

Subject: Inspection of Regional Water Infrastructure

**Report to:** Public Works Committee **Report date:** Tuesday, April 5, 2022

- 1. That staff **BE DIRECTED** to consult with the area municipalities to review options for reinstating a water loss committee to collectively review strategies for targeted investigation and reduction of water loss, with a goal of providing an update to the 2007 Regional Water Loss report; and
- 2. That this Report **BE CIRCULATED** to the Local Area Municipalities.

#### **Key Facts**

- In 2021, Niagara Region delivered 56,065 ML of treated water through six water treatment plants and 313 km of watermain across 11 municipalities.
- Operations staff monitor variations in flow and pressure throughout the system, and immediately report suspected main breaks to Regional and Area Municipal staff as observations warrant. Breaks on transmission mains are repaired immediately.
- Distribution flow is monitored using 25 flow meters across Niagara, which are verified and calibrated on a semi-annual basis by a third party contractor. These flows are used not only for billing calculations, but also long-term planning associated with servicing, development planning and capital project design.
- Between 2004 and 2007 a Water Loss Reduction Task Force comprised of Regional and Area Municipal representatives was formed to share experiences regarding water loss levels and strategies for reduction.
- Niagara's water transmission system is comprised of large diameter water mains of various pipe material. Approximately 89 per cent of these transmission mains are non-metallic, which is not favourable to acoustic leak detection. Leak detection involving invasive technologies or system shutdowns will potentially impact thousands of customers and may not be feasible on trunk systems.

#### **Financial Considerations**

Watermains are designed for a useful service life greater than 80 years and appurtenances such as valves are designed for a useful service life of 25 years. Access chambers are designed for a useful service life of 50 to 100 years. Asset service life and condition are influenced by various factors such as material, quality, location, use, and

the environment that it is installed in. As thresholds for these criteria are met, watermains are selected for replacement through Capital funds.

The annual cost of calibration, for flow meters used for billing, is approximately \$18,000. A breakdown of these costs is provided in Table 2 below (Analysis: Calibration and Verification).

A comprehensive review of water loss along all of Niagara Region's transmission mains would be approximately \$3,000 to \$25,000 per km of main depending on the diameter of main and the water loss technology used. This estimate is based on the Region's previous work regarding water loss strategies, and is contingent on watermain material, location and configuration of the transmission system. A summary of leak detection strategies is presented in the Analysis section below.

#### **Analysis**

Niagara Region owns and maintains 313 km of watermain and 973 underground enclosures across 11 municipalities. Appendix 1 contains a detailed summary by municipality.

Table 1 below identifies the total length of pipe in the Regional network, by pipe material.

Table 1: KM of Watermain by Pipe Material

Material	KMs of Watermain	Percent of System	Life Expectancy (Years)	Average Age (Years)
Concrete Pressure Pipe	137	44	70-80	43
PVC Plastic Pipe	108	35	75	17
Asbestos Cement Pipe	32	10	60-70	49
Ductile Iron	14	4	60-70	29
Cast Iron	10	3	60-70	58
Other	11	4	60-70	37

Operational Monitoring and Break Response

Niagara operates six (6) water treatment plants. Operators at these facilities monitor variations in flow and pressure throughout the system and immediately report suspected main breaks to Regional and Area Municipal staff as observations warrant. As breaks

are suspected, Niagara Region initiates the resources to investigate. Region staff often support Area Municipalities in locating and confirming breaks on Local infrastructure. To troubleshoot these events, Regional staff rely on trends from a variety of online instruments which measure flow, pressure, level etc. In the event that a failure is on Region infrastructure, Niagara Region maintenance staff use contractors for immediate repair of the main from a preapproved list of external parties detailed in the Water and Wastewater Emergency Response Procedure.

#### **Inspection and Maintenance**

Underground enclosures (valve chambers) are routinely inspected by internal maintenance personnel through routine preventative maintenance programs, such as the valve turning program. As required, maintenance personnel inspect and report on valve chamber condition and general operation to support troubleshooting of operational or distribution issues. For example, in January 2022, maintenance personnel inspected chambers along transmission watermains in the City of Port Colborne to provide feedback to the City on concerns related to main breaks in the local distribution system. At the time of inspection, all visible piping and valves were in good working order.

#### **Investigations Completed to Date**

Through Capital Project scoping and design, many studies and condition assessments have been completed to evaluate the integrity of transmission mains, valves and appurtenances. In addition to these studies, the following specific water loss investigations have occurred:

# 2004 to 2007: Water Loss Reduction Task Force and Regional Water Loss Assessment Project

In 2004 the "Water Loss Reduction Task Force" comprised of Regional and Area Municipal representatives was formed. The purpose of this group was to share experiences regarding water loss levels and strategies for reduction. Through the "Water Loss Assessment Project" water balances were completed based on the data provided by the Region and Area Municipalities. The study was completed by Veritec Consulting Inc. and was finalized in 2007. The Regional Water Loss Assessment Project report is included in Appendix 2.

# 2011 - 2015: City of Port Colborne – Integration of Water Loss Analysis Tools into a SCADA System

Between 2011 and 2014 a study was developed and conducted in the City of Port Colborne to develop off-line and real time tools to integrate the City's water usage data with flow data from four district metered areas (DMAs). Niagara Region provided in-kind (SCADA) support for this project, which was also funded through the Showcasing Water Innovation Program. The goal of this project was to provide the City with flow monitoring to aid in locating and remediating unaccounted for water.

# 2020: Niagara Region Billing Meter Verification Demonstration to Town of Fort Erie

In response to questions from the Town of Fort Erie, the Region invited Town staff to witness a third party calibration process at the Rosehill Water Treatment Plant for the billing meters impacting the Town. Following this demonstration, Niagara Region shared verification certificates with Town staff.

#### 2021 – 2022; Niagara Region – Water and Wastewater Billing Flowmeter Audit

This project is currently underway to review, confirm and make recommendations for improvements for all processes that contribute to the volumes used for billing. This work includes an audit of the accuracy and suitability of the Region's billing flow meters and a comparison of current methods, including meter type and installation against best practices.

#### **Calibration and Verification**

Water meters are essential for process automation and are calibrated on a semi-annual basis. The cost for these calibrations is shown in Table 2 below.

**Table 2: Calibration of Flow Meters** 

Program Name	Frequency	Cost		
Calibration of Non Mechanical Flow Meters	Semi-annual	≈ \$15,200		
Calibration of Mechanical Flow Meters	Semi-annual	≈ \$2,200		

When establishing the frequency of calibration required, Niagara Region takes into account whether or not the meter is used to meet legal requirements, industry standards for calibration, manufacturer recommendations and the conditions of use such as importance of collected data for use in other processes such as billing. There are 25 water meters used for billing, all of which are calibrated on a semi-annual frequency.

#### Water QMS Risk Assessment

An internal risk assessment is required every 36 months for each of Niagara Region's water systems, with complementary risk assessment reviews to be completed at 12 and 24 months between the assessments. A full risk assessment for the Water QMS was completed in 2021, with reviews to follow in 2022 and 2023.

Through the risk assessment exercise, the Water-Wastewater Asset Management group assesses risk associated with watermains using the risk scoring criteria outlined in the Corporate Asset Management Risk Assessment (CAMRA) model. Criteria for consideration includes factors such as; likelihood of failure, impact on users and the environment, financial risks and risks associated with compliance or social reputation of Niagara Region. There were no high-scoring risks identified during the 2021 full risk assessment. Any previously identified high-scoring risks have been mitigated through capital projects, operational adjustments, or through continual improvement initiatives.

#### **Leak Detection Technologies for Transmission Mains**

The three (3) most common methods of leak detection for transmission systems are inline acoustic monitoring, non invasive acoustic monitoring and district metering. Costs associated with these methods vary depending on diameter and type of technology used and are detailed under the Financial Considerations section of this report.

For both in-line and non invasive acoustic monitoring, sensors discern the acoustic activity associated with leaks by sending acoustic pulses to receivers attached to pipe appurtenances. Leak location is estimated by the arrival time of the pulses. When in-line acoustic monitoring is used, condition and configuration of the pipe i.e. tubercles, valves, bends and pipe appurtenances may obstruct equipment, and terrain changes may make installation and removal of equipment difficult. In-line monitoring can be disruptive to operations. While non-invasive installations pose less disruption to service and flow, this type of installation is sensitive to interferences. With increasing pipe diameter, there is less accuracy of the sensors to detect leakage. All acoustic leak detection is sensitive to pipe material and diameter. Acoustic methods work best with

smaller diameter metallic pipes, and are less accurate with large diameter transmission mains. Approximately 89 per cent of Niagara Region's transmission mains are non-metallic, and all are large diameter.

District metering is an audit of the meters within a portion of the distribution system. Meters are installed to measure flow into and throughout a defined portion of the system, and flows are monitored to determine if leakage may be an issue. The installation of meters that detect bidirectional flow can also aid in locating leaks.

Due to the size and configuration of Niagara Region watermains it may not be economically feasible to conduct a complete inspection of the entire transmission system. Regional infrastructure valves for shutting down sections of main are often located a considerable distance apart, and isolation and draining of sections at a time can put a significant number of residents and businesses out of service. In addition to these concerns, pressure transients caused by putting a main back into service could cause breaks within the Area Municipal system.

Currently staff focus on areas where mains are known to be aged, have a higher occurrence of failure or the pipe material is most conducive to water loss investigation. Both infrastructure age and failure are well documented through the QMS Risk Assessment Process.

#### **Alternatives Reviewed**

The alternatives to reinstating a water loss committee to collectively review strategies for targeted investigation and reduction of water loss are:

- 1. Do nothing. Niagara Region could continue with current practices but this may be less effective in addressing the opportunities to further reduce any water loss.
- 2. Council could direct staff to procure external resources to undertake a comprehensive water loss assessment. This is not recommended without first reestablishing the water loss committee with Local Area Municipal staff participation to ensure that any assessment is comprehensive and has access to all available information.

#### **Relationship to Council Strategic Priorities**

Recommendations presented in this report relate directly to Council's Strategic Priority 4.1 of committing to "high quality, efficient and coordinated core services". Through coordinated efforts, the Region and Area Municipalities can collaborate on water loss reduction strategies.

Prepared by:

Erin Shisler Water Process Specialist W-WW Services

Recommended by:

Bruce Zvaniga P.Eng. Commissioner of Public Works (Interim) **Public Works Department** 

Submitted by:

Ron Tripp, P.Eng. Chief Administrative Officer

This report was prepared in consultation with John Brunet, Associate Director, Water Operations and Maintenance, and reviewed by Joe Tonellato, Director, W-WW Services.

#### **Appendices**

Appendix 1 Niagara Region – Watermain Statistics

2007 Regional Water Loss Assessment Project Appendix 2

## PW 14-2022 Appendix 1 - Niagara Region Water Main Statistics

Water	FE	NOTL	Grimsby	NF	STC	PC	Welland	Thorold	Lincoln	West Lincoln	Pelham	Total
No. of connections to local infrastructure	79	109	26	97	144	25	117	50	54	3	35	739
Average age of infrastructure (water mains)	29.26	25.36	30.80	44.00	34.00	26.00	44.50	24.60	28.74	20.04	40.50	34
Km of Local water main	275.79	200.06	135.03	483.26	593.77	111.57	273.47	117.74	112.00	34.84	85.34	2423
KM of Regional water main	50.90	43.14	20.46	47.13	53.90	7.80	29.22	20.28	18.38	12.58	9.56	313
KM of water mains replaced over the past 10 years (2011)	5.50	0.06	2.50	0.08	12.77	1.41	0.74	2.57	0.06	0.52	0.00	26
KM of mains to be replaced over next 10 years	10.44	3.51	1.70	0.00	0.03	1.62	0.00	0.00	3.53	7.42	0.00	28
No. of Regional Underground Enclosures	129	98	76	133	180	30	149	74	57	32	15	973
No. of LAM Underground Enclosures	0	0	854	0	101	7	0	1	11	0	1	975



# Region of Niagara

## **Regional Water Loss Assessment Project**



**JUNE 2007** 

FINAL REPORT



#### **Executive Summary**

With increasing regulatory requirements dealing with water quality, water takings, and full cost recovery the need to understand the performance of water systems has never been more prevalent. Efficient management (and operational control) of water distribution system includes managing real *and* apparent water losses. In November 2004, representatives from both the Region and its area municipalities attended a two day workshop on current industry best practices for dealing with water loss assessment, validation, measurement and control. The group identified that a proper assessment (and validation) of the water loss levels within each AM's water system should be initiated.

The Region contracted Veritec Consulting Inc. to complete water balances for each of the area municipalities. This report highlights the results of the water balances completed for each participating area municipality.

Balances were completed using PIFastCalc for Canada, a licensed software tool incorporating the standard water balance procedure and terminology adopted by both the AWWA and Canadian InfraGuide. PIFastCalc also calculates many benchmarking Performance Indicators (PIs). With respect to validation PIFastCalc for Canada incorporates confidence intervals that highlight data quality.

Non-Revenue Water (NRW) is a "Basic" financial PI. Excluding demands in the City of Welland, the project identifies that collectively, the percentage of NRW in the Region is approximately 14% (i.e, 86% of water sold by the Region is accounted for by billed consumption in the area municipalities). The components of NRW are:

- ✓ Unbilled, Authorized Consumption,
- ✓ Apparent Losses, and
- ✓ Real Losses

Individually the percentage of NRW in the area municipalities ranges from 0% to 37%. Percentages of NRW, however, should not be used to compare and contrast the performance of one system versus another.

The Infrastructure Leakage Index (ILI) is a ratio of the volumes of Current Annual Real Losses (CARL) to Unavoidable Annual Real Losses (UARL). Unavoidable losses vary from system to system based on their characteristics (e.g. kilometers of water main, average system pressures, etc.). Calculated values of ILIs may facilitate the comparison of systems with respect to others as well as benchmark individual performance for annual comparisons.

The World Bank Institute and AWWA have developed general descriptions, guidelines, and recommendations based on the Infrastructure Leakage Index and these may be reviewed by each municipality based on its calculated ILI.

### **Table of Contents**

	cutive Sum le of Conten	•		i ii
1.0	Introduct	ion		1
2.0	Project M	Iethodolog	gy	2
3.0	Results: 1	Phase I – D	Oata Collection	
	3.1.0	Water Su	pplied	4
			uthorized Consumption Metered	6
			uthorized Consumption Un-metered	8
			Authorized Consumption Metered	8
			Authorized Consumption Un-metered	8
			ized Consumption	8
			Loss – meter under-registration	9
			Loss – customer meter data handling errors	10
	3.9.0			10
			of Hydrants	11
	3.11.0		of Separately Billed Properties	11
			of Unbilled Service Connections	11
			pipe length, property line to billing meter pressure when system pressurized	11 12
			Marginal Costs	12
	3.13.0		Assessed Marginal Costs of UACM	13
			Assessed Marginal Costs of UACU	13
			Assessed Marginal Costs of UC	13
			Assessed Marginal Costs of ALMUR	13
			Assessed Marginal Costs of ALDCD	13
			Assessed Marginal Costs of RL	13
	3.16.0		Operating the System	14
4.0	<b>Results:</b>	Phase II –	Water Balances	
	4.1.0	Financial	Performance Indicators	
		4.1.1	Non-Revenue Water as % of System Input by Volume	14
		4.1.2	Non-Revenue Water as % of System Input by Value	16
	4.2.0		nal Performance Indicators	
		4.2.1	Apparent Losses as a % of System Input	16
		4.2.2	Real Losses in litres/service connections/day	17
		4.2.3	Real Losses as Infrastructure Leakage Index (ILI)	18
5.0	Discussio			
		5.1.0	World Bank Institute Target Matrix	20
		5.2.0	AWWA Guidelines	20
6.0	Recomme	endations		22

## **Table of Contents (con't)**

#### Appendices

Appendix A	IWA Terminology
Appendix B	Supply Meter Accuracy Reports
Appendix C	Draft Report on Meter Accuracy in Niagara Region
Appendix D	NRW Trends
Appendix E	Component Analysis to Calculate Unavoidable Annual Real Loss
Appendix F	PIFastCalc Results – Fort Erie
Appendix G	PIFastCalc Results – Grimsby
Appendix H	PIFastCalc Results – Lincoln
Appendix I	PIFastCalc Results – Niagara Falls
Appendix J	PIFastCalc Results – Niagara-on-the-Lake
Appendix K	PIFastCalc Results – Pelham
Appendix L	PIFastCalc Results – Port Colborne
Appendix M	PIFastCalc Results – St. Catharines
Appendix N	PIFastCalc Results – Thorold
Appendix O	PIFastCalc Results – West Lincoln

#### 1.0 Introduction

With increasing regulatory requirements dealing with water quality, water takings, and full cost recovery the need to understand the performance of water systems has never been more prevalent. Efficient water system(s) management and operational control includes managing real *and* apparent water losses. The now defunct term "unaccounted-for-water" undermined efficiency in so far as the term "unaccounted-for" failed to identify causes or solutions. The term non-revenue water underlines inefficiencies and highlights the real cost(s) of water losses.

Recognizing both costs and regulatory requirements, successful water loss programs must be two-fold; firstly, establishing the level of water losses and secondly, establishing programs to control and/or reduce these losses. The former justifies the investment in water loss reduction and control programs and may be used to track and report on project successes as well as identify program short-comings.

In 2004, the Regional Municipality of Niagara created a working group consisting of Regional staff and representatives of its twelve area municipalities (AMs). The purpose of the "Water Loss Reduction Task Force" is to share experiences regarding water loss levels and strategies. In November 2004, a two day workshop on current industry best practices for dealing with water loss assessment, validation, measurement and control was sponsored by the Region.

