

Non-Revenue Water and Unbilled Authorised Consumption

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NRW AND UNBILLED AUTHORISED CONSUMPTION

Summary

Based on IWA definitions, Unbilled Authorised Consumption (UAC) is not a water loss but it is one of the 3 major components of the Non-Revenue Water as shown on the following water balance.

Volume from Own Sources (corrected for known errors)	System Input Volume (corrected for known errors)	Authorised Consumption	Billed Authorised Consumption (includes Water Exported)	Revenue Water	Billed Metered Consumption	Billed Water Exported (corrected for known errors)	Water Supplied
			Unbilled Authorised Consumption		Non-Revenue Water	Billed Metered Consumption excluding Water Exported	
Apparent (Commercial) Losses				Billed Unmetered Consumption			
		Real (Physical) Losses	Unbilled Metered Consumption				
Unbilled Unmetered Consumption							
Unauthorised Consumption							
Customer Metering Errors							
Errors in Estimate of Unmetered Consumption							
Errors throughout Data Acquisition Cycle							
Water Imported (corrected for known errors)		Water Losses		Leakage on Transmission and Distribution Mains			
			Leakage and Overflows at Utility's Storage Tanks				
			Leakage on Service Connections up to point of customer metering				

Figure 1: IWA Water Balance showing Unbilled Authorised Consumption

UAC needs to be measured or assessed in order to establish the water balance and calculate the level of water losses. Underestimating or neglecting UAC in any top-down or bottom-up approach would lead to overestimated values of real or apparent losses and to erroneous action planning. In addition, the value of UAC needs to be minimized for obvious financial reasons. This paper aims at summarizing definition, approach and standards currently used in some countries.

1. Definition and basic issues

Unbilled Authorised Consumption (UAC), the name of which is self-explanatory, is a component of Non-Revenue Water. Therefore, a proper evaluation is required to establish the water balance.

Operators often neglect this NRW component and it may lead to misevaluation in the apparent and real losses. The unbilled authorised consumption may be classified into two categories.

- *Servicing water:* the volume of water that is used for operation purpose by the Utility’s operator itself
- *Free water supply:* the volume of water that is provided free of charge to some categories of consumers

Servicing consumption is common to all water utilities: tank cleaning, pipe cleaning (or flushing), water discharge to preserve water quality, hydrant flow and pressure tests, specific water treatment devices (e.g. network chlorinators), and others.

Free water supply may cover many specific cases depending on contractual arrangements with customers or local habits. In some cases, the Utility is not allowed to bill water for some type of use by law (e.g. firefighting). In some other cases, the Utility does not wish to bill itself (e.g. a Municipality with its own buildings, parks and gardens, etc.).

For instance, the Water Utility – that may be private, municipal or national – may provide water free of charge to some or all of the following consumers:

- its own premises and/or the municipal and government premises
- for street and market cleaning
- for the cleaning of sewage and sewerage facility, managed by itself or by other entity
- its own staff and/or the staff of the municipality
- some specific religious premises: church, mosques and some VIP consumers
- some public stand pipes and drinking fountains
- water tank lorries operated by the Utility or external vendors
- filling, cleaning and maintaining municipal swimming pools and fountains

The basic issues are the following:

- inventory of the UAC
- quantification of each type of UAC: metered or unmetered
- legal aspects: on which legal basis these kinds of consumption have been authorised,
- economical aspects: how to reduce the UAC as a NRW component?

2. Inventory and quantification

The first step is to set up an inventory of the UAC (generally, it does not exist). The inventory needs to be as exhaustive as possible. At this stage, it is necessary to consider all the cases where a consumer receives water without being invoiced.

Considering the variety of cases in various national contexts, it is not possible to provide a standard and exhaustive list of cases. Some examples are presented in Table 1.

