies like lakes, rivers, oceans, ponds, swamps, etc.	-	**n.a.**		**path (default)**	**Standard surface waters**					
		-	n.a.		0	Only applies to special cases, where the surface water is not biologically nor chemically contaminated, like mountain lakes, water bodies far away from civilization, etc.					
		-	n.a.		biochem	Surface water that has been polluted by nearby pit latrines or sanitary wastewater					
		-	n.a.		chem	Surface water close to industrial & mining activities without effluent treatment, intense agriculture, brakish or sea water etc. or in areas with geogenic contamination					
Groundwater (springs and aquifers)	The water originates from groundwater aquifers. It is either pumped to the surface prior to use or reaches the surface naturally at springs.	-	**n.a.**		**0 (default)**	**Standard (deep) groundwater**					
		-	n.a.		path	(Shallow) groundwater, close to pit latrines or human activities without source protection					
		-	n.a.		biochem	Groundwater that has been polluted by nearby pit latrines or sanitary wastewater					
		-	n.a.		chem	Groundwater affected by chemicals from industry, fertilizers from agriculture, mining effluents, brakish/saline groundwater or geogenic contaminated					
Bottled water	Water that has been industrially treated, bottled and sealed by a company	-	n.a.		0	5 gallon bottles containing industrially purified drinking water					

Node	Definition	input water quality	Judgement of input to node	examples for inputs	output water quality	examples for outputs
Drinking water treatment & Distribution		**In**			**Out**	
Treatment						
Turbidity treatment	Drinking water treatment plant that has sedimentation, coagulation/flocculation or roughing filter	0	appropriate	Deep groundwater	0	
		path	unknown	Surface water	path	
		biochem	problematic	Water that has been polluted by nearby pit latrines or sanitary wastewater	biochem	
		chem	problematic	Surface water contaminated from a nearby mining site	chem	
		?	unknown		?	
Microbial treatment	Drinking water treatment plant that has UV, filtration with ceramic, sand or membranes (micro- & ultrafiltration) or chlorination	0	appropriate	Deep groundwater	0	
		path	appropriate	Lake water/shallow groundwater	**0 (default)**	
		biochem	problematic	Water that has been polluted by nearby pit latrines or sanitary wastewater	biochem	
		chem	problematic	Chemically (and maybe biologically) contaminated water, e.g. from a mining site	chem	
		?	unknown		?	
Advanced treatment	Drinking water treatment plant that has nanofiltration, reverse osmosis, desalination, activated carbon or geogenic treatment	0	appropriate		**0 (default)**	
		path	appropriate		0	
		biochem	appropriate	Water that has been polluted by nearby pit latrines or sanitary wastewater		
		chem	appropriate	Chemically (and maybe biologically) contaminated water entering a treatment plant that uses advanced treatment technologies	0	
		?	unknown		?	
Distribution		**assumption: input quality = output quality**				
Piped	Piped drinking water distribution network		dependent on use, refer to entries for "use" below	The quality in the distribution does not change. Refer to the quality before the distribution to judge whether the quality suits the use!		
Unpiped	Unpiped water distribution, where the water needs to be transported from the source to the home in jerry cans or bottles carrying by hand or using bicylces, motor bikes, donkeys, trailers, trucks, ….		problematic	Following SDG 6.1: safely managed = available on premises		