The task force identified that a proper assessment and validation of the water loss levels within each AM's water system should be initiated. The AWWA and the Canadian InfraGuide have both adopted the International Water Association's (IWA) Standard Water Balance.

Using PIFastCalc for Canada V1, a licensed software package purchased by the Region on behalf of its area municipalities, water balances were completed based on the data provided by the area municipalities themselves.

The following report summarizes the data collected as well as the results of the water balances with respect to the benchmarking performance indicators calculated within the software package. Individual copies of the PIFastCalc outputs are included in the appendices.

#### 2.0 PROJECT METHODOLOGY

The goal of the Water Loss Assessment Project is to provide an appreciation of the components of water loss across the region and to identify areas in which losses can be addressed and ultimately reduced. Traditionally many distribution systems describe water losses as the percentage of unaccounted-for-water based on the simple calculation illustrated below:

The IWA/AWWA Standard Water Balance (Figure 1) accounts for the total volume of water supplied by identifying the various components<sup>1</sup> of both consumption as well as water losses using either measured or estimated quantities

		Water Exported				Billed Water Exported
Own Sources	System Input		Authorised Consumption	Billed Authorised Consumption	Revenue Water	Billed Metered Consumption
	ı	Water Supplied				Billed Unmetered Consumption
Water	(allow for			Unbilled Authorised Consumption		Unbilled Metered Consumption Unbilled Unmetered Consumption
Imported	known errors)			Apparent Losses	Non- Revenue	Unauthorised Consumption Customer Metering Inaccuracies
			Water Losses	Real Losses	Water	Leakage on Mains Leakage and Overflows at Storages Leakage on Service Connections up to point of Customer Metering

Figure 1: Overview of the Components of the IWA/AWWA Standard Water Balance

PIFastCalcs is a licensed software package, purchased by the Region on behalf of its area municipalities, underlying the water loss assessment program. As evidenced in Figure 2 on the following page the standard water balance methodology is incorporated into the software. Based on the water balance, PIFastCalcs automatically calculates "Performance Indicators" (PIs) to assess both real and apparent water losses. And these performance indicators benchmark current losses allowing each area municipality to compare its own performance year-to-year as well as with other systems (locally and internationally).

Tools (e.g., process reliability bands and 95 % confidence limits) highlight the potential need to further evaluate and/or verify data as well as track the overall effect of uncertainty regarding the data used to derive the water balance.

.

<sup>&</sup>lt;sup>1</sup> Appendix A includes the standard terminology of each of the balance's components as included in PIFastCalcs.

Migggra	7	//	7

### VATER BALANCE CALCULATIONS    VATER BALANCE CALCULATIONS   PROGRAM   PIFact Calculation   Part		'LEAKS' Suite of LE	AKAGE EVA	LUATIO	N and AS	SESSM	ENT KNO	W-HOW S	OFTWAR	E				
Bate   Calculation should be known or efficiently print for all appets of the metaboral in featilise metaboral in featilises when is saving software   philitary	VA	TER BALANCE AND PERFORMANCE INC	Cales'	Standard	Version 1a	2nd De	c 2005	C	anada					
Water   Components of the content	AHE	IVAL WATER BALANCE CALCULATION IN IWA STANDA	ARD FORMAT, W	ITH 95% C	OHFIDENCE	LIHITS	Data entry	Defaults	Calculate	d Values	From east	From another Worksheet		
Note   Second   Sec		Male:Calumbaliana abundd be baard on a 12-moulh preiod for all aspeals of the morbobret to fountion occer						\$C		н	4	<b>-3</b>		
March   Marc	Utility	Enter Licensee's name when issuing software			DS			t=		-	365	days		
WOS: Values fram Ous Severar (corrected for known systematic errors)										Data				
WOS: Values fram Ous Severar (corrected for known systematic errors)	cess bility ad	WATER BALANCE CALC	ULATIONS			i.								
WOS: Values fram Ous Severar (corrected for known systematic errors)	15.58	IVA Terminolog	17			paris.		Tarianca						
WOS: Values from Oun Sources (corrected for known systematic errors)	~ ~	COMPONENTS OF WATER BALANCE				н	,							
Wi: Water Impurited (corrected for house systematic errors)		WOS: Valume from Oun Sources (corrected for know	un systematice	·rr=rx)				0	0.02	<u>.</u>	1	!		
WS: WATER SUPPLIED - SIV - BACE		WI: Water Impurted (currected for known systemati	c ørrærs)					0	0.02		*=	1		
WS: WATER SUPPLIED - SIV - BACE		SIV: SYSTEM INPUT VOLUME				0.0	0.02	0	0.02	-44		Į į		
BACM1: Billed Authorized Consumption: Hetered   0 0.02   0 0.02   N   N		BACE: Water Experted						0	0.02	111	4 .			
BACM1: Billed Authorized Consumption: Hetered   0 0.02   0 0.02   N   N		WS: WATER SUPPLIED - SIT - BACE				0.0	0.02	0	0.02		1	•		
BACH3: Billed Authorized Congrumption: Material		BACM1: Billed Authorized Consumption: Metered						0	0.02	112	1 2 2 4	į		
BACH3: Billed Authorized Congrumption: Material		BACM2: Billed Authorized Consumption: Metered						0	0.02		43	*		
NRW: NON-REVENUE WATER   0.0 0.02 0 0.02 0.0000 0.0 0.02		BACM3: Billed Authorized Consumption: Metered						0	0.02	".]	] ]	N		
UACH: Unbilled Authorized Consumption: Metered   uf WS   0.0   100.02   0.02   0.0   0.02		BACU: Billed Authorized Consumption: Unmetered						0	0.02	\$C/m3	\$Cx1000	×		
UACU: Unbilled Authorized Consumption: Unmotors Estimated as   1.2502   of WS   0.0   100.02   0   0.02   0.000   0.0   0.02		NRV: NON-REVENUE WATER				0.0	0.02	0	0.02	0.0000	0.0	0.02		
WL WATER LOSSES		UACM: Unbilled Authorized Consumption: Metered			∎f ₩S			0	0.02		0.0	0.02		
UC: Unauthurized Cunrumption:   Ertimated at   0.2502   of   WS   0.0   100.02   0   0.02   0.0   0.02		UACU: Unbilled Authorized Consemption: Unmeters	Estimated as	1.250%	∎f ₩S	0.0	100.02	0	0.02		0.0	0.02		
ALMUR1: Apparant Luzz - motor under-requirtration		VL WATER LOSSES				0.0	0.02	0	0.02	0.0000	0.0	0.02		
ALMUR2: Apparent Lazz - meter under-requirtration		UC: Unauthorized Consumption:	Ertimated ar	0.250%	∎f WS	0.0	100.02	0	0.02		0.0	0.02		
ALMUR3: Apparent Lars - motor under-requirtration under under-requireration under under under under requireration under		ALMUR1: Apparent Larr - meter under-registration			∎f BACM1	0.0		0	0.02		0.0	0.02		
ALMUR3: Apparent Lars - motor under-requirtration and UACM UACM UACM UACM UACM UACM UACM UACM		ALMUR2: Apparent Lurr - meter under-registration				0.0		0	0.02		0.0	0.02		
ALCO Curtamor mater data handling errors  O 0.02 0.02 0.000 0.0 0.02  REC REAL LOSSES  O 0.02 0 0.02 0.000 0.02  O 0.02 0 0.02 0.000 0.02  Curtamor mater data handling errors  O 0.02 0.000 0.02  O 0.02 0 0.02  Curtamor mater data handling errors  O 0.02 0.000 0.00  O 0.02 0 0.000 0.00  O 0.02 0 0.000 0.000  O 0.02 0 0.0000  O 0.02 0 0		ALMUR3: Apparent Lazz - meter under-registratiun			444	0.0		0	0.02		0.0	0.02		
RL: REAL LOSSES		ALDCD Curtumor motor data handling orrars						0	0.02		0.0	0.02		
X mf perind xyxtom prozzurizo4 - 100.02 365.0 days Cart mf running xyxtom in perind - \$Cx1000		AL: Sum of APPARENT LOSSES				0.0	0.02	0	0.02	0.0000	0.0	0.02		
		RL: REAL LOSSES				0.0	0.02	0	0.02		0.0	0.02		
CARL: CURRENT ANNUAL REAL LOSSES (when system is pressurized) 0.00 MH/4-y		% of period system pressurized -	100.02	365.0	days			Cart of rea	sing system	in periud -		\$C±1000		
		CARL: CURRENT ANNUAL REAL LOSSES (whe	n system is pro	essurized	)	0.00	Hildey							

Figure 2: Copy of the "Water Balance & PIs" worksheet from PIFastCalc V1a

#### 3.0 RESULTS: PHASE I – DATA COLLECTION

The following section summarizes the data collected with respect to the various components of the standard water balance.

#### 3.1.0 Water Supply

Municipality The Regional Niagara itself is responsible for bulk supply, treatment, transmission, and storage. Therefore the Region directly provided a summary of metered monthly volumes for each of its thirty-three billing meters. Based on the billing equations provided (Table 1) the data was used to derive the total volume of water supplied to each area municipality per month.

Figure 3 illustrates the breakdown of nearly 74.5 million cubic meters sold in 2005.

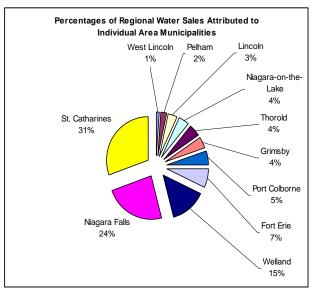


Figure 3: Water Supply in Niagara Region

The Region also provided copies of the meter calibration tests completed in 2005 (Appendix B)<sup>2</sup>. Meters for accuracy reports were provided are highlighted in Table 1.

# Table 1 Regional Billing Equations

Area Municipality	Billing Equation (Accuracy Reports provided for highlighted meters)
Fort Erie	2T1+2T2-2S
Grimsby	6T1-6D1- <mark>6D2</mark>
Lincoln	5D7+5D8+6D1
Niagara Falls	1T1+1T2- <b>1D1-1D2-1D3-1D4</b>
Niagara-on-the-Lake	5D5+5D6+ <b>1D1+1D2+1D3</b> +5D9
Pelham	3D1+3D2
Port Colborne	4T1+4T2
St. Catharines	(5T1+5T2+5T3+5T4+5T5)- <b>5D1-5D2-5D3-</b> 5D4- <b>5D5-5D6-</b> 5D7-5D8-5D9
Thorold	1D4+ <b>5D1-5D2+5D3</b> +5D4
Welland	3T1+3T2+3T3-3D1-3D2
West Lincoln	6D2

<sup>&</sup>lt;sup>2</sup> Veritec distinguished between calibration reports for the meter vs. loop calibration reports.

Table 2 summarizes the results of the meter accuracy tests. Each meter is tested at several flow rates. The range of accuracies recorded for each individual flow rate was between 96.5 and 101.6 percent<sup>3</sup>. Based on this data, and that meter accuracy reports for all the meters were not available, the confidence interval used in the PIFastCalcs software for the Region's meters is +/- 3%.

Table 2
Summary of Supply Meter Accuracy Results

		% Accuracy								
Meter	Date		As Found			As Left				
ID	Tested	Avg.	Min.	Max.	<u>Avg.</u>	Min.	Max.			
6D2	5/24/2005	99.7	97.0	101.0						
1D1	5/4/2005	97.0	94.3	101.0	99.3	96.5	101.0			
	10/13/2005	99.7	99.7	101.0						
1D2	5/4/2005	99.8	97.0	100.6						
1D3	5/20/2005	101	100.8	101.3						
1D4	5/4/2005	49.8	9.8	101.3	100.2	98.2	101.1			
	10/13/2005	0.0	0.0	0.0	100.4	99.9	100.9			
5D1	5/20/2005	100.1	99.7	100.6						
5D2	5/20/2005	99.4	98.8	100.0						
5D3	5/24/2005	100.7	99.3	101.6						
5D5	5/202005	100.0	99.7	100.4						
5D6	5/20/2005	99.4	97.5	101.0						
OV	ERALL 4	70.5	0.0	101.6	100.0	96.5	101.1			
UV	ENALL	(100.0)	(97.0)	(101.6)	100.0	90.5	101.1			

Accuracy reports did highlight problems with the Mewburn Road meter. This meter records flows out of the Niagara Falls system and into the Niagara-on-the-Lake system. Figure 4 suggests that the meter was failing to record demands in N-O-T-L prior to being calibrated in May '05 and that it began failing again within weeks of the calibration. The failure of this meter may lead to overestimating supply to Niagara Falls and underestimating supply to N-O-T-L<sup>5</sup>.

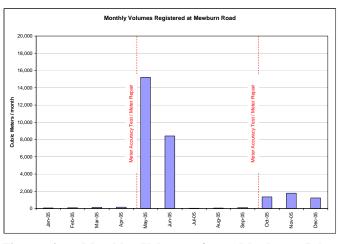


Figure 4: Monthly Volumes from Mewburn Rd.

Veritec Consulting Inc. 5

\_\_\_

<sup>&</sup>lt;sup>3</sup> Excludes meters that required calibration.

<sup>&</sup>lt;sup>4</sup> Overall results for the "As Found" are summarized both with (and without) the meters requiring calibration.

<sup>&</sup>lt;sup>5</sup> Based on the original billing equations provided it also appears that flows recorded at 1D4 were subtracted from Niagara Falls but were not added to Niagara-on-the-Lake. It is likely that issues

Data for the remainder of the balances were collected from the individual area municipalities. Table No. 3 on the following page summarizes, based on the input parameters of the PIFastCalc software, which area municipalities provided supporting data for each of these parameters.

#### 3.2.0 Billed, Authorized Consumption – Metered (BACM)

All municipalities provided at least partial data with respect to BACM<sup>6</sup>. The information provided ranged from complete billing databases to a single figure identified as the annual volume of water sold.

With respect to establishing the water balances, errors introduced into the value of BACM may include the following:

- ✓ Meter Accuracy,
- ✓ Data Handling,
- ✓ Estimated Readings, and
- ✓ Meter Lag Times

Meter accuracy and data handling errors are specifically addressed within the framework of the IWA Standard Water Balance and therefore are not evaluated with respect to the defining confidence in the value of BACM.

Estimated readings and meter lag times may be used to indicate confidence in the value of BACM. The percentage of estimated reads reported by the AMs ranged from none (or, at least, no data was provided) to 16.4 % in St. Catharines. Municipal methods for estimating ranged from using the previous month, an average of the previous six months, or even doubling the previous bill (to get the customer's attention). It is impossible to quantify or address errors due to estimated reads without copies of the billing database.

Meter lag times introduce a difference between *when* water is consumed and *when* it is billed. As an example, in an analysis of the Niagara Falls billing approximately 7.6 % of billing in 2004 relates to water consumed prior to the start of the year, and similarly, 7.3 % of 2004's consumption is derived based on meter readings recorded in 2005 (assuming that water is consumed equally throughout the period between meter readings). On an annual basis, it is often assumed these values will counter balance each other. Where possible, based on the datasets provided, meter lag times were addressed.

Veritec Consulting Inc.

CI

surrounding this meter account for N-O-T-L reporting more water sold within the municipality than purchased from Region.

<sup>&</sup>lt;sup>6</sup> Billing data for Welland contained a limited number of accounts (~530). Much of Welland remains unmetered and customers are billed a flat rate. There was not deemed enough data to complete a water balance for Welland.

Table 3
Summary of Data Collected by PIFastCalc Input Parameters

Input Parameters for PIFastCalc (refer to Appendix A for Definition of Terminology)			Grimsby	Lincoln	Niagara Falls	N-0-T-L	Pelham	Port Colborne	St. Catharines	Thorold	Wainfleet	Welland	West Lincoln
WOS	Volume from Own Sources		A	ll water	r suppli	ed via	the Reg	gional N	Aunicip	ality of	f Niaga	ra	
WI	Water Imported	$\sqrt{}$			$\sqrt{}$	$\sqrt{}$			$\sqrt{}$	V	$\sqrt{}$		
BACE	Billed, Authorized Consumption Exported	$\sqrt{}$		$\sqrt{}$	$\sqrt{}$	$\sqrt{}$			$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$
Assessed n	narginal cost of RL	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$
BACM	Billed, Authorized Consumption Metered	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	'04	P	P	$\sqrt{}$	'04	P			$\sqrt{}$
BACU	Billed, Authorized Consumption Un-metered	_	$\sqrt{}$										-
UACM	Unbilled, Authorized Consumption Metered												
UACU	Unbilled, Authorized Consumption Un-metered	$\sqrt{}$	$\sqrt{}$					$\sqrt{}$					
UC	Unauthorized Consumption	V	$\sqrt{}$					$\sqrt{}$		-			$\sqrt{}$
ALMUR	Apparent Loss – meter under-registration		V			$\sqrt{}$		V					
ALDCD	Apparent Loss – customer meter data handling errors												
Lm	Mains Length	V	$\sqrt{}$	$\sqrt{}$	V	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	V	$\sqrt{}$		$\sqrt{}$	$\sqrt{}$
Nh	Number of Hydrants	V	$\sqrt{}$	$\sqrt{}$	V	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	V	?			$\sqrt{}$
Nb	Number of Separately Billed Properties	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$		$\sqrt{}$	$\sqrt{}$	$\sqrt{}$	$\sqrt{}$		$\sqrt{}$	$\sqrt{}$
R	Ratio of billed Service Connections to Billed Properties												
Nu	Number of Unbilled Service Connections	$\sqrt{}$					$\sqrt{}$			$\sqrt{}$			$\sqrt{}$
Lp	Average pipe length, property line to billing meter		$\sqrt{}$		$\sqrt{}$	$\sqrt{}$			V	$\sqrt{}$			$\sqrt{}$
P	Average pressure when system pressurized	V	$\sqrt{}$		V	$\sqrt{}$		$\sqrt{}$	$\sqrt{}$				
	Assessed marginal cost of UACM												
Retail Cost / m <sup>3</sup>	Assessed marginal cost of UACU		,				<b>,</b>	,					
(excluding	Assessed marginal cost of UC		$\sqrt{}$					$\sqrt{}$		$\sqrt{}$			
base rate)	Assessed marginal cost of ALMUR												
	Assessed marginal cost of ALDCD		ļ										<b></b> _
Costs of Ru	unning system over period (excluding capital projects)		$\sqrt{}$	$\sqrt{}$		$\sqrt{}$				$\sqrt{}$		$\sqrt{}$	$\sqrt{}$

#### 3.3.0 Billed, Authorized Consumption – Un-metered (BACU)

With the exception of identifying 179 flat rate customers in one specific municipality no details were provided with respect to what the flat rate was or what the estimated consumption was equal to. The remaining AMs provided no details regarding the volume of BACU. There are several flat rate customers in Welland.