Category of UAC	Types of UAC	Metered/Unmetered	Method for evaluation	Unavoidable Level Applicability
Servicing (or field operation consumption)	Tank cleaning	unmetered	estimated or standard volume	Yes
	Pipe cleaning	unmetered	estimated or standard volume	Yes
	Discharge	unmetered	estimated or standard volume	Yes
	Hydrant tests	unmetered	estimated, metered or standard volume	Yes
	Water treatment devices	metered/unmetered	estimated, metered or standard volume	Yes
	Others	metered/unmetered	estimated, metered or standard volume	Yes
Consumption Free of charge	Utility staff	metered/unmetered	estimated or metered volume	No, should be metered
	Special Customers	metered/unmetered	estimated or metered volume	No, should be metered
	Utility premises	metered/unmetered	estimated or metered volume	No, should be metered
	Others	metered/unmetered	estimated or metered volume	No, should be metered

Table 1 : Breakdown of Unbilled Authorised Consumption

Table 1 shows that UAC can be sub-divided into Metered and Unmetered components. In terms of quantification of the UAC, the best method is obviously the installation of permanent or temporary water meters, to identify Unbilled Metered Consumption. However, when this is not possible, volumes of Unbilled Unmetered Consumption need to be identified and systematically assessed.

Table 2 (Astee, 2011) provides a general breakdown of UAC and general information on methods to evaluate consumption recommended in France. The last column relates to the applicability of the concept of unavoidable level of consumption. This point is important in the frame of an analysis to reduce UAC as an NRW component.

Use of Water	Method for Estimation		Order of magnitude
A. Consumers' Consumption without Water Meters			
Tests on Fire Hydrants	To be estimated with the Fire Fighting department: N° Tests by year x Duration x 60 m3/h		7 to 10 m3/year /unit
Fire exercise or operation	To be estimated with the Fire Fighting Department: N° Opening x Duration x 60 m3/h		
Gardening without water meters	Two methods may be considered		
	No Opening x Duration X Flow-rate to be estimated	Installing meters on a sample of BI (10%) and extrapolating	
Fountains without water meters	Two methods may be considered		
	N° fountains by category x estimated consumption by category	Installing meters on a sample of fountains (10%) and extrapolating	
Street cleaning	With specialized water tankers:	With network washing equipment:	
	N° truck x N° shift per day x N° working days	N° of opening x Duration x Estimated flow-rate	2 m3/shift /truck
Water discharge in sewers	N° discharging tanks x N° actions x Volume of a discharging tank		2 to 5 m3 per day and per tank
B. Servicing the Water Distribution Network			
Cleaning and washing water tanks	The volume includes the volumes of discharged water and the volumes needed for cleaning and rinsing out before putting the tank into operation again		
	Accurate calculation made by the operator	By default: Low level + 10% of the tank's useful capacity	
Pipe Disinfection after works	Distribution network: 8 times the pipe volume (1 for discharging, 3 for rinsing after disinfection, 1 for disinfection and 3 for rinsing after disinfection)		
	Service connections: N° Service Connection x 0,20 m3		
Discharge and pipe washing	Accurate calculation made by the operator	By default:	
		N° Water Discharge x Duration X 2,5 m3/h	
		Discharge against freezing: 0,3 m3/h x N° opening days x N° of equipped pipes	
		Water/air/water washing: 5 times the volume of pipes to be washed	
Boosters	N° Pumps x Estimated Flow-rate		90 m3/year/pump
Chlorine analyser or any analyser under pressure	N° analysers x Estimated Flow-rate x Duration		65 to 80 l/hour i.e. 570 to 700 m3/year/ analyser
Other consumption	Should be negligible except for special cases to be justified. Example: discharge for water quality problem.		

Table 2: Recommended Assessment Methods for Unbilled Unmetered Consumption (Astee, 2011)

Halifax Regional Water Commission in Canada (2002) included the following examples of assessed unbilled unmetered consumption.

- Fire training using hydrants;
- Fire Fighting : filling engines;
- Fire Fighting: direct from mains
- Street cleaning;
- Sewer cleaning;
- Sewer cleaning from hydrants
- Annual flushing program;
- Blow off Washouts;
- Fire testing of Sprinkler Lines
- Backflow Prevention Testing;
- Flushing of new mains; Flushing of renewed mains
- Temporary services during main renewal;
- Hydrant flushing following main breaks
- Sampling lines;
- Cleaning of Reservoirs;
- Miscellaneous – fire flows, vandalism, pump tests, etc.
- Services frozen, public advised to let taps run

In 2004, the above components of Unbilled Unmetered Consumption accounted for 1.6% of Water Supplied, or 1.5% of Billed Metered Consumption; which leads to discussion of the use (and possible misuse) of standard or maximum default ‘all-in’ assessments of unmetered components of UAC based on statistical analysis; such assessments should not be exceeded without independent verification.