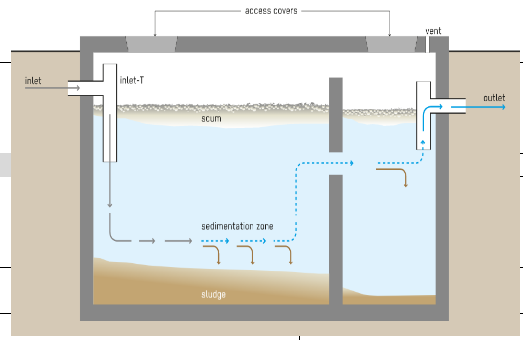
Node	Definition	input water quality	Judgement of input to node	examples for inputs	output water quality	examples for outputs
Use		**In**			**Out**	
Domestic Use	Water that is used by private households for domestic purposes (drinking, hygiene, cooking, gardening, washing, pools, …)	0	appropriate	Uncontaminated source or fully treated water	**biochem (default)**	Sanitary wastewater
		path	problematic	Pathogenically contaminated source (surface water) or incomplete treatment	biochem	Sanitary wastewater
		biochem	problematic	Biochemically contaminated source (e.g. surface water contaminated with sanitary wastewater) or incomplete treatment	biochem	
		chem	problematic	Chemically contaminated source (geogenically contaminated groundwater) or incomplete treatment	chem	Sanitary wastewater if input was chemically contaminated
		0	appropriate	Uncontaminated source or fully treated water	path	Non-sanitary wastewater (from kitchen/washing)
		path	problematic	Pathogenically contaminated source (surface water) or incomplete treatment	path	Non-sanitary wastewater (from kitchen/washing)
		?	unknown		?	
		If distribution =	problematic	Following SDG 6.1: safely managed = available on premises		
Industrial/Commercial Use	Water that is used in industry as process water (for washing, as product ingredient, mining, ...) or in commerical activities in shops, hotels, office buildings, etc.	0	appropriate	Water from uncontaminated sources or fully treated drinking water	**chem (default)**	Wastewater from industry
		path	problematic	Water from pathogenically and/or chemically contaminated source (surface water) or incomplete treatment. If there is evidence, that the industry needs water of lower quality for the processes (biologically/chemically contaminated), it can also be judged as "appropriate" (or the part of the flow where it is valid).	**chem (default)**	Wastewater from industry
		biochem	problematic		chem	Wastewater from industry
		chem	problematic		**chem**	Wastewater from industry
		0	appropriate	Uncontaminated source or fully treated water	path	If there is strong evidence, that the industry activities only discharge biologically contaminated water to the environment
		path	problematic	Pathogenically contaminated source (surface water) or incomplete treatment	path	If there is strong evidence, that the industry activities only discharge biologically contaminated water to the environment. If there is evidence, that the requirements for the industry are satisfied with biologically contaminated water, it can also be judged as "appropriate"
		?	unknown	If there is evidence, that the industry needs water of lower quality for the processes (biologically/chemically contaminated), it can also be judged as "appropriate" (or the part of the flow where it is valid)	?	
		If distribution = unpiped	problematic			

Node	Definition	input water quality	Judgement of input to node	examples for inputs	output water quality	examples for outputs
Public Use	Water that is used for public purposes in public institutions (hospitals, administration, care taking facilities, ...), by the water utility (to maintain the distribution network, measuring errors of water meters), and for firefighting purposes (firefighting water is usually distributed via the drinking water pipe system)	0	appropriate	**Water from uncontaminated sources (e.g. deep groundwater) or fully treated drinking water**	**biochem (default)**	
		path	problematic	**Water from pathogenically, biochemically and/or chemically contaminated source (surface water) or incomplete treatment**	biochem	
		biochem	problematic		biochem	
		chem	problematic		chem	
		0	appropriate	Uncontaminated sources or completely treated drinking water	path	Non-sanitary wastewater (e.g. from washing) with evidence, that there is only pathogenic contamination
		path	**problematic**	Contaminated sources or incompletely treated drinking water	path	
		chem	**problematic**		chem	
		?	unknown		?	
		If distribution = unpiped	**problematic**	Following SDG 6.1: safely managed = available on premises		
Agricultural Use	Water that is used for irrigation, animal breeding, washing etc. in agriculture	0	appropriate	Uncontaminated sources or completely treated drinking water	**chem (default)**	
		path	appropriate	Contaminated sources or incompletely treated drinking water	chem	output of agricultre is generally chemically contaminated because of use of fertilizer, pesticides, fungicides, …
		biochem	problematic	Water that has been polluted by nearby pit latrines or sanitary wastewater	chem	
		chem	problematic	Chemically contaminated source (geogenically contaminated groundwater) or incomplete treatment	chem	
		0	appropriate	Uncontaminated sources or completely treated drinking water	biochem	if there is strong evidence, that water is only biolocially contaminated (e.g no pesticides/fertilizer, organic farming)
		path	appropriate	Contaminated sources or incompletely treated drinking water	biochem	if there is strong evidence, that water is only biolocially contaminated (e.g no pesticides/fertilizer, organic farming)
		?	unknown		?	
		If distribution = unpiped	problematic			
Losses & non-revenue water	Water that is lost in the piped water network due to leaks & water that is not billed for or informally used	not relevant	appropriate	If water losses are below 10%	not relevant	
		not relevant	problematic	If water losses are above 10%		
Heating and cooling	Water that is used for heating and cooling purposes	0	appropriate	No quality change for heating/cooling	0	No quality change for heating/cooling
		bio	appropriate		bio	
		chem	appropriate		chem	
External water	All water that is continuously flowing in the sewer system besides the actual wastewater, like water that infiltrates from the groundwater into the sewer system or originates from public fountains.	not relevant	problematic	groundwater, public fountains	not relevant	sewer system