#### 3.4.0 Unbilled, Authorized Consumption – Metered (UACM)

The Town of Grimsby identified street sweeping and sewer flushing as components of UACM. Assumedly the town provides a mobile hydrant meter but does not invoice the contractors who would be working for the Town.

#### 3.5.0 Unbilled, Authorized Consumption – Unmetered (UACU)

Identified sources of Unbilled, Authorized Consumption – Unmetered primarily relate to hydrant usage for the following:

- ✓ Water Main Construction and Repairs (e.g. dewatering & flushing),
- ✓ Water Service Repairs,
- ✓ Fire Fighting & Training, and
- ✓ Street Cleaning & Sewer Flushing (i.e., re-filling equipment)

Figure 3 illustrates calculated estimates provided by Grimsby.

	С	omponents in	MI			Additional information on sources of data and basis of estimates
Components of Authorised Consumption	Billed	Billed	Unbilled	Unbilled	Total	E = estimated
	Metered	Unmetered	Metered	Unmetered		R = Based on recordings
Hydrant Usage (mobile meter)			2.12			R = Based on recordings, less Avertex
New Construction/Rehab				2.45		E = estimated; 6 jobs x 3/job x 500 gpm x 1 hr.
Fire/Training				13.64	13.64	E = estimated; 1 fire/yr. 2,000 lmp. Gal; Training 68 hrs/yr @ 1,000 gpm = 3,000,000 lmp. Gal
Hydrant Flushing				18.18	18.18	E = estimated; dead-end 20 locations x 6/yr. x 3,000 lmp Gal + 3,000,000 lmp. Gal
Hydroguard				2.95	2.95	E = estimated; 20 gpm x 6-4 hrs./day (50% of this in winter)
Recreation				0.47	0.47	F = estimated: 3 parks approx. 6 gpm x 2 hrs/day x 5 months

Figure 3: Portion of the "Consumption" worksheet extracted from Grimsby's Balance

Table 4 on the following page illustrates that Grimsby and Port Colborne provided breakdowns of their estimates that equate to 1.17% and 6.7 % of Water Supply, respectively. Thorold, Niagara-on-the-Lake, and Fort Erie identified relevant sources of UACU in their system and the latter provided an overall estimate equal to 5 % of Water Supply. The default estimate in PIFastCalcs is equal to 1.25% of Water Supplied. In the absence of estimates made by the municipality themselves the balances accept the default estimate. The 95 % confidence limits of +/- 100 % and process reliability band of "D" highlight the uncertainty with regards to this component.

#### 3.6.0 Unauthorized Consumption (UC)

Common components of unauthorized consumption are by-pass tampering, unauthorized use of fire services, and unauthorized use of hydrants.

The default estimate in PIFastCalcs is equal to 0.25 % of Water Supply (+/- 100%). Both Grimsby and Fort Erie estimated 1 % whereas West Lincoln estimated 0.02 %. Port

Colborne suggests approximately 5 household per year tamper with the meter by-pass but did not estimate the amount of loss. In the absence of a provided estimate the default value is accepted.

Table 4
Summary of Data Collected Pertaining to UACU

	√ indica	Estimates in ML/year √ indicates the AM recognizes this as a use but did not provide an estimate							e an	
	Fort Erie Grimsby Lincoln Niagara Falls N-O-T-L Pelham Port Colborne St. Catharine Thorold								West Lincoln	
Water Main Construction & Repairs		7.8					1.8			
Water Service Repairs							94.2			
Water Quality	V						86.4		V	
Hydrant Flushing	V	18.4					13.1			
Blow-offs					1				1	
Fire Fighting / Training	√	13.6			$\sqrt{}$		44.4		<b>√</b>	
Sewer Flushing	V						44.0		<b>V</b>	
Street Cleaning	<b>√</b>						14.6			
Recreation		0.6					6.4			
TOTAL	197	40.4	-	-	-		260.9	-	-	-

#### 3.7.0 Apparent Losses – Meter Under-Registration (ALMUR)

As meters deteriorate with age and usage they are more likely to under-register water use. Because of the relative small number of meter accuracy reports provided an aggregated analysis of the tests provided by Grimsby, Niagara-on-the-Lake, and Port Colborne (Appendix C) was completed. The results of this analysis are summarized below.

Table 5
Calculated Values of Meter Under-Registration & 95% Confidence Limits

	% Under Registration	95 % Confidence Limits
Meters < 1"	0.5	7
Meters > 1"	1.0	7

Most municipalities provided a breakdown of consumption based on accounts for which meters are read based on cycles (e.g., 3 or 4 times per year) and those that are read monthly. In these cases the former group was associated with meters smaller than one inch and the latter with meters larger than one inch. If no breakdown was provided a 70/30 ratio was estimated and an overall value of 0.6% under-registration was assumed (with 95% confidence limits equal to +/-7%).

#### 3.8.0 Apparent Losses – Customer Data Handling (ALDCD)

Across the Region, numerous methods are employed to retrieve and manage meter readings. Meter reads are collected using customer reading cards, physical meter reads, roll dial remotes, touchpads, and radio-reads. Billing software packages include: Easyroute, USTI Water System, Vadium, Vailtech, and AS400. Niagara Falls maintains a customized database.

Sources of customer data handling errors are numerous and may collectively introduce significant error. Specifically, examples of the data handling errors which were identified included:

- ✓ In Niagara Falls approximately 2% of records in the raw database were duplicates.
- ✓ In Grimsby the summary spreadsheets of 2004 and 2005 contained inconsistent data pertaining to periods where meter reads bridged the calendar year; representing a potential error of approximately 1%.
- ✓ In West Lincoln the original data submitted mismatched data billed monthly in 2004 with data billed quarterly in 2005. The 2005 summary provided included regional billing data from 2004.
- ✓ Simple errors in arithmetic or difference in numbers, depending on the source used

These examples are of errors that have been identified and corrected within the balance but undoubtedly there are errors that remain undetected – either because they are inherent in the data provided or because not all the data was provided

#### 3.9.0 Length of Water Mains (Lm)

The total length of water mains in the reporting AMs is equal to approximately 2,000 kilometers.

Age and material are not specifically required in the water balance. Nonetheless most municipalities provided data on materials and Figure 4 provides an overall breakdown of the mains across the Region.

It is assumed that the inventory of water mains is most likely accurate to within +/- 2 %.

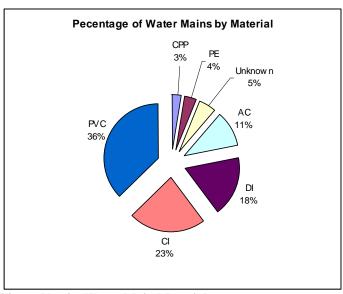


Figure No. 4 – Water Main Materials

Some inaccuracies may be as a result of some AM including Regional water mains while others may not. Additionally, databases may be out of date with regards to new construction.

#### 3.10.0 Number of Hydrants (Nh)

There are approximately 10,500 hydrants in total. All of the AMs provided this data.

#### 3.11.0 Number of Separately Billed Properties (Nb)

PIFastCalc uses two values, the Number of Separately Billed Properties and the Ratio of Service Connections to Billed Properties (R) to calculate the Number of Billed Service Connections (Ns). Most AMs provided the number of billed services directly and a ratio of 1:1 is used. The total number of separately billed properties is equal to 113,228 – equivalent to the number of meters.

#### 3.12.0 Number of Unbilled Service Connections (Nu)

Unbilled service connections may include the following:

- ✓ Fire connections, and
- ✓ Un-metered municipal connections

Most AM did not provide any data with regards to the number of unbilled service connections. Table 6 summarizes the data that was provided.

Table 6
Summary of Reported Unbilled Service Connections

Area Municipality	Number of Unbilled Service Connections (Nu)
Fort Erie	100
Port Colborne	28
Thorold	25
West Lincoln	6

#### 3.13.0 Average Pipe Length – Property Line to Meter (Lp)

Private service pipe length is an important consideration in the calculation of the performance indicators assessing real losses. This is because it is generally accepted that the majority of leaks occur on service connections. Table 7 summarizes the reported data.

Table 7
Summary of Reported Lengths (in meters) – Property Line to Meter (Lp)

Area Municipality	Lp	Area Municipality	Lp
Fort Erie	10	St. Catharines	7
Grimsby	10	Thorold	10
Niagara Falls	18	West Lincoln	9
N-O-T-L	8.5		

#### 3.14.0 Average System Pressure (P)

The average system pressure entered in PIFastCalc should be a weighted average determined, for example, based on a list of static hydrant pressures many AM record during hydrant inspections. Table 8 summarizes the data provided which in some cases was simply a range of pressures.

Table 8
Summary of Reported Pressures (in PSI)

	Pressure(s)
Fort Erie	75
Grimsby	75
Lincoln	-
Port Colborne	58
Niagara Falls	94
Niagara-on-the-Lake	
Zone 1	44 – 69
Zone 2	56 – 97
Zone 3	45 – 102
Zone 4	66 – 92
St. Catharines	
Zone 1	50 – 100
Zones 2 & 3	50 - 80
Thorold	62
West Lincoln	62

#### 3.15.0 Assessed Marginal Costs

Within PIFastCalc several marginal costs are used to attempt to more accurately reflect the actual costs of various components of NRW.

Unbilled, authorized consumption is typically valued at the cost which the AM purchases the water from the Region. Justification of this is that the AM, by not billing the customer, is assuming the costs. The costs of apparent losses is equal to the rate which the AM charges customers because this water is in fact being consumed by customers (sewer surcharges may also be applicable). Unauthorized consumption such as theft may be valued at a rate equal to the retail costs of water without the applicable sewer

surcharge. Real losses are valued at the wholesale costs of water because this water is not consumed or used by anyone – eliminating the real losses eliminates the demand!

Many AM may have never considered assessed marginal costs based on the components of the IWA Water Audit and therefore could not identify costs according to this breakdown.

#### 3.15.1 Assessed Marginal Costs of UACM

The rate(s) at which the individual AMs re-sell water vary. If base rates apply it may be difficult to directly distinguish the marginal costs of UACM. Table 9 summarizes the data collected.

Table 9
Summary of Reported Water Rates

	Rate(s)
Grimsby	\$0.73/m <sup>3</sup>
Port Colborne	\$0.756/m <sup>3</sup>
Thorold	\$47.76 for the first 27 m <sup>3</sup> (\$1.769/m <sup>3</sup> )
	\$0.742/m <sup>3</sup> in excess
West Lincoln	\$1.109/m <sup>3</sup>

#### 3.15.2 Assessed Marginal Costs of UACU

In most cases the assessed marginal cost of unbilled, authorized consumption will be the same regardless of whether it is metered or un-metered. Possible exceptions may include considerations of sewer surcharges related to water consumption.

#### 3.15.3 Assessed Marginal Costs of UC

No data.

#### 3.15.4 Assessed Marginal Costs of ULMUR

No data.

#### 3.15.5 Assessed Marginal Costs of ALDCD

No data.

#### 3.15.6 Assessed Marginal Costs of RL

The assessed marginal cost of real losses is equal to the wholesale water rate at which the AM purchase water from the Region. This rate was equal to  $0.40/\text{m}^3$  and  $0.446/\text{m}^3$  in 2004 and 2005, respectively.

#### 3.16.0 Costs of Running the System Over the Period of the Balance

The costs of running the system should be determined based on the operational costs plus the internal manpower costs minus the capitalized costs of self-constructed assets. Reported costs are summarized in Table 10 on the following page.

Table 10
Summary of Reported Costs (\$) of Running Water System(s)

	Reported Costs
Grimsby	\$3,166,740
Lincoln	\$3,505,747
Thorold	\$2,648,400
West Lincoln	\$ 372,750

#### 4.0 RESULTS: PHASE II – WATER BALANCES

The following sections highlight the results of the individual water balances included in Appendices F through O.

#### **4.1.0** Financial Performance Indicators

#### 4.1.1 Non-Revenue Water as a Percentage of System Input Volume

Percentage of Non-Revenue Water by Volume is considered a "Basic Level" Financial Performance Indicator. NRW may be particularly misleading with regards to comparing one system to another.

Region wide the combined volume of BACM reported accounts for approximately 85% of the water purchased from the region by the reporting area municipalities. Individually the percentage of NRW within the area municipalities ranges from -1.3 % to 36.8 %.

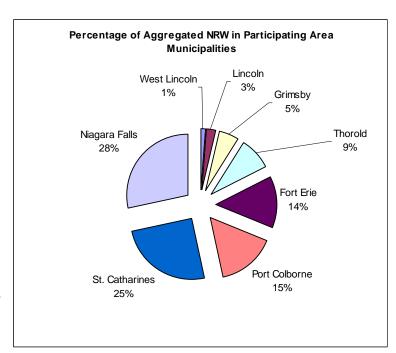


Figure 5: Percentage of Aggregated NRW in Participating Area Municipalities

Figure 6 illustrates the values of NRW in each area municipality. Confidence intervals are derived based on the confidence attributed to both the Region's billing and the billing meters. The negative value calculated for Niagara-on-the-Lake may be accounted-for in part due to meter error discussed on page 5 of this report.

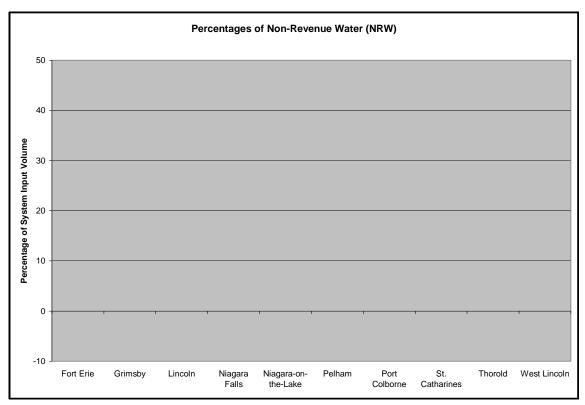
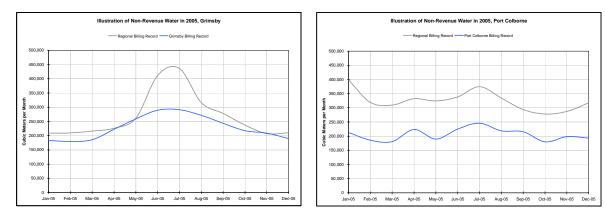


Figure 6: Non – Revenue Water as a Percentage of System Input Volume

Insofar as trends in NRW may be more telling than an annual volume, a monthly analysis was completed for those municipalities that provided sufficient data (Appendix D). Figures 7a & 7b illustrate two examples of monthly variations in NRW which suggest different potential causes.



Figures 7a & b - Trends in Non-Revenue Based on Monthly Volumes Purchased & BACM

Figure 7a (Grimsby) suggests excessive unbilled water use in the summer period accounting for approximately 5 % of Water Supplied annually. Use of estimated reads, based on average annual consumption, may also account for Grimsby's trend. Figure 7b (Port Colborne) suggests unbilled water use underlying billed consumption throughout the year. This underlying water use may be attributable to several factors including leakage.

#### 4.1.2 Non-Revenue Water as % of System Input by Value

As identified any Section 3.16 of this report many municipalities did not provide the costs of running the system during the period of the balance. Table 11 summarizes the results.

Table 11 Non-Revenue Water as % of System Input by Value

	% of Non-Revenue Water as % of System Input by Value
Fort Erie	8.4 % (+/- 25.2 %)
Grimsby	3.6 % (+/- 35.6 %)
Lincoln	14.7 % (+/- 12.8 %)
Thorold	13.1 % (+/- 25.0 %)

#### **4.2.0** Operational Performance Indicators

#### 4.2.1 Apparent Losses as a % of Water Supply

The recommended Performance Indicator for Apparent Losses is the % of Apparent Losses relative to Water Supply. Apparent losses include meter under-registration, errors in customer data handling, and unauthorized consumption. The values calculated for each of the municipalities are identified below.