For the purposes of these Guidance Notes on management of Apparent Losses, such short-cut approaches should only be used after the components of UAC have been systematically identified by the Utility or its consultants as being only a minor component of the Water Balance – probably less than 1% of Water Supplied.

Broadly, based standard or maximum defaults of UAC have tended to be expressed as:

- Percentage of System Input Volume
- Percentage of Water Supplied
- Percentage of Billed Metered Consumption (excluding Water Exported).

Because some Utilities export substantial volumes of Water, whilst others do not, percentage of Water Supplied is clearly preferable to % of System Input Volume.

Percentage of Water Supplied may be a practical approach in the early stages of national NRW reduction initiatives, but percentage of Billed Metered Consumption (excluding Water Exported) is preferable. This is because once UAC is reduced, the volume reduction in UAC simply becomes part of Billed Authorised Consumption. This also means that it is logical to value UAC at the average sale price of water.

Table 3 is a summary of maximum defaults identified from international data and publications since 2004; further information on these examples can be found in the Appendix.

Source Country of Default Assessment	Unbilled Authorised Consumption				Expressed as a percentage of		
	Year or Source of Data	Metered	Unmetered	Total	System Input Volume	Water Supplied WS (excludes water exported)	Billed Metered Consumption BMC (excluding exports)
23 England & Wales Companies: analysis of OFWAT published data	2002--03			Yes		0% to 2.5% Median 1.25%	
WSAA: Water Services Association of Australia	2009-10		Yes			0.5% of Water Supplied	
New Zealand Water & Wastes Association	2010		Yes			0.5% of Water Supplied	
European Union 'Good Practices on Leakage Management' quick	2015			Yes			0.5% of BMC (excluding Exports)
North America: AWWA M36 Manual, 4th Edition, Water Audits and Loss Control Programs	2016		Yes			1.25% of Water Supplied	

Table 3: Some recommended maximum defaults for UAC expressed as %s: See Appendix for more details

Warning : it is most important to note that, where defaults are used for quick calculations, a common internationally applicable % should not be expected, as each country and group that uses these has different circumstances and different objectives.

3. Legal aspects

The list provided in Table 1 refers to the UAC volumes that are not billed. However, are these free consumptions really authorised? How should legitimate UAC be defined?

Several approaches may be envisaged.

(i) Using the IWA PIs Manual definition.

The manual mentions that unbilled authorised consumption may include items such as firefighting and training, flushing of mains and sewers, street cleaning, watering of municipal gardens, public fountains, frost protection, building water, etc., if these are unbilled.

These may be metered or unmetered, according to local practices.

Some may consider that anything not in the list then becomes unauthorised. Nevertheless, this position does not seem acceptable because the list of the manual is not presented as an exhaustive list.

(ii) Using a pragmatic approach

Servicing consumption generally does not create any problem and it is recognised anywhere as unbilled authorised consumption. The only problem refers to the level of servicing consumption that should be optimized. This point is treated further.

As far as the other kinds of UAC are concerned the authorisation may be based on:

- Statute of the Utility
- Laws, bylaws or any juridical document
- Decision by the management of the Utility
- Non-written agreements or habits

It is recommended that utilities draw up their own list of what they consider unauthorised unbilled consumption. Legal justifications need to be mentioned and non-justified cases need to be questioned.

Note: This pragmatic approach clearly recognises that the concept and the definition of UAC is not, and can not be uniform worldwide. It creates some discrepancy in the calculation of NRW. However, the same discrepancy does exist when one uses the PIs Manual definition that recognised that: “some consumptions may be considered as UAC by some Utilities whilst the same consumptions are billed by other utilities”.

4. UAC reduction and economical aspects

As a component of NRW, UAC needs to be reduced as much as possible. There are two obvious ways to reduce UAC volumes in all the cases:

- Minimize Service Water. Many Utilities use much more water than necessary for servicing; each use needs to be optimized.
- Detect the consumers who have no right for receiving water free of charge and bill them.