Node	Definition	input water quality	Judgement of input to node	examples for inputs	output water quality	examples for outputs
Wastewater Transport & Treatment		**In**			**Out**	
Onsite Treatment						
Unlined or partly lined pit	Onsite sanitary wastewater containement with effluent infiltration or pit with semi-permeable walls or open bottom. From unlined pits, 70% of the water infiltrates into the groundwater, 15% evaporates and 15% goes into the sludge.	biochem	appropriate	Unlined pit latrines and septic tanks	biochem (default)	
		chem	appropriate	Pit latrines and septic tanks	chem	
Septic tank with baffle	Sealed septic tank with two chambers seperated by a baffle that are emptied when full and do not leak biochemically contaminated water into the environment. 93% of the water overflows into the soak pit and from there into the groundwater, 5% goes into sludge and 2% evaporates.	biochem			biochem	the sludge that is emptied
		biochem			path	the outlet of the second chamber that infiltrates into the groundwater
		chem			chem	
Fully lined pit	Sealed and emptied onsite sanitary wastewater containement such as a properly installed and maintained cess pits or pit latrines that are emptied when full and do not leak biochemically contaminated water into the environment. For fully lined pit latrine, 15% of the water evaporates, and 85% of the water is stored in the sludge.	biochem	appropriate	Properly sealed and contained spit latrines or cess pits	biochem	
		chem	appropriate	Properly sealed and contained pit latrines or cess pits	chem	
No onsite	Direct discharge, open defecation or overhang latrines (effluent	biochem	problematic	kitchen, showers)	biochem	
		chem	problematic	Effluent of industry, agroindustry that is not collected and treated	chem	
Conveyance						
Non-sewered	Emptying of sludge from septic tanks, pit latrines and similar onsite containments with trucks, trailers, containers or similar	not relevant	appropriate	Sludge emptied by vacuum truck that is operated by staff with personal protection equipment and practice	same as input	
		not relevant	problematic	Sludge emptied manually without protective equipment	same as input	
		not relevant	unknown	It is unknown, how the containment is emptied	same as input	
Open sewered	Open drainage system at the surface with channels rather than pipes	not relevant	problematic	Effluent of septic tanks discharged into open drainage	same as input	
Sewered	Underground, piped sewer system	not relevant	appropriate	Municipal wastewater collected in centralied or decentralised sewer system	same as input	
		0	problematic	Excessive discharge of rainwater or infiltration of groundwater into sewer system is more than 40% of the municipal wastewater	biochem/chem	
Centralised Wastewater Treatment						
Primary Treatment	Primary treatment is based on physical treatment only (mainly settling and filtration) and used for the preliminary removal oil, grease, and solid material from wastewaters and sludge. For unplanted drying beds to treat sludge, 30% of the water evaporates, 40% infiltrates into the groundwater, and 30% remains in the sludge.	chem	problematic	Wastewater that is chemically contaminted (e.g. from industry, agriculture, …)	chem	Chemically contaminated wastewater (with non-biodegradable chemicals) treated in a primary wastewater treatment plant
		biochem	problematic	Standard wastewater	biochem	Biochemically contaminated wastewater (with biodegradable material) treated in a primary wastewater treatment plant
		?	unknown		?	
Secondary	Follows primary treatment to achieve the removal of biodegradable organic matter and suspended solids from wastewater effluent based aerobic and anaerobic biological and chemical (e.g. coagulation) processes.	chem	appropriate	Wastewater that is chemically contaminted (e.g. from industry, agriculture, …)	chem	Chemically contaminated wastewater (with non-biodegradable chemicals) treated in a secondary wastewater treatment plant
		biochem	problematic	Standard wastewater	path (default)	Biochemically contaminated wastewater (with biodegradable material) treated in a secondary wastewater treatment plant
		?	unknown		?	
Tertiary Treatment	Follows secondary treatment to achieve enhanced removal of residual suspended solids and nutrients (e.g. nitrogen and phosphorus).	chem	appropriate	Wastewater that is chemically contaminted (e.g. from industry, agriculture, …)	path (default)	Chemically contaminated wastewater (with non-biodegradable chemicals) treated in a tertiary wastewater treatment plant
		biochem	appropriate	Standard wastewater	path	Biochemically contaminated wastewater (with biodegradable material) treated in a tertiary wastewater treatment plant
		?	unknown		?	
Advanced Treatment	Advanced treatment includes the removal of pathogens through disinfection or of persistant chemicals through advanced filtration (e.g. activated carbon) or oxidation (e.g, ozonation).	chem	appropriate	Wastewater that is chemically contaminted (e.g. from industry, agriculture, …)	path (default)	