Table 12 Summary of Apparent Losses by Area Municipality

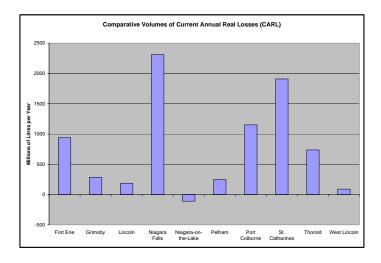
	% of Apparent Losses	95 % Confidence Limits
Fort Erie	1.4	35.1%
Grimsby	2.1	36.6%
Lincoln	0.8	31.9%
Niagara Falls	0.7	36.6%
Niagara-on-the-Lake	0.9	30.0%
Pelham	0.8	33.6%
Port Colborne	0.7	18.7%
St. Catharines	0.8	33.5%
Thorold	0.7	34.1%
West Lincoln	0.6	6.0%

Differences in apparent losses primarily reflect the estimated percentages of unauthorized consumption (page 9). Values of meter-under registration were assumed equal in all the

municipalities and no municipalities provided any estimates regarding data handling errors. Therefore, because Fort Erie and Grimsby estimated unauthorized consumption to be higher than the default value their apparent losses are greater.

#### 4.2.2 Current Annual Real Losses in litres/service connection/day

Figure 8a illustrates the Current Annual Real Losses (CARL) in each of the area municipalities. CARL are calculated by subtracting authorized consumption and apparent losses from the total volume of water supplied. The recommended Performance Indicator for Real Losses (Figure 8b) expresses the value of CARL in litres/service connection/day, when the system is pressurized<sup>7</sup>.



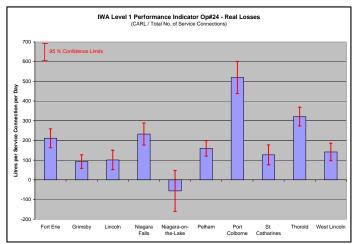


Figure 8a & b: Comparative, calculated values of Current Annual Real Losses expressed in (a) ML/yr, and (b) litres/service connection/day when pressurized

As illustrated in Figures 8a and b the volume of real losses in itself may be misleading in comparing area municipalities because it fails to account for the relative size of the

the case of all these audits the systems are pressurized 100% of the th

<sup>&</sup>lt;sup>7</sup> In the case of all these audits the systems are pressurized 100% of the time.

distribution systems. By expressing losses in terms of litres/connection per day when the system is pressurized the volume of losses is put into context. Nonetheless the expression of CARL in these terms is considered a Level 1 (or basic) performance indicator because it does not account for differences in system pressure which significantly influence water losses due to leakage.

#### 4.2.3 Infrastructure Leakage Index (ILI)

The advanced (Level 3) operational performance indicator for real losses is the Infrastructure Leakage Index (ILI). The ILI is a ratio of the CARL to Unavoidable Annual Real Losses.

#### **Unavoidable Annual Real Losses (UARL)**

Some "measure" of water loss due to leakage is unavoidable in all water distribution systems. Background leakage, including small leaks and weeps, is unavoidable in that individual sources are either undetectable and/or the cost-to-benefit does not justify repair/replacement. In addition there are unavoidable losses due to reported/unreported leakage. These losses relate to the time between when leak(s) occurs and is repaired.

Unavoidable losses are controllable through various best-management-practices (e.g., speed and quality of repairs, active leakage control). The calculated values of UARL assume best-management-practices. Appendix E provides a summary of the component analysis for calculating UARL.

Based on the assumptions described in Appendix E, the value of UARL in each area municipality is calculated based on the following:

- total length of water mains
- total number of service connections
- total length of customer supply pipe, and
- the average system pressure

Figure 9, on the following page, illustrates the components of CARL in each of the area municipalities. Potentially recoverable losses represent the difference between CARL and UARL.

The Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure<sup>8</sup>.

<sup>&</sup>lt;sup>8</sup> The ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management.

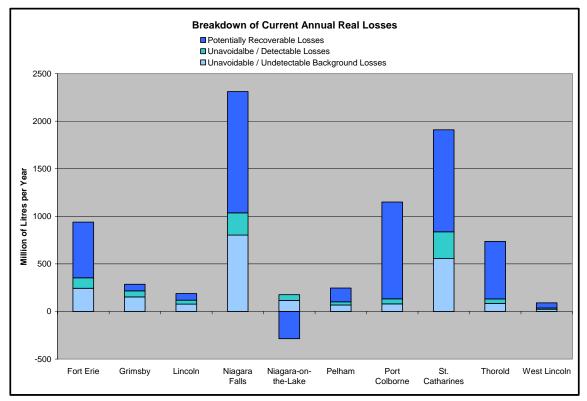


Figure 9: Illustration of the components making up the Current Annual Real Losses (CARL)

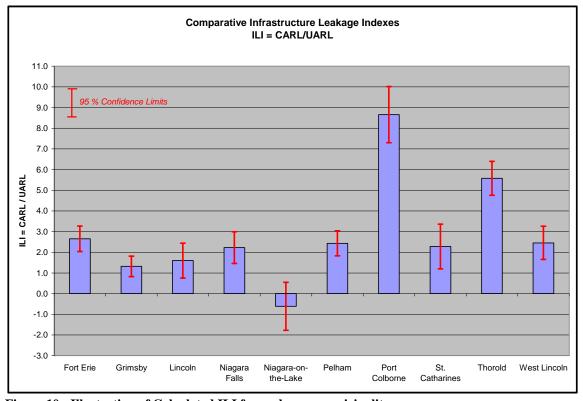


Figure 10: Illustration of Calculated ILI for each area municipality

An ILI equal to 2, for example, suggest Current Annual Real Losses (CARL) are twotimes greater than the Unavoidable Annual Real Losses (UARL) if best-managementpractices were followed. Figure 10 on the preceding page illustrates the calculated ILIs of each of the participating area municipalities.

Based on the calculated ILIs and on the guidelines provided by both the World Bank Institute and the AWWA the following section provides some general discussion of the real losses in the area municipalities.

#### 5.0 DISCUSSION

#### 5.1.0 World Bank Institute Target Matrix / Banding

PIFastCalc identifies where the calculated ILI fits into a target matrix developed by the World Bank Institute and incorporated into its NRW training modules. These guidelines are included in the individual reports in Appendices F through O and summarized in the following table. In the WBI's target matrix, general descriptions are made which describe a system's performance in real loss management based on its calculated ILI.

Table 13
General Description of Real Loss Management Performance

ILI Range	Band	Area Municipality	ILI	General description of Real Loss Management Performance
		Niagara-on-the-Lake	-0.6	Further loss reduction may be uneconomic
< 2	A	Grimsby	1.3	unless there are shortages; careful analysis
		Lincoln	1.6	needed to identify cost-effective improvement
		Niagara Falls	2.2	Detential for more and improvements, consider
		St. Catharines	2.3	Potential for marked improvements; consider pressure management, better active leakage
2 to 4	В	Pelham	2.4	control practices, and better network
		West Lincoln	2.5	maintenance
		Fort Erie	2.7	mantenance
4 to 8	C	Thorold	5.6	Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
>8	D	Port Colborne	8.7	Very inefficient use of resources; leakage reduction programs imperative and high priority

#### **5.2.0** AWWA General Guidelines

Table 14, on the following page, summarizes the general guidelines developed by AWWA's Water Loss Committee which again categorize system based on the calculated ILI.

Table 14 **AWWA General Guidelines Pertaining to Infrastructure Leakage Index** 

ILI Range	Band	Area Municipality	ILI	Water Resource Considerations	Operational Considerations	Financial Considerations		
Kange	Danu	Niagara-on-the-Lake	-0.6	Available resources are	Operating with system leakage above this level would	Water resources are costly to develop or purchase; ability to		
< 2	A	Grimsby	1.3	greatly limited and are very difficult / environmentally	require expansion of existing infrastructure and/or	increase revenues via water rates is greatly limited because		
		Lincoln	1.6	unsound to develop	additional water resources to meet demand	of regulation or low ratepayer affordability		
		Niagara Falls	2.2	Water resources are believed	Existing water supply	Water resources can be		
	St. Ca	St. Catharines	2.3	to be sufficient to meet long-	infrastructure capability is	developed or purchased at reasonable expense; periodic		
2 to 4 B	Pelham	2.4	term needs, but demand management interventions	sufficient to meet long-term demand as long as reasonable	water rate increases can be			
		West Lincoln	2.5	(leakage management, water	leakage management controls	reasibly imposed and are		
		Fort Erie	2.7	conservation) are included in long-term planning	are in place	tolerated by the customer population		
4 to 8	C	Thorold	5.6	Water resources are plentiful, reliable, and easily abstracted	Superior reliability, capacity and integrity of the supply infrastructure make it relatively immune to shortages	Cost to purchase or obtain/treat water is low, as are rates charged to customers		
>8	D	Port Colborne	8.7	Although operational and financial considerations may allow a long-term ILI greater than 8.0 such a level of leakage is not an effective utilization of water as a resource. Setting a target lever greater than as an incremental goal to a smaller long-term target – is discouraged				

#### 6.0 RECOMMENDATIONS

The water balances have been completed based on the data provided. In all cases it is advisable to update and complete the data.

With regards to managing real losses (leakage and overflows from systems up to the point of customer metering or consumption) best management practices recognize the following:

- ✓ Pressure Management
- ✓ Speed and Quality of Repairs
- ✓ Active Leakage Control, and
- ✓ Pipeline and Assets Management

PIFastCalc's recommendations are based on the World Bank Institute's ILI Bands. Individual municipalities are grouped in these bands in Tables 13 and 14. Table 15 is reproduced from the ILI Guidelines worksheet within the software.

Table 15 WBI Recommendations

WBI Recommendations for BANDS	A	В	C	D
Investigate pressure management options	Yes	Yes	Yes	
Investigate speed and quality of repairs	Yes	Yes	Yes	
Check economic intervention frequency	Yes	Yes		
Introduce/improve active leakage control		Yes	Yes	
Identify options for improved maintenance		Yes	Yes	
Assess Economic Leakage Level	Yes	Yes		
Review break frequencies		Yes	Yes	
Review asset management policy		Yes	Yes	Yes
Deal with deficiencies in manpower, training and communications			Yes	Yes
5-year plan to achieve next lowest band			Yes	Yes
Fundamental peer review of all activities				Yes

Appendix A

IWA Water Balance Terminology

<b>Volume from Own Sources:</b>	The volume of water input to a system from the Water
	Supplier's own sources
Water Imported or Exported:	The volume(s) of bulk transfers across operational
	boundaries
System Input Volume:	The volume input to that part of the water supply
	system to which the water balance calculation relates,
	corrected for known errors. Equal to VOLUME
	FROM OWN SOURCES plus WATER IMPORTED
Water Supplied:	Equal to the SYSTEM INPUT VOLUME minus
	WATER EXPORTED
<b>Authorized Consumption:</b>	Volume of metered and/or un-metered water taken by
	registered customers, the water supplier and others
	who are implicitly or explicitly authorized to do so by
	the water supplier, for residential, commercial and
	industrial purposes. Authorized consumption may
	include items such as fire fighting and training,
	flushing of mains and sewers, street cleaning, watering
	of municipal gardens, public fountains, frost
	protection, building water, etc. These may be billed or
	unbilled, metered or un-metered.
Water Losses:	The difference between SYSTEM INPUT and
	AUTHORISED CONSUMPTION. Water losses can
	be considered as a total volume for the whole system,
	or for partial systems such as raw water mains,
	transmission or distribution systems, or individual
	zones. In the above definition of Water Losses,
	'Authorized Consumption' includes bulk exports of
	water across operational boundaries. When doing the
	Water Balance calculation, a convenient alternative
	method of calculating Water Losses is 'Water Supplied
Annount Laggage	- (Authorized Consumption - Water Exported)'
Apparent Losses:	Includes all types of inaccuracies associated with
	customer metering, plus unauthorized consumption (theft or illegal use). Over-registration of customer
	meters, leads to under-estimation of REAL LOSSES.
	Under-registration of customer meters, leads to over-
	estimation of REAL LOSSES.
Real Losses:	Physical water losses from the pressurized system, up
Ital Lusses.	to the point of measurement of customer use. The
	annual volume lost through all types of leaks, breaks
	and overflows depends on frequencies, flow rates, and
	average duration of individual leaks, breaks and
	overflows. Although physical losses after the point of
	customer flow measurement or assumed consumption
	are excluded from the assessment of REAL LOSSES,
	are exercised from the assessment of REAL LOSSES,

	this does not necessarily mean that they are not
	significant or worthy of attention for demand
	management purposes.
Revenue Water:	Those components of SYSTEM INPUT which are
	billed and produce revenue (also known as BILLED
	AUTHORISED CONSUMPTION). Equal to BILLED
	WATER EXPORTED, BILLED METERED
	CONSUMPTION and BILLED UNMETERED
	CONSUMPTION
Non- Revenue Water:	Those components of SYSTEM INPUT which are
	not billed and do not produce revenue. Equal to
	UNBILLED AUTHORISED CONSUMPTION,
	APPARENT LOSSES and REAL LOSSES
Unbilled, Authorized	Those components of AUTHORISED
Consumption:	CONSUMPTION which are not billed and do not
_	produce revenue. Equal to UNBILLED METERED
	CONSUMPTION and UNBILLED UNMETERED
	CONSUMPTION

## Appendix B

**Supply Meter Accuracy Test Reports** 

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

### Service Order/Report

New P.O. 3	801678	Old P.O.	30513	Invoice	No 28	792	REGN	IA S	ervice Dat	te 5/2	4/2005
Invoiced To Service Prov	2201 ST. E P.O. BOX THOROLD L2V 4T7	AVIDS ROA 1042	ON' CANADA	TARIO		Job Address Acct No Occupant Contact Cust Contact	METER # AREA #3 PAUL COI	LEMAN 905-6			
Meter Mfg Size Type Reg Unit	INVENSY: 4" W-1000 D/R 1M3	S	Lo			TESTED IN-SH EXCHANGE Chamber	HOP N		Job C	Completed	V
Serial No Meter Runn Meter Seale	_		SNE PROTESTON		ĝ	As Found	Meter R	-	r Service		
Bypass Seald If NO, Was I Mtr Running tr Valves	It Open	ure		HF OUT HF IN LF OUT LF IN		9	32213		93222	22	
Broken Valv Static PSI	ves Tagged	Res As Fou	idual PSI	o <b>T</b>	A EST R	t 0 ESULTS	Rate	Of Flow After Serv	0 vice	At	
R.O.F.	QTY	HIGH	LOW	TOTAL	%	R.O.F.	QTY	нідн	LOW	TOTAL	%
500 GPM	4110.00	4105.00	0.00	4105.00	99.8	8	0.00	0.00	0.00	0.00	#Num!
150 GPM	2004.50	2020.00	0.00	2020.00	100.7	7	0.00	0.00	0.00	0.00	#Num!
50 GPM	1010.00	1020.00	0.00	1020.00	100.9	9	0.00	0.00	0.00	0.00	#Num!
10 GPM	1010.00	980.00	0.00	980.00	97.0	3	0.00	0.00	0.00	0.00	#Num!
	Meter	Runs At Mi	n. Flow			-d	Meter	Runs At Mir	n. Flow		

Comments METER PRETESTED WITHIN AWWA SPECIFICATION C701 FOR CLASS II TURBINE METERS.

SERVICING: \$247.00

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

### Service Order/Report

New P.O.	301743	Old P.O.	303511	Invoid	ce No 28	3793	REGI	NIA	Service Da	ite	5/4/2005
Invoiced To	2201 ST. P.O. BOX THOROL L2V 4T7	DAVIDS RO	ON CANADA	A VTARIO		Job Addres Acct No Occupant Contact Cust Contac	METER # AREA #1 HERB MA	k3 ARACLE 906	5-295-4831		
Meter Mfg Size Type	INVENS' 6" F/S ECR 5M3			ocation est Fittings						One of the second secon	
Reg Unit Serial No	16436770					Chamber	Υ		Job (	Completed	V
Meter Runi	ning On Arr	ival	<b>~</b>				Meter R	eading			
Meter Seale			<b>✓</b>			As Found		Af	ter Service		
Bypass Seal	ed On Arriv	/al	<b>V</b>	HF OU	Γ				And an every specific the evene		
If NO, Was	It Open			HF IN		C	00825	<u> </u>	0008	34	
Mtr Runnin	g On Depar	ture	<b>✓</b>	LF OUT	Г 📑				an tala ya tala ambandan ya ja a a a a a a a a a a a a a a a a a		
Mtr Valves Broken Valv		Departure	<b>✓</b>	LF IN		0	56290		2562	96	
Static PSI	100	Re	sidual PSI	20	A	200	Rate	Of Flow	8	At	12:00 P
ā	7	As Fou	nd	Т	EST R	ESULTS		After Ser	vice		
R.O.F.	QTY	HIGH	LOW	TOTAL	%	R.O.F.	QTY	HIGH	LOW	TOTAL	%
8 GPM	1000.00	0.00	1010.00	1010.00	101.00	8 GPM	1000.00	0.00	1010.00	1010.0	101.00
200 GPM	3000.00	2049.00	780.00	2829.00	94.30	200 GPM	3000.00	2140.00	830.00	2970.0	99.00
100 GPM	1000.00	431.00	535.00	966.00	96.60	100 GPM	1000.00	485.00	520.00	1005.00	100.50
60 GPM	1000.00	200.00	760.00	960.00	96.00	60 GPM	1000.00	240.00	725.00	965.00	96.50
e tyrodronous trad	Meter	Runs At Mi	n. Flow	<b>V</b>	territor as t		Meter l	Runs At Mi	n. Flow	<b>✓</b>	I.