How to reduce UAC?

In addition to the general recommendation referring to metering and case inventory, some examples of reduction of UAC are presented hereafter:

- Limitation of the free supply based on a limited free volume: for instance, when the Utility provides free water to its employees, the volume must be metered and the gratuity is limited to 20m³/month. The full gratuity and the lack of metering are dangerous: in some cases, employees were providing water (free or not) to their neighbours: UAC was transformed into Apparent Loss as Unauthorised Consumption.
- Improved operation procedures enable to reduce service water: for instance, it is recommended to start the cleaning of the water tanks when the water level is the lowest in the reservoir.
- Some chlorinators installed on the water distribution system may have a significant water consumption: select the device with the lowest consumption

Economics

All unbilled authorisation should be valued at the sale price of water (within the financial balance)

Case of national tariff regulation:

Some cases are more complicated. When there is a high level of regulation, authorised consumption, be it billed or unbilled, metered or unmetered, own use/service or other, is only a loss provided it does not exceed the allowance explicitly included in the tariff by the regulator or internal target. For this reason, unauthorised consumption that is not subject to a tariff needs to be monitored to make sure it is within limits.

5. Summary

Some recommendations:

- Utilities should draw up their own list of what they consider to be ‘authorised’ unbilled consumption and give appropriate justification (bylaws or others)
- Wherever feasible, unbilled authorised consumption should be metered to improve the reliability of the Water Balance and the Financial Balance
- Standard or maximum default assessment of unbilled authorised consumption should preferably be expressed as a percentage of billed metered consumption, and should be valued at the sale price of water (within the financial balance)
- The water consumption for servicing purpose must be audited and reduced as much as possible.
- Any free water consumption must have a juridical basis, through by-laws and internal documents duly approved by the management or the utility’s board.

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Appendix: International examples of Maximum Default Values

UNITED KINGDOM (2004)

An analysis of data from 23 England and Wales Utilities in 2002-03 showed UAC quoted in independently validated Water Balances varied from 0% to 2.5% of Water Supplied, with a median of 1.25% (Lambert, 2004, analysis of OFWAT data for 2002-03).

AUSTRALIA AND NEW ZEALAND (2010)

During a multi-year drought 2002-11, Water Services Association of Australia National Performance Framework 2009 - 10 Urban Water Performance Report Indicators and Definitions Handbook was modified to include a default for Unbilled Unmetered Authorised Consumption of 0.5% of Water Supplied (which excludes Water Exported). If a water utility uses values greater than the above default, sufficient data must be provided to satisfy an auditor as to the accuracy of the values used.

New Zealand Water & Wastes Association adopted the same approach as WSAA in their Water Loss Guidelines, 2010

These are very challenging defaults given that WSAA and NZWWA defaults for are 0.1% of Water Supplied for Unauthorised Consumption, and 2.0% of Residential and Non-Residential consumption for customer metering errors.

EUROPEAN UNION (2015)

Section 6 of the January 2015 EU Reference document 'Good Practices on Leakage Management' WFD CIS WG PoM Main Report, January 2015, recommended a maximum default guideline for UAC of 0.5% of Billed Metered Consumption (excluding Water Exported) when doing quick initial approximate calculations for an initial overview assessment of a Utility's Water Balance. This maximum default for total UAC (metered and unmetered) is also included in the simplified EurWB&PICalcs Water Balance and Performance Indicators free software.

More detailed European Water Balances split UAC into Metered and Unmetered components.

NORTH AMERICA

The 4th Edition (2016) of the American Water Works Association Manual of Water Supply Practices M36, Water Audits and Loss Control Programs, contains a 10-page Section on Unbilled Metered and Unmetered Consumption

The volumes for UAC in the AWWA version of the IWA Water Balance are split into metered and unmetered components:

- the metered component of UAC is entered as a separate item in the Water Balance
- the unmetered component can be assessed from detailed estimates of components, but a default of 1.25% of Water Supplied volume is considered acceptable for use by an auditor, to avoid tedious collection of data on many small uses of water which, in total, are likely to be a small portion of the volume of water supplied to the distribution system.