Septic tank with two chambers and overflow



Node	Definition	input water quality	Judgement of input to node	examples for inputs	output water quality	examples for outputs					
		biochem	appropriate	Standard wastewater	path						
		?	unknown		?						

Node	Definition	input water quality	Judgement of input to node	examples for inputs	output water quality	examples for outputs
Water Disposal/Recharge		**In**			**Out**	
Surface water disposal/recharge	Water discharged into surface water bodies (lakes, rivers, …) directly after use or after wastewater treatment	chem	problematic	Untreated or partially (primary/secondary treatment) water that is discharged into a surface water body after use without treatment	-	
		biochem	problematic	Untreated or partially (primary/secondary treatment) water that is discharged into a surface water body after use without treatment	-	
		path	appropriate	Treated and quality-assured effluent and/or stormwater directly discharged into surface water bodies (such as rivers, lakes, etc.).	-	
		0	appropriate	Treated and quality-assured effluent directly discharged into surface water bodies (such as rivers, lakes, etc.).	-	
		?	unknown		-	
Groundwater disposal/recharge	Treated and quality-assured effluent and/or stormwater directly (with minimal soil treatment) injected into groundwater either through sub-surface drainage	chem	problematic	Untreated or partially (primary/secondary treatment) water that is discharged into a groundwater body after use without treatment	-	
		biochem	problematic	Untreated or partially (primary/secondary treatment) water that is discharged into a groundwater body after use without treatment e.g. effluent of septic tank inflitrated into groundwater	-	
		path	appropriate	Treated and quality-assured effluent and/or stormwater directly discharged into groundwater	-	
		0	appropriate	Treated and quality-assured effluent directly discharged into groundwater	-	
		?	unknown		-	
Advanced groundwater recharge	Engineered and controlled groundwater recharge with soil aquifer treatement	chem	appropriate		-	
		biochem	appropriate		-	
		path	appropriate		-	
		0	appropriate		-	
		?	unknown		-	
Evapotranspiration	Water lost to the athmosphere in irrigation	not relevant	problematic	Evapotranspiration losses are always judged "problematic"		
Water Recycling		**In**			**Out**	
Untreated, non-potable reuse	Reuse of wastewater that is only partly treated dependent on the purpose of reuse	0, biochem, path, chem	Dependent on the water quality requirements of the use -> see "use". If the recycled water meets the requirements, it is considered as appropriate. If not, it's problematic.	Greywater reused for controlled irrigation	0, path, chem	
Treated, potable reuse	Reuse of wastewater that has been treated up to drinking water standard and therefore can be broadly used without concerns	0	appropriate	Greywater that has been treated in advanced treatment and is reused for showering.	0	