Comments PRETESTED AND CALIBRATED METER TO WITHIN AWWA SPECIFICATION C703 FOR FIRE SERVICE TYPE METERS.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

### Service Order/Report

New P.O.	303511	Old P.C	), 303511	Invo	ice No	29175	REC	GNIA	Service D	ate 1	0/13/2005
Invoiced To Service Prov	2201 ST P.O. BO THORO L2V 4T7	LD	DAD	NTARIO		Job Addre Acct No Occupant Contact Cust Conta	METER AREA # HERB M	1 1ARACLE 90	5-295-4831		
Meter Mfg Size Type Reg Unit	INVENS 6" F/S ECR 5M 1643677	YS 3	I	ocation		ER OF BEVAN & FPORT Chamber	MELROSE		Job	Completed	<b>∨</b>
Serial No Meter Runni	ng On Arı	ival	<b>V</b>				Meter I	Reading			
Meter Sealed Bypass Sealed If NO, Was It	d On Arri t Open	val		HF OU		As Found	01065	Afi	ter Service 0010	70	
Mtr Running 'r Valves S Broken Valves	ealed On 1		<b>▽</b>	LF OUT		C	73001		0730	04	
Static PSI	100	Res As Fou	sidual PSI	20 T		At 443 ESULTS	Rate	Of Flow After Serv	40	Ąt	1:15 P
R.O.F.	QTY	HIGH	LOW	TOTAL	%	R.O.F.	QTY	HIGH	LOW	TOTAL	%
.51 LPS	1000.40	0.00	1010.00	1010.00	100.9	6	0.00	0.00	0.00	0.00	
28 LPS	4210.00	3560.00	600.00	4160.00	98.8	1	0.00	0.00	0.00	0.00	#Num!
12.6 LPS	2007.00	1400.00	590.00	1990.00	99.18	5	0.00	0.00	0.00	0.00	#Num!
2.8 LPS	1003.00	40.00	960.00	1000.00	99.70		0.00	0.00	0.00	0.00	#Num!
	Meter l	Runs At Mir	. Flow	V		es Barrella antigation and	Meter I	Runs At Min	. Flow		

Comments METER PRETESTED WITHIN SPECIFICATIONS,

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

### Service Order/Report

New P.O.	301743	Old P.O.	303511	Invoid	e No 28	3793	REGN	NIA S	Service Da	ıte	5/4/2005
Invoiced To		DAVIDS RO . 1042		A ITARIO		Job Address Acct No Occupant	METER #			ATION	
	L2V 4T7		CANADA			Contact Cust Contact		ARACLE 905- CETTOLA	-295-4831		
Service Pro	vided By:	S. PATE /	D. JONES		***************************************	oust Contact		0211027			
Meter Mfg	INVENSY	⁄S	L	ocation	1795 THC	ROLD TOWN	LINE				
Size Type	6" F/S		Te	est Fittings	2" TEST I	PORT					
Reg Unit	HSPU 1M	13				Chamber	Υ		Job (	Completed	<b>✓</b>
Serial No	1413619							<u> </u>			
	ing On Arr		V				Meter R	Ü			
	d On Arriva		✓	HF OU	r	As Found		Aft	er Service		
	ed On Arriv	al	<b>✓</b>		·						
f NO, Was	_			HF IN	_	0	61815		0618	25	
	g On Depar		<b>✓</b>	LF OUT		and the second s					
atr Valves Broken Valv	Sealed On I	Departure	<b>✓</b>	LF IN		20	0612.3		20615	5.0	
static PSI	es Taggeu 100	Da	sidual PSI	30		450				***************************************	
tatic 151		As Fou			At EST RI	ESULTS	Rate	Of Flow After Serv	40 vice	At	5:30 F
R.O.F.	QTY	HIGH	LOW	TOTAL	%	R.O.F.	QTY	HIGH	LOW	TOTAL	%
8 GPM	100.00	0.00	100.50	100.50	100.50	)	0.00	0.00	0.00	0.00	) #Num!
450 GPM	5000.00	4415.00	638.00	5053.00	101.06		0.00	0.00	0.00	0.00	#Num!
200 GPM	3000.00	2220.00	798.00	3018.00	100.60		· 0.00	0.00	0.00	″ 0.00	#Num!
55 GPM	1000.00	275.00	695.00	970.00	97.00		0.00	0.00	0.00	0.00	#Num!

Comments METER PRETESTED WITHIN AWWA SPECIFICATION C703 FOR FIRE SERVICE TYPE METERS.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

### Service Order/Report

New P.O.	303511	Old P.O	303511	Invoi	ice No	29175	REG	NIA	Service D	ate 1	0/13/2005
Invoiced To	INEQ. IVIC	DAVIDS RC K 1042		RA NTARIO		Job Addres Acct No Occupant Contact	METER AREA #1 HERB M	1 ARACLE 905		TATION	
Service Prov	vided By:	PARSONS	S/OSTROW	ALKER		Cust Contac	t TONY AC	CETTOLA			
Meter Mfg Size Type	INVENS	YS		ocation est Fittings	1795 TH 2" TES1	HOROLD TOWN	LINE				
Reg Unit Serial No	HSPU 11 1413619		Mitaesa			Chamber	Y	·	Job	Completed	✓
Meter Runni	_		V				Meter R	Reading			
Meter Sealed			V	HF OU	. r	As Found		Aft	er Service		
Bypass Seale If NO, Was I		/al	<b>☑</b>	HF IN	<b>'</b>		70.405				
Mtr Running	•	tura		LF OUT	, <b> </b> -	U	72485		724	91	
_	Sealed On 1		<b>&gt;</b>	LF IN		17	476.1		17478	3.7	
Static PSI	100	Res	sidual PSI	25	A	At 570	Rate	Of Flow	65	At	11:15 PI
		As Fou	nd	Т	EST R	ESULTS		After Serv	vice		
R.O.F.	QTY	HIGH	LOW	TOTAL	%	R.O.F.	QTY	HIGH	LOW	TOTAL	%
.32 LPS	100.20	0.00	99.00	99.00	98.8	0	0.00	0.00	0.00	0.00	#Num!
36 LPS	5503.00	4875.00	642.50	5517.50	100.2	6.	0.00	0.00	0.00	0.00	#Num!
12.6 LP\$	2625.00	1875.00	780.50	2655.50	101.1	6	0.00	0.00	0.00	0.00	#Num!
2.8 LPS	1005.00	35.00	963.50	998.50	99.3	5	0.00	0.00	0.00	0.00	#Num!
	Meter I	Runs At Mir	ı. Flow	<b>V</b>			Meter I	Runs At Min	. Flow		

Comments METER PRETESTED WITHIN SPECIFICATIONS.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

### Service Order/Report

New P.O.	301678	Old P.O.	303511	Invoic	e No 287	793	REGN	IIA S	Service Da	te	5/4/2005
Invoiced To Service Prov	2201 ST. I P.O. BOX THOROLI L2V 4T7		AD ON CANADA	A ITARIO		Job Addres Acct No Occupant Contact Cust Contac	METER # AREA #1 HERB MA	4 RACLE 905	-295-4831		
Meter Mfg	INVENSY	S	Lo	ocation	MEWBURI	N RD SOUTH	OF QEW		· · · · · · · · · · · · · · · · · · ·		<u> </u>
Size Type	4" SRH		Te	est Fittings	2" TES <b>T</b> P	ORT					
Reg Unit	ECR 5M3					Chamber	Υ		Job (	Completed	V
Serial No	1502170								7	<u> </u>	
Meter Runni	ing On Arri	val	<b>✓</b>				Meter R	eading			
Meter Sealed	l On Arriva	I	<b>✓</b>			As Found		Aft	er Service		
Bypass Seale	d On Arriva	aI	<b>✓</b>	HF OUT							
f NO, Was I	t Open			HF IN		1	30104	Commence of the second	1301	13	
Atr Running	g On Depart	ure	<b>✓</b>	LF OUT	,	and the second s	and the second s	er er er selver district gegenne er er er selver			
Atr Valves S	Sealed On D	eparture	<b>✓</b>	LF IN		and the second s		n e 199 <del>0 de la comp</del> ensa de la compensa de la compe	<del>and and a second and an area and an area and area area.</del>		
Broken Valv	es Tagged					· · · · · · · · · · · · · · · · · · ·					
tatic PSI	100	Res	idual PSI	80	At	100	Rate	Of Flow	30	At	2:30 F
		As Fou	nd	T	EST RE	SULTS		After Serv	vice		
R.O.F.	QTY	HIGH	LOW	TOTAL	%	R.O.F.	QTY	HIGH	LOW	TOTAL	%
4 GPM	100.00	0.00	78.00	78.00	78.00	4 GPM	100.00	0.00	101.00	101.00	101.00
100 GPM	1000.00	101.00	0.00	101.00	10.10	100 GPM	1000.00	1005.00	0.00	1005.00	100.50
50 GPM	1000.00	1013,00	0.00	1013.00	101.30	50 GPM	1000.00	1011.00	0.00	1011.00	101.10
24 GPM	1000.00	98.00	0.00	98.00	9.80	24 GPM	1000.00	982.00	0.00	982.00	98.20

Comments PRETESTED, REPAIRED AND CALIBRATED METER TO WITHIN AWWA SPECIFICATION C702 FOR COMPOUND METERS. SMALL SIDE COORDINATOR GEAR CLUSTER WORN, REPLACED COORDINATOR.

PARTS AND REPAIR TIME TO BE INVOICED SEPARATE.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

### Service Order/Report

New P.O.	303511	Old P.O	303511	Invoi	ce No 2	9175	REG	NIA	Service De	ate 10	)/13/2005
Invoiced To	2201 ST. P.O. BOX THOROL L2V 4T7	DAVIDS RC 1042 D		NTARIO		Job Addres Acct No Occupant Contact Cust Contac	METER # AREA #1 HERB M	ARACLE 905	i-295-4831		
Meter Mfg	INVENS) 4" SRH	/S	L	ocation		RN RD SOUTH	OF QEW				
Size Type  Reg Unit  Serial No	ECR 5M3	}	Т	est Fittings	2" TEST	PORT Chamber	Y		Job	Completed	
Meter Runn		ival					Meter R	leading			
Meter Seale	•••		<b>V</b>	HF OU	т Г	As Found	46765	Aft	er Service	70 ]	
Bypass Seale If NO, Was I		aı		HF IN		·	46767		1467 1467		
Mtr Running	· .		✓ ✓	LF OUT	Γ				1707		
Broken Valve	es Tagged					. '		· · · · · · · · · · · · · · · · · · ·			
Static PSI	110	Res	sidual PSI	100	Ā	100	Rate	Of Flow	65	At	3:15 P
	·	As Fou	nd	T	EST R	ESULTS		After Serv	vice		
R.O.F.	QTY	нісн	LOW	TOTAL	%	R.O.F.	QTY	HIGH	LOW	TOTAL	%
.25 LP\$	100.00	0.00	0.00	0.00	0.00	.25 LPS	100.30	0.00	100.70	100.70	100.40
6.3 LPS	1000.00	0.00	0.00	0.00	0.00	6.3 LPS	1001.00	1000.00	0.00	1000.00	99.90
3.2 LPS	1000.00	0.00	0.00	0.00	0.00	3.2 LPS	1001.00	1010.00	0.00	1010.00	100.90
1.3 LPS	1000.00	0.00	0.00	0.00	0.00	1.3 LPS	1005.00	1010.00	0.00	1010.00	100.50
	Meter I	Runs At Mi	n. Flow			<u> </u>	Meter I	Runs At Min	. Flow	<b>✓</b>	

Comments PRETESTED, REPAIRED AND CALIBRATED METER TO WITHIN SPECIFICATIONS.

SEE SEPARATE INVOICE FOR PARTS AND REPAIR TIME.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

### **Service Order/Report**

New P.O.	302638	Old P.O.	30513	Invoice	e No 2	8792	REGN	IA S	ervice Dai	te 5/2	20/2005
Invoiced To	2201 ST. I P.O. BOX THOROLI L2V 4T7	DAVIDS ROA 1042	ON CANADA	TARIO		Job Address Acct No Occupant Contact Cust Contact	METER # AREA #3 PAUL CO	LEMAN 905-6		OAD	
Meter Mfg Size Type Reg Unit	10" W-550 HSPU 100	'S 00	Lo			E TESTED IN SH E EXCHANGE Chamber	HOP N		Job (	Completed	<b>V</b>
Serial No Meter Runn Meter Seale	d On Arriva	ı		HF OUT		As Found	Meter R	_	er Service		
•	It Open g On Depar Sealed On I	ture		HF IN LF OUT		66:	3420X		663424	X.	
Broken Valv Static PSI	es Tagged 0	Res As Fou	sidual PSI	0 <b>T</b> I		At 0 RESULTS	Rate	Of Flow After Serv	0 vice	At	
R.O.F.	QTY	HIGH	LOW	TOTAL	%	R.O.F.	QTY	HIGH	LOW	TOTAL	%
600 GPM	10128.00	10150.00	0.00	10150.00	100.2	22	0.00	0.00	0.00	0.00	#Num!
200 GPM	10039.00	10010.00	0.00	10010.00	99.7	71	0.00	0.00	0.00	0.00	#Num!
100 GPM	10981.00	11050.00	0.00	11050.00	100.6	53	0.00	0.00	0.00	0.00	#Num!
50 GPM	5003.00	5000.00	0.00	5000.00	99.9	34	0.00	0.00	0.00	0.00	#Num!
· ·	Meter	Runs At Mi	n. Flow				Meter	Runs At Mir	ı. Flow		

Comments METER PRETESTED WITHIN AWWA SPECIFICATION C701 FOR CLASS II TURBINE METERS.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

### **Service Order/Report**

New P.O. 3	301678	Old P.O.	30513	Invoice	e No 28	792	REGN	IA S	ervice Dai	te 5/2	20/2005
Invoiced To	REG. MUN	NCIPALITY (	OF NIAGARA	١		Job Address	TUPPER I	ORIVE REVE	RSE		· · · · · · · · · · · · · · · · · · ·
	2201 ST. [	DAVIDS ROA	<b>ND</b>			Acet No	METER #	10			
	P.O. BOX	1042				Occupant	AREA #3				
	THOROLE	)	ON	TARIO		Contact	PAUL COI	_EMAN			
	L2V 4T7		CANADA			Cust Contact	TONY ACC	ETTOLA			
Service Prov	vided By:	J. OSTROV	<u>WALKER</u>						·		-·
Meter Mfg	INVENSY	S	Lo	cation	MODULE	TESTED IN-SH	HOP				
Size Type	10" W-550	00	Te	st Fittings	MODULE	EXCHANGE					
Reg Unit	HSPU 10	<b>M</b> 3				Chamber	N		Job C	Completed	<b>V</b>
Serial No	1111559								<u> </u>		
Meter Runn	ing On Arri	val					Meter R	eading			
Meter Seale	d On Arriva	1				As Found		Afte	r Service		
Bypass Seale	ed On Arriv	al		HF OUT	гГ						
If NO, Was	It Open			HF IN		00	8335X	, 14.00 - 1 - 14.4 - 20 - 1114 BEAU AT BASTES	008338	3X	
Mtr Running	g On Depar	ture		LF OUT		Mt. 11/2			<u> </u>		
tr Valves	Sealed On I	Departure		LF IN	<u></u>	, ne ver en			a a designera del como atogra proprio de com		
Broken Valv	es Tagged				Ĺ	Table State Control of the Control o			antonials or standard 705		
Static PSI	0	Res	sidual PSI	0	A	t 0	Rate	Of Flow	0	At	
		As Fou	nd	T	EST R	ESULTS		After Serv	vice		
R.O.F.	QTY	HIGH	LOW	TOTAL	%	R.O.F.	QTY	HIGH	LOW	TOTAL	%
600 GPM	12199.00	12050.00	0.00	12050.00	98.7	8	0.00	0.00	0.00	0.00	#Num!
200 GPM	10003.00	10000.00	0.00	<sup></sup> 10000.00	99.9	7	0.00	0.00	0.00	0.00	#Num!
100 GPM	10402.00	10300.00	0.00	10300.00	99.0	2	0.00	0.00	0.00	0.00	#Num!
50 GPM	5001.00	5000.00	0.00	5000.00	99.9	8	0.00	0.00	0.00	0.00	#Num!
	Meter	Runs At Mi	n. Flow			<u> </u>	Meter	Runs At Mir	ı. Flow		X-3

Comments METER PRETESTED WITHIN AWWA SPECIFICATION C701 FOR CLASS II TURBINE METERS.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

### **Service Order/Report**

New P.O.	301678	Old P.O.	30513	Invoic	e No	28792	REGN	IIA S	'ervice Da	te 5/	24/2005
Invoiced T	REG. MU	NICIPALITY	OF NIAGAR	Α		Job Address	FRONT S	T THOROLD	FLUORIDE		
		DAVIDS RO	AD			Acct No	METER#	9			
	P.O. BOX THOROLI		01	ITABIO		Occupant	AREA #3				
	L2V 4T7	J	CANADA	ITARIO		Contact	PAUL CO	LEMAN 905-	684-5353		
Service Pro		J. OSTRO				Cust Contact	TONY ACC	CETTOLA			
Meter Mfg	INVENSY	'S	Lo	ocation	MODU	LE TESTED IN-SH	IOP	·		· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·
Size Type	6" W-200	0	Te			LE EXCHANGE					
Reg Unit	HSPU 1M	13		_		Chamber	N		Job (	Completed	V
Serial No	28871662	?			· 3444				3		<u> </u>
Meter Run	ning On Arri	ival					Meter R	eading			
Meter Seale	d On Arriva	ıl				As Found		Afte	er Service		
Bypass Seal	ed On Arriv	al		HF OUT	r						
If NO, Was	It Open			HF IN		50	07107	The state of the s	50712	27	
Mtr Runnir	g On Depar	ture		LF OUT		Control of the second		and the state of t			
.tr Valves	Sealed On I	Departure -		LF IN	<b> </b>	and the alleger to the same and and the same		· · · · · · · · · · · · · · · · · · ·			
Broken Val	ves Tagged				L.						
Static PSI	0	Res	idual PSI	0		<b>At</b> 0	Rate	Of Flow	0	At	
		As Fou	nd	<b>T</b> .	EST :	RESULTS		After Serv	rice		
R.O.F.	QTY	HIGH	LOW	TOTAL	%	6 R.O.F.	QTY	HIGH	LOW	TOTAL	%
600 GPM	5053.00	5135.00	0.00	5135.00	101	I.62 600 GPM	5042.00	5105.00	0.00	5105.00	101.25
200 GPM	2133.00	2155.00	0.00	2155.00	101	.03 200 GPM	2024.00	2035.00	0.00	2035.00	100.54
100 GPM	1008.00	1015.00	0.00	1015.00	100	0.69 100 GPM	1007.00	1010.00	0.00	1010.00	100.30
20 GPM	1002.00	995.00	0.00	995.00	99	<sup>1.30</sup> 20 GPM	1001.00	985.00	0.00	985.00	98.40
	Meter	Runs At Mi	n. Flow				Meter I	Runs At Mir	. Flow		

Comments PRETESTED AND CALIBRATED METER TO WITHIN AWWA SPECIFICATION C701 FOR CLASS II TURBINE METERS.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

### **Service Order/Report**

New P.O. 3	02638	Old P.O.	30513	Invoice	e No 28	792	REGN	IA S	ervice Dat	e 5/2	0/2005
Invoiced To Service Prov	2201 ST. I P.O. BOX THOROLI L2V 4T7	DAVIDS ROA 1042	ON' CANADA	TARIO		Job Address Acct No Occupant Contact Cust Contact	METER #7 AREA #3 PAUL COI	-EMAN 905-6		AD	
Meter Mfg Size Type Reg Unit Serial No	INVENSY 10" W-556 HSPU 101 1182334	00				TESTED IN-SH EXCHANGE Chamber	IOP N		Job C	Completed	<b>~</b>
Meter Runn Meter Seale	ing On Arri d On Arriva	1		HF OUT	r	As Found	Meter R	Ü	r Service		
	lt Open g On Depar Sealed On I	ture		HF IN  LF OUT		935	9682X		939686	SX.	
Broken Valv Static PSI	es Tagged 0	Res As Fou	sidual PSI	o <b>T</b> I	A EST R	t 0 ESULTS	Rate	Of Flow After Serv	0 rice	At	
R.O.F.	QTY	HIGH	LOW	TOTAL	%	R.O.F.	QTY	HIGH	LOW	TOTAL	%
600 GPM	10125.00	10100.00	0.00	10100.00	99.7	5	0.00	0.00	0.00	0.00	#Num!
200 GPM	10006.00	10000.00	0.00	10000.00	99.9	4	0.00	0.00	0.00	0.00	#Num!
100 GPM	10006.00	10050.00	0.00	10050.00	100.4	4	0.00	0.00	0.00	0.00	#Num!
50 GPM	5820.00	5800.00	0.00	5800.00	99.6	6	0.00	0.00	0.00	0.00	#Num!
	Meter	Runs At Mi	n. Flow			. "	Meter	Runs At Mii	ı. Flow		

 ${\color{red} \textbf{Comments}} \quad \textbf{METER PRETESTED WITHIN AWWA SPECIFICATION C701 FOR CLASS II TURBINE METERS.}$ 

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

### Service Order/Report

New P.O. 3	01678	Old P.O.	30513	Invoice	No 287	92	REGN	IA S	ervice Dat	te 5/2	0/2005
Invoiced To	INCO. INIOI	DAVIDS ROA 1042		TARIO		Job Address Acct No Occupant Contact Cust Contact	METER #8 AREA #3 PAUL COL	3 _EMAN 905-6	684-5353		
Service Prov		J. OSTROV	<u>VLAKER</u>						· · · · · · · · · · · · · · · · · · ·		
Meter Mfg Size Type	NEPTUNE 2" T10	=				ER TESTED II					
Reg Unit	D/R IG		Te	st Fittings	FULL ME I	ER EXCHANG  Chamber	ie N		Ioh (	Completed	<b>V</b>
Serial No	4745830		-			Champer			JUD (	.ompieteu	<u>V</u>
Meter Runn	ing On Arri	val					Meter R	eading			
Meter Seale	d On Arriva	1				As Found		Afte	er Service		
Bypass Seale	ed On Arriv	al		HF OUT							
If NO, Was It Open				HF IN 000888			00888	000893			
Mtr Runnin	g On Depar	ture		LF OUT					AND	A CONTRACTOR OF THE CONTRACTOR	
tr Valves	Sealed On I	Departure		LF IN				The state of the s	See Shirth County of the See See See See See See See See See S		
Broken Valv	es Tagged				<b>L</b>	244.02.160g.20					
Static PSI	0	Res	idual PSI	0	At	0	Rate	Of Flow	0	At	
		As Fou	nd	T	EST RI	ESULTS		After Serv	rice		
R.O.F.	QTY	HIGH	LOW	TOTAL	%	R.O.F.	QTY	HIGH	LOW	TOTAL	%
100 GPM	1000.00	990.00	0.00	990.00	99.00		0.00	0.00	0.00	0.00	#Num!
50 GPM	1000.00	1010.00	0.00	1010.00	101.00		0.00	0.00	0.00	0.00	#Num!
25 GPM	1000.00	1000.00	0.00	1000.00	100.00		0.00	0.00	0.00	0.00	#Num!
2 GPM	1000.00	975.00	0.00	975.00	97.50		0.00	0.00	0.00	0.00	#Num!
	Meter	Runs At Mi	n. Flow				Meter 1	Runs At Mir	ı. Flow		

Comments METER PRETESTED WITHIN AWWA SPECIFICATION C700 FOR DISPLACEMENT TYPE METERS.

SERVICING: \$105.00

Appendix C

**Draft Customer Meter Accuracy Report** 

#### Analysis background

Customer meters are the cash register of the utility and are responsible for ensuring an equitable distribution of water volume and income throughout various different customer classes within a utility and as such it is extremely important to analyze the accuracy of the meters on a regular basis and where necessary make repairs or replace groups of meters. In addition to being the cash register meters are responsible for a large amount of consumption data which can be used for other engineering functions such as hydraulic models and in this case the annual water balance which is used to disaggregate components of consumption, apparent loss and real loss in order to identify appropriate and efficient intervention programs for each loss type and volume.

# Using AWWA test flows and volumetric participation to identify weighted average accuracy for water balance purposes

Data has been imported into our analysis programs and analyzed using the volume weighted percentages suggested in AWWA manual M36 table 2-7 for small meters and table 2-10 for large meters. It should be noted that further improvements to this analysis could be made by data logging samples of meter consumption profiles and applying them to the weighted average calculations as opposed to using the suggested values in M36<sup>1</sup> and M6<sup>2</sup>.

AWWARF Project No. 418 Residential Water Use Patterns of 1993 states; "Standards for domestic 5/8in. and 3/4in. water meters are based on a flow range of 0.25gpm to 20gpm. The range is assumed to be typical of the average domestic consumer. However, limited surveys of these domestic water use rates have not, until now, adequately substantiated this range." Although the project concluded that "overall patterns of water use across the range of hours and flow rates were remarkably stable across geographic regions"

Based on AWWA published data the following weighted % volumes have been used for the 5/8 inch and ¾ inch meter weighted accuracy calculations. There were no 1 inch meters in the test sample so these have not been considered. In order to check if the volumes used in the M36 report are representative Veritec has undertaken a detailed analysis of 1200 data logged residential consumption profiles consisting of meters 5/8 to 1 inch in diameter, which were undertaken as part of the national AWWARF REUWS study in 1999³.

1

<sup>&</sup>lt;sup>1</sup> "Water audits and leak detection" American water works association (AWWA) manual of water supply practices M36 second edition 1999 page 20 table 2-7 (5/8 inch meters)

<sup>&</sup>lt;sup>2</sup> "Water meters-selection installation testing and maintenance" AWWA manual of water supply practices M6 fourth edition 1999 page 60

<sup>&</sup>lt;sup>3</sup> "Residential end uses of water" American Water Works Association Research Foundation 1999

Percent of Time	Range (gpm)		Average (gpm)	Percent of Volume
	(9)	piri)	(95111)	
15%	Low	0.50 to 1	0.75	2%
70%	Medium	1 to 10	5.00	63.8%
15%	High	10 to 15	12.50	34.2%

Table 1 percent of volume calculations used for small meters taken from AWWA M6 and M36 table 2-7

The results shown below in *Table* 2 clearly indicate that the M36 results are in the right order of magnitude and that the volumes actually passed at the flow rates used to generate the low flow test results are very small compared to those volumes which pass at the medium and high test flow rates. It is important to note that this data set included 100 profiles from an Eastern Ontario utility.

Flow range		
GPM	Volume	%
0 – 0.25	4,978.79	0.05
0.26 - 0.50	63,756.66	0.59
0.51 - 0.75	121,274.58	1.13
0.76 – 1.0	192,455.03	1.79
1.01 – 10.0	7,835,760.04	72.77
> 10	2,549,331.51	23.68
Total	10,767,556.61	100.00

Table 2 volumes consumed at different flow ranges from AWWARF REUS

The percent of volume at each flow rate changes for larger meter sizes and based on the same AWWA publication material available the following percent of volume were used for the estimations of weighted meter accuracy for large meters;

- ♦ Low 10%
- ♦ Medium 65%
- ♦ High 25%

It should be noted that larger customer meters are generally subject to a wider variation of flow profile as the nature of demand can differ – Veritec therefore reiterates the need to check a sample of flow profiles for the larger meter class.

#### Statistics of the sample set and the meter population

Customer meter test data ranging from 5/8 inch to 6 inch was made available from 3 cities within the Niagara Region as shown below:

- **♦** Town of Grimsby
- Niagara on the Lake
- ♦ Port Colborne

No information was provided as to whether or not the test samples were representative of random samples so for Veritec analysis we have assumed they are. Veritec recommends stratified random sampling of various meter sizes for future more detailed analysis of economic meter maintenance.

Data supplied broken into small and large meter classes was as follows:

- Small meters are classed as 1 inch and less 11 samples
- **♦** Large meters classed as 1.5 inch and more 26 samples

The total meter population for the Niagara Region is as follows:

- **♦** Large meters 8,380

#### Results

The tables below show the first look at the weighted meter accuracy by volume for small meters in *Table 3* and for large meters *Table 4*.

Both sets of meters have an overall meter accuracy which is within the AWWA recommended range. However upon review of the low flow accuracy it can be seen that on average it is significantly below the recommended AWWA range however using the volume weighted % contribution the lower flows have little impact on the overall average.

Test Flow Rate	Test High	Test Medium	Test Low
No. of Test Results	11	11	11
Average Accuracy	98.46%	99.84%	84.28%
Variance	0.001	0.000	0.089
Standard Dev	2.47%	1.80%	29.78%
95% Confidence	1.46%	1.06%	17.60%

Average Meter Error at each flow rate	-1.54%	-0.16%	-15.72%
% of Consumption Volume Passed at Test Flow	34.2%	63.8%	2.0%
Contribution to Overall Average Meter Error	-0.53%	-0.10%	-0.31%

Overall Meter Error	-0.94%
Overall Meter Accuracy	99.06%

Table 3 First look meter accuracy for small meters

Veritec would suggest that the cities continue to review meter accuracy using this component based approach paying particular attention to the medium flow range which has most impact on the overall meter accuracy.

Once this starts to deteriorate then it is time to consider meter replacement in the case of the smaller meters and meter replacement or repair in the case of the larger meters.

Test Flow Rate	Test High	Test Medium	Test Low
No. of Test Results	26	26	26
Average Accuracy	100.10%	99.50%	92.54%
Variance	0.001	0.001	0.035
Standard Dev	2.25%	2.47%	18.59%
95% Confidence	0.87%	0.95%	7.15%
Average Meter Error at each flow rate	0.10%	-0.50%	-7.46%
% of Consumption Volume Passed at Test Flow	25.0%	65.0%	10.0%
Contribution to Overall Average Meter Error	0.03%	-0.32%	-0.75%
		<b>.</b>	
Overall Meter Error	-1.04%		
Overall Meter Accuracy	98.96%		

Table 4 First look meter accuracy for large meters

#### Confidence

Confidence in the test results has been calculated first for each of the test flow rates used in this analysis and then secondly confidence in the overall meter accuracy has been calculated for use in the annual water balance.

Both small and large meter tests sets display a small variance around the mean for the medium and high flow rates and a larger variance around the mean for the low flow results.

The small meter test sample has one stuck meter at the low flow rate which makes a big difference to the small test set. *Table 5* below shows the difference in confidence if this meter is removed from the sample.

Test Flow Rate	Test High	Test Med	Test Low
No. of Test Results	10	10	10
Average Accuracy	98.48%	100.24%	92.71%
Variance	0.001	0.000	0.012
Standard Dev	2.60%	1.31%	10.83%
95% Confidence	1.61%	0.81%	6.71%
Average Meter Error at each flow rate	-1.52%	0.24%	-7.30%
% of Consumption Volume Passed at Test Flow Rate	34.2%	63.8%	2.0%
Contribution to Overall Average Meter Error	-0.52%	0.15%	-0.15%
		ī	
Overall Meter Error	-0.51%		
Overall Meter Accuracy	99.49%		

Table 5 Confidence is increased in low flow tests if the stuck meter is removed

Confidence in that range of tests improves from 17.6% as shown in *Table* 3 to 6.7% as shown in *Table* 5.

This example indicates the influence that one stuck meter can have on a sample test set, particularly when the test sample is small. Veritec would recommend that a larger set of data is used for future more detailed analysis and that stuck meters are removed from the test sets and the issue of stuck meters is dealt with as a separate component of the water balance. Further details can be supplied upon request.

Analysis by percentage meter error					
Total pop (N)	104,848				
Sample count (n)	10				
Average registration % (AWWA method)	99.49%				
Average meter error %	0.51%				
Sample variance off % under-reg	0.0126				
N-n	104,838				
n-1	9				
Var(Ybar)	0.001396929				
Sqrt(Var(Ybar))	0.037375507				
Zstat for 95%	1.96				
CI limits +/- of meter error %	7.33%				

Table 6 Confidence in overall meter accuracy for small meters for annual water balance

As there has been no analysis of stuck meter frequency or response time to replace stuck meters the stuck meter has been removed from the test set and overall confidence increases from +/-17 to +/-7.3%. However this is still a large range and could be improved by a larger test sample.

Analysis by percentage meter error					
Total pop (N)	8,380				
Sample count (n)	26				
Average registration % (AWWA method)	98.96%				
Average meter error %	1.04%				
Sample variance off % under-reg	0.0357				
N-n	8,354				
n-1	25				
Var(Ybar)	0.001423053				
Sqrt(Var(Ybar))	0.037723377				
Zstat for 95%	1.96				
CI limits +/- of meter error %	7.39%				

Table 7 Confidence in overall meter accuracy for large meters for annual water balance

There were no stuck meters in the large meter test sample and therefore the overall average accuracy and the confidence have been taken at face value.

#### Recommendations

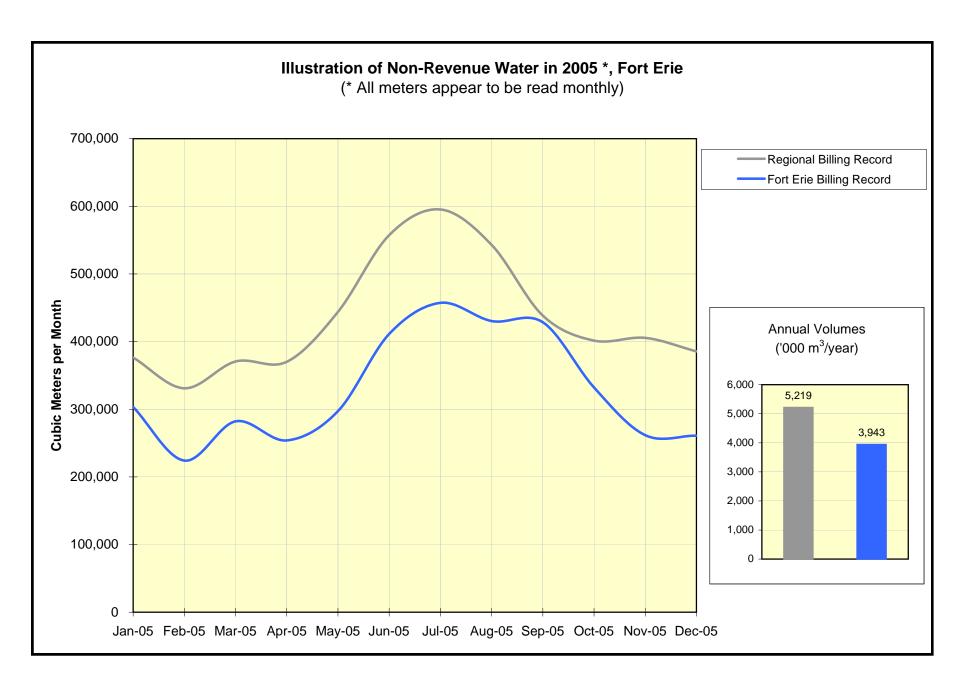
This analysis serves as a first look at the impact of weighted overall meter accuracy by small and large meter category and allows volumes of apparent loss to be calculated in the annual water balance along with the confidence in

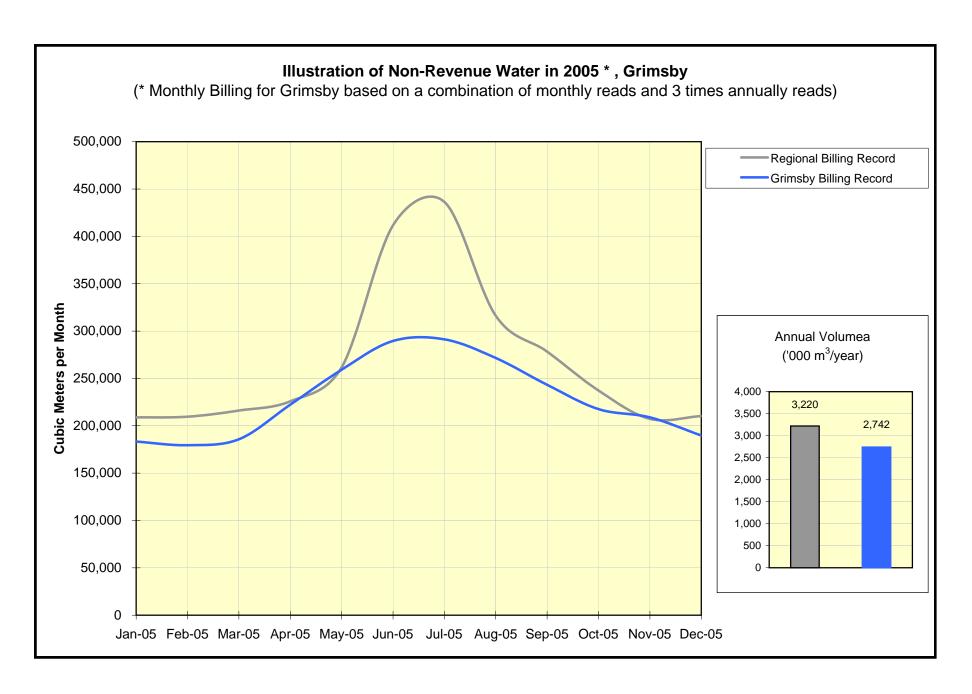
those volumes. Should the Region wish to refine this analysis in order to improve confidence in the apparent loss volumes and also to build a stronger business case for the correct meter accuracy intervention plan then Veritec would suggest that ongoing analysis include the following tasks:

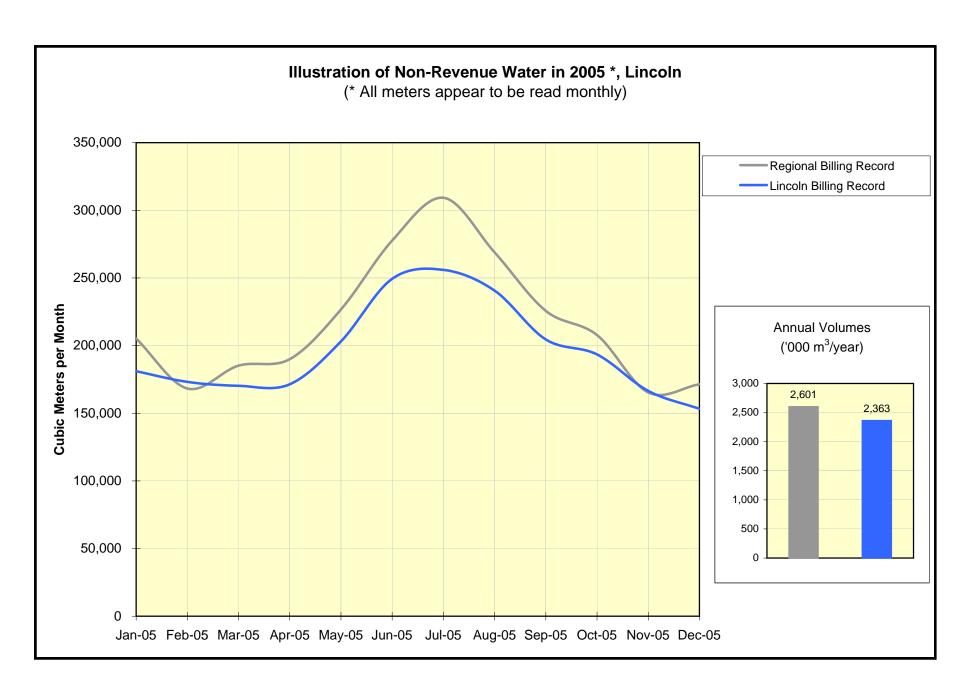
- ♦ Undertake flow profiling of key meter sizes and classes to determine weighted volume components for low, medium and high flow rates
- Undertake stratified random sampling and analysis of key meter sizes
- ♦ Increase sample size to in excess of 30 for each class to be analyzed
- ◆ Treat stuck meters separately and look at utility response time to change out to calculate volume for annual water balance

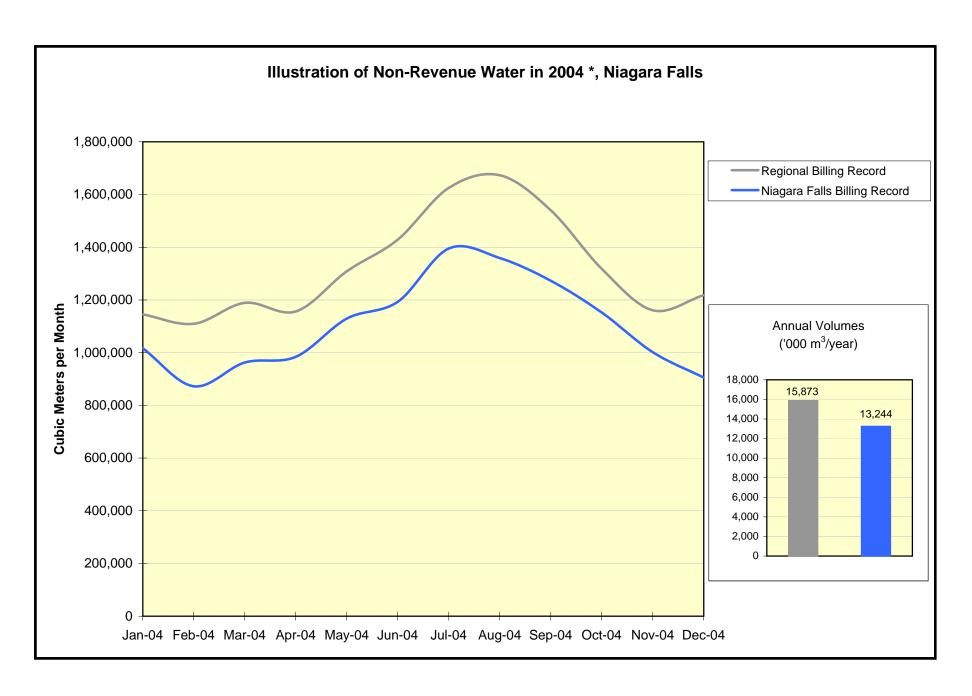
## **Appendix D**

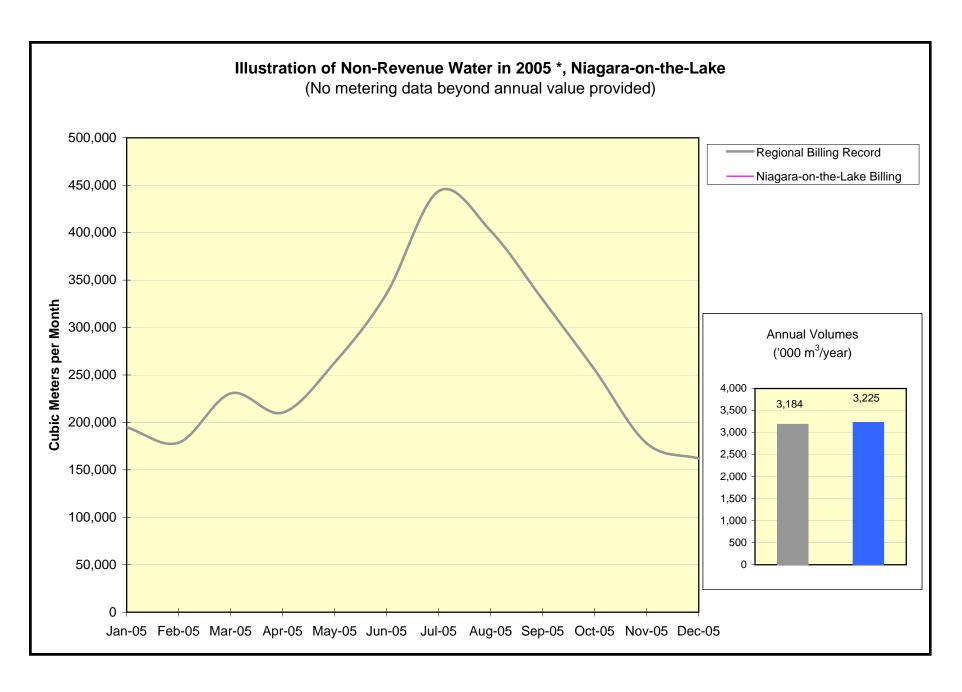
**Non-Revenue Water Trends** 

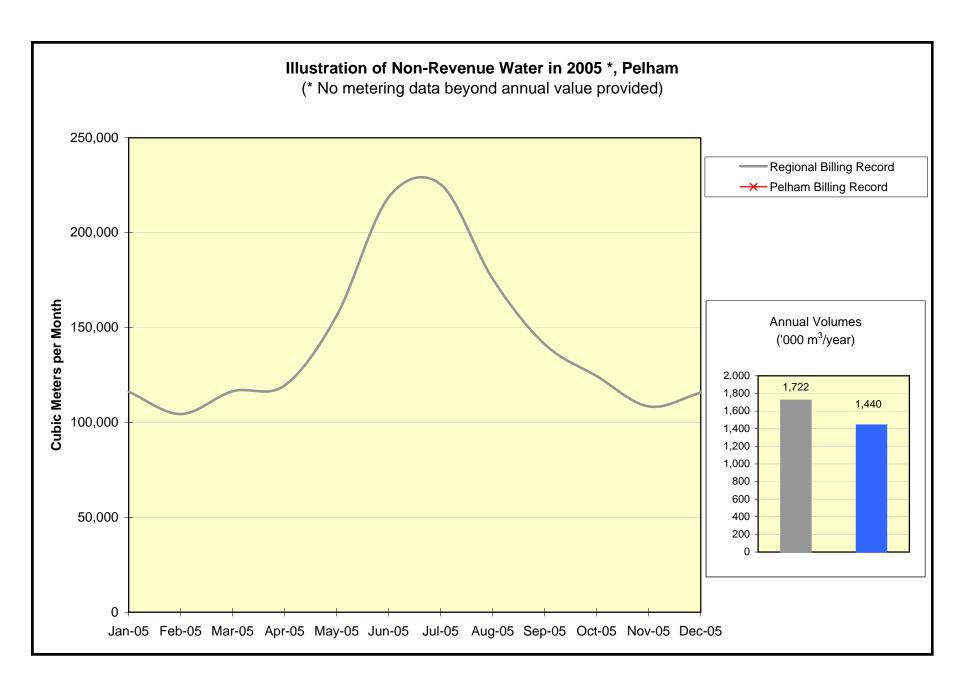


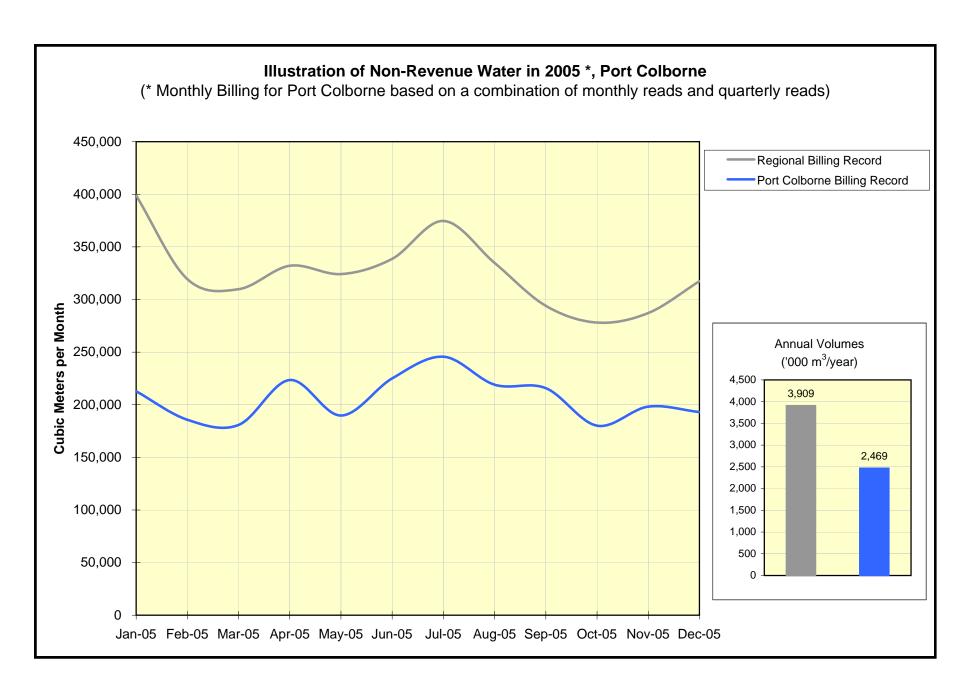


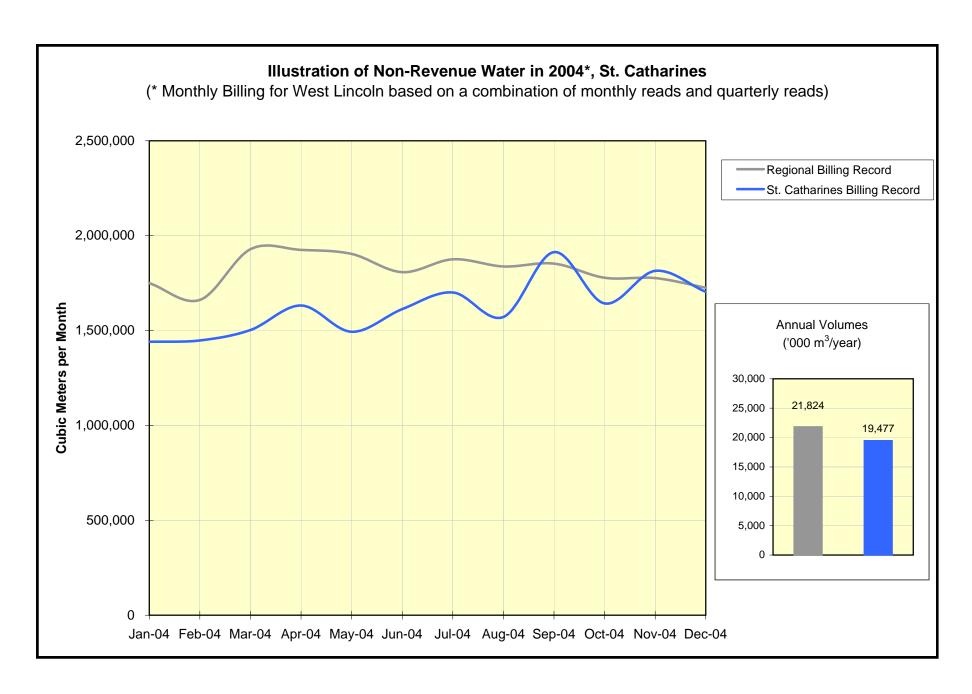


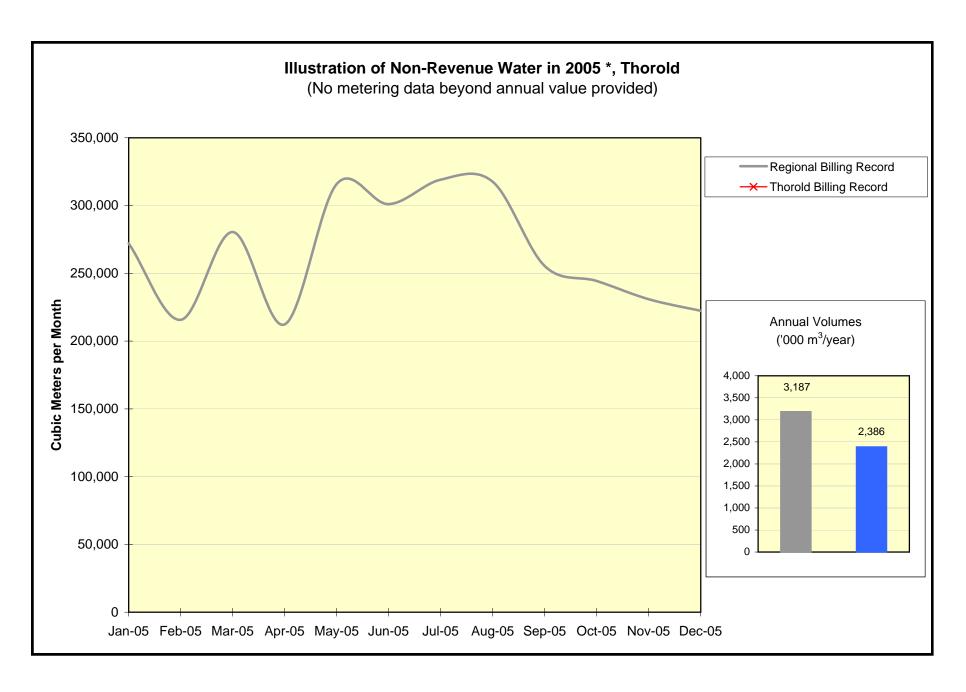


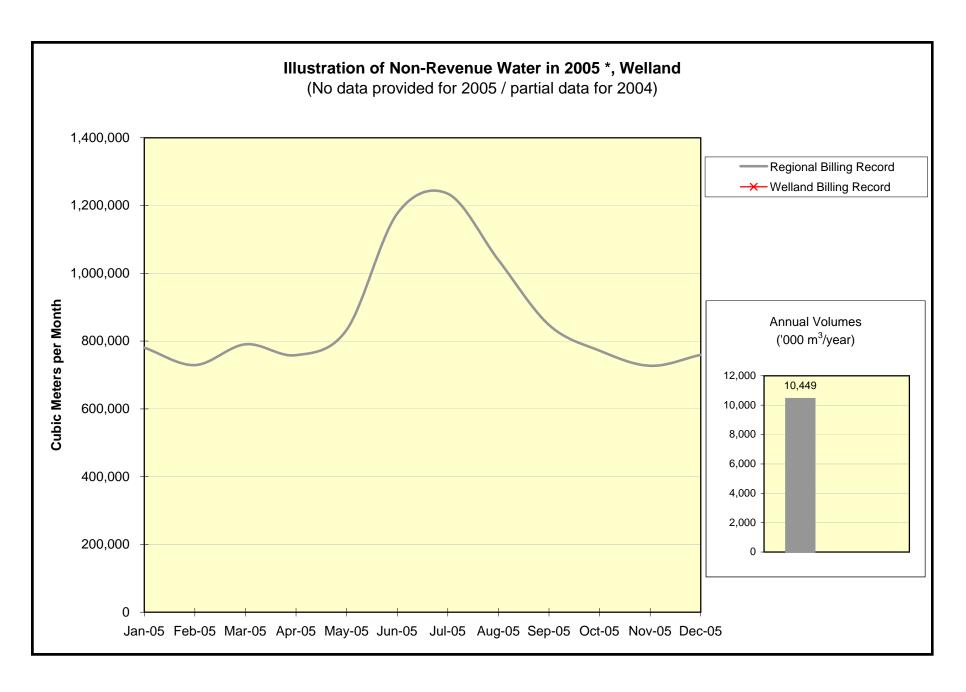


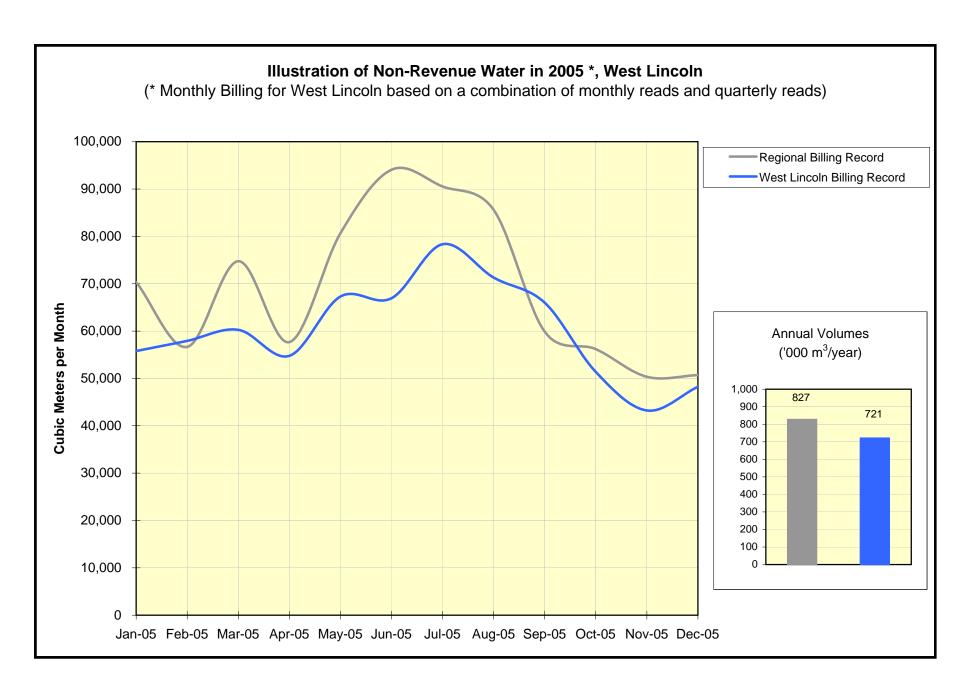












## **Appendix E**

**Component Analysis to Calculate UARL** 

#### Appendix D: Component Analysis to Calculate Unavoidable Annual Real Losses

Mains: assumed new burst frequency 13/100 km mains/year at 50m pressure

- 95% of events reported, 5% unreported
- Reported mains leaks average 864 m<sup>3</sup> loss each (12 m<sup>3</sup>/hr for 3 days, or equivalent)
- So loss/km/year from reported mains leaks = 864 x 13 x 0.95/100
   = 107 m<sup>3</sup>/km/year
- Unreported mains leaks average 7200 m<sup>3</sup> loss each (6 m<sup>3</sup>/hr for 50 days, or equivalent)
- So loss/km/year from unreported mains leaks =  $7200x 13 \times 0.05/100$  =  $47 \text{ m}^3/\text{km/year}$
- Background leakage: 20 l/km/hour for 365 days  $= \frac{175 \text{ m}^3/\text{km/year}}{\text{Total for mains at 50m pressure}} = \frac{329 \text{ m}^3/\text{km/year}}{329 \text{ m}^3/\text{km/year}}$

Service Connections: assumed new leak frequency 5/1000 connections/year at 50m pressure

- Data split into 'main to property line' (3/1000 conns/year at 50m pressure) and 'after property line' (2/1000 conns/year, for 15m average length of unmetered underground private pipe)
- 75% of events reported, 25% unreported
- Assumed flow rate for all new leaks is 1.6 m3/hr at 50m pressure

#### Service Connections, Main to property line

- Reported leaks (main to property line) average 307 m<sup>3</sup> loss each (1.6 m<sup>3</sup>/hr for 8 days)
- So loss/conn/year from these reported leaks =  $(307 \times 3 \times 0.75)/1000$  =  $0.7 \text{ m}^3/\text{conn/year}$
- Unreported leaks (main to property line) average 3840 m<sup>3</sup> loss each (1.6 m<sup>3</sup>/hr for 100 days)
- So loss/conn/year from these unreported leaks =  $(3840 \times 3 \times 0.25)/1000$  = 2.9 m<sup>3</sup>/conn/year
- Background leakage (main to property line) =1.25 l/conn/hr for 365 days

  Total for service connections, main to property line =  $\frac{11.0 \text{ m}^3/\text{conn/year}}{14.6 \text{ m}^3/\text{conn/year}}$

#### Service Connections, private underground pipe between property line and meter

- Reported leaks (15m private pipe) average 346 m<sup>3</sup> loss each (1.6 m<sup>3</sup>/hr for 9 days)
- So loss/conn/year from these reported leaks =  $(346 \times 2 \times 0.75)/15$  =  $35 \text{ m}^3/\text{km/year}$
- Unreported leaks (15m private pipe) average 3878 m³ loss each (1.6 m³/hr for 101 days)
- So loss/conn/year from these unreported leaks =  $(3878 \times 2 \times 0.25)/15$  = 129 m<sup>3</sup>/km/year
- Background leakage = 0.5 l/conn/hr for 15m/connection for 365 days

  Total for 15m private pipe, property line to customer meters  $= 292 \text{ m}^3/\text{km/year}$   $= 456 \text{ m}^3/\text{km/year}$

Table A1: Summary of Unavoidable Annual Real Losses Component Analysis at 50m pressure

Infrastructure Component	Background	Reported	Unreported	Total	Units	
	Leakage	Leaks	Leaks			
Mains	175 11.0	107 0.7	47 2.9	329 14.6	M <sup>3</sup> /km mains/yr	
Service Connections, mains to property line					M3/service connection/yr	
Underground pipe, where customer meter is located after property line	292	35	129	456	M3/km of pipe/ year	

In Table 4 of Lambert et al (1999), the above figures were multiplied by 1000 (to convert to litres), divided by 365 (to convert to average daily values) and divided by 50 metres (to present the figures 'per litre per day per metre of pressure', assuming a linear pressure:leakage relationship). These are shown Table A2 below.

Table A2: Summary of Unavoidable Annual Real Losses Components in AQUA Paper Format

Infrastructure Component	Background Leakage	Reported Leaks	Unreported Leaks	Total	Units
Mains	9.6	5.8	2.6	18.0	1/km mains/day/ metre of pressure
Service Connections, mains to property line	0.60	0.04	0.16	0.80	l/service conn/ day/m. pressure
Underground pipe, where customer meter is located after property line	16.0	1.9	7.1	25.0	1/km of pipe/ day/ metre of pressure

Appendix F

PIFastCalc Output Fort Erie

	WATER BALANCE AND PERFORMANCE IN	DICATORS PRO	GRAM 'P	PIFastCalcs		Standard	Version 1a	2nd De	2005	0	anada
	ANNUAL WATER BALANCE CALCULATION IN IWA STAND	DARD FORMAT, WITH S	95% CONFID	DENCE LIMITS	8 <u> </u>	Data entry	Defaults	Calculate	d Values	From anol	her Worksheet
	Note: Calculations should be based on a 12-month period for	all aspects of the wor	ksheet to fu	unction correc	tly	Currency =	\$C	Volume units	MI	and	m <sup>3</sup>
Utility	Town of Fort Erie	Bulk supply (BS) or I System (DS		DS		01/01/2005	to	01/01/2006	-	365	days
	Whole System	Do most custom storage tan		No		Calculation by	Steve	Genser	Date	4-	Dec-06
Process lability Band	WATER BALANCE CALC	ULATIONS			Volume in period	95% Contidence	Variance	FINANCIAL		NCE INDICATO	ORS FOR NON-
Reliability	(WA Terminolog	y				Limit as 4/- %	variance	% of System			as % of System
å	COMPONENTS OF WATER BALANCE				MI			Input Volume	Ru	nning Costs is	n Period
	WOS: Volume from Own Sources (corrected for known system	matic errors)					0	0.0%	ģ	lua!	E
A	WI: Water Imported (corrected for known systematic errors)				5218.8	3.0%	6381	100.0%	of No	se of Individual Revenue Water	systom
	SIV: SYSTEM INPUT VOLUME				5218.8	3.0%	6391	100,0%	Assessed marginal cost dividual components of I Revenue Water	of in	S Bu
	BACE:Water Exported						0	0.0%	ngh Sono	Value Non R	running
	WS: WATER SUPPLIED = SIV - BACE	/1			5218.8	3.0%	6381	100,0%	d ma	72	~
A/B	BACM1: Billed Authorised Consumption: Metered	Re	sidential		3404,8	1.5%	679	65,2%	Box	Assessed marginal cost of Individual components of Non- Revenue Water sessed Unit Value of Individua mponents of Non Revenue Wat	500
A	BACM2: Billed Authorised Consumption: Metered	Billed Authorised Consumption: Metered Large Com				1,5%	17	10.3%	Asso	Assessed Unit 1	8
	BACM3: Billed Authorised Consumption: Metered			0	0.0%	Ē	Ass	*			
	BACU: Billed Authorised Consumption:Unmetered			0	0.0%	SC/m3	\$Cx1000	- 56			
NRW: NON-REVENUE WATER						12.9%	7077	24.4%	0.4771	608.7	0.0%
A	UACM: Unbilled Authorised Consumption: Metered 0.00%						0	0.0%	0.4460	0.0	0.0%
C/D	UACU: Unbilled Authorised Consumption: Unmetered:	Estimated as	5.000%	of WS	260,9	50.0%	4431	5.0%	0,4460	116.4	0.0%
	WL WATER LOSSES				1014,7	20.7%	11508	19.4%	0.4851	492.3	0.0%
C/D	UC: Unauthorised Consumption:	Estimated as	1,000%	of WS	52.2	50.0%	177	1.0%	0,7300	38.1	0.0%
B/C	ALMUR1: Apparent Loss - meter under-registration:	Residential	0.50%	of BACM1	17.1	7.0%	0	0.3%	1.5500	26.5	0.0%
B/C	ALMUR2: Apparent Loss - meter under-registration:	Large Commercial	1.00%	of BACM2	5,4	7.0%	0	0,1%	1.5500	8.4	0.0%
	ALMUR3: Apparent Loss - meter under-registration:			of BACM3 and UACM	0.0		0	0.0%	1.5500	0.0	0.0%
D	ALDCD Customer meter data handling errors			72			0	0.0%	1,5500	0.0	0.0%
	AL: Sum of APPARENT LOSSES				74.7	35.0%	178	1.4%	0.9774	73.0	0.0%
	RL: REAL LOSSES				940.0	22.5%	11685	18.0%	0,4460	419.2	0.0%
	% of period system pressurized	= 100.0%	365.0	days			Cost				

Process Reliability Band	SYSTEM INFRASTRUCTURE AND PRESSURE DA	TA	Valid for UARL& ILI calc?	95% CLs as +/- %
A	Lm: Mains Length, km	303,10	Yes	1,0%
A	Nh: Number of Fire Hydrants	1475		1.0%
A/B	Nb: Number of Separately Billed Properties	12098		2.0%
A/B	R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb)	1.000		2.0%
Ns: No. of billed Service Connections		12098		2.8%
В	Nu: Number of Unbilled Service Connections	101		10.0%
	Nt: Total Number of Service Conns (= Ns + Nu), mains to property line	12199	Yes	2.8%
	DC: Density of Connections/ km of mains = Ns/Lm	40.2	19	3,0%
В	Lp: Average pipe length, property line to meter (m)	10,2		2.4%
	Lp: Total pipe length, property line to meter (km)	123.40		3.7%
В	P: Average pressure when system pressurised (psi)	75.0	C Water	5.0%
	P: Average pressure when system pressurised (m)	53.0	Yes	5.0%

ASSESSMENT OF UNAVOID POTENTIAL	LLY RECOVER			ND COST OF
Notes: If Lm and Lp are in	km	and pres	sure P is in	metres
UBL in litres/hour =	(20 x Lm +	1.25 x NI +	33 x Lp) x	(P/50) <sup>1.5</sup>
UARL in litres/day =	(18 x Lm +	0.8 x Nt +	25 x Lp) x	Р
COMPONENT OF REAL LOSSES	MI per day	MI in period	\$Cx1000 In period	95% CLs as +/
UBL: UNAVOIDABLE BACKGROUND LEAKAGE	0.67	243	108.5	7.7%
UARL: UNAVOIDABLE ANNUAL REAL LOSSES	0.97	354	158.0	5,3%
CARL: CURRENT ANNUAL REAL LOSSES	2.58	940	419.2	22,5%
POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL	1.61	586	261.3	36.3%

IWA BEST PRACTICE PERFORMANCE INC	NCATOR	UNITS OF PERFORMANCE INDICATOR	Best estimate	95% CLs as +/- %	Lowest Estimate	Highest Estimate
Non Revenue Water Basic (IWA Level 1,	Fin36)	% of System Input by Volume	24.4	13.3%	21.2	27.7
Non Revenue Water Basic (IWA Level 1,	Fin37)	% of System Input by Value	(1111011570)	13.3%	BERT.	18/48
A (AVA 0-22)	Best Op23 Pl >	% of Water Supplied (Distribution Systems)	1.4	35,1%	0.9	1.9
Apparent Losses (IWA Op23)		% of System Input Volume (Bulk Supply Systems)	1.4	35.1%	0.9	1.9
Real Losses Basic (IWA Level 1, Op24)	Best Op24 Pf >	Litres/service connection/day, when system pressurised	211	22.7%	163	259
Heal Losses Basic (IWA Level 1, Op24)		m3/km of mains/day, when system pressurised	8.6	22.6%	6,6	10,4
Real Losses Detailed (IWA Level 3, Or	25)	Infrastructure Leakage Index ILI (non-dimensional)	2.65	23.1%	2.04	3.27

### Comments:

Region Billing Equation = 2T1 + 2T2 -2S (Accuracy ranges between 97 and 101.6 percent)

Process Reliability Bands:

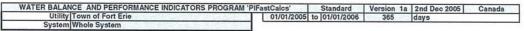
- A actual data
  B calculated based on actual data
  C calculated estimate
  D no data / default

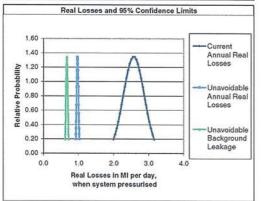
Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

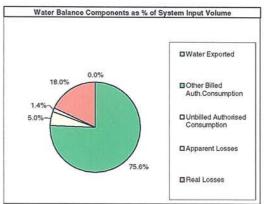
No costs for operating the system provided.

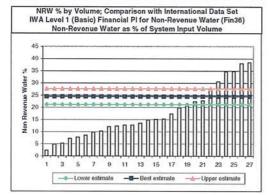
	WATER	BALANCE	AND PI	ERFORMA	ICE IND	WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs	GRAM 'PIFast	tCalcs'		
DETAILED CALCULATION OF COMPON	NENTS OF AU	N OF COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION	UNAUTHO	RISED CONSUI	IPTION		Data entry	Calculated Values		From another Worksheet
Utility Town of Fort Erie						01/01/2005 to 01/01/2006	01/01/2006 =	365 days	ote	10044373006
System Wildle System						Calculation by	Sieve delisei		Date	-
		Components in	MI			Addi	Additional information on sources of data and basis of estimates	on sources of data	and basis of	estimates
Components of Authorised Consumption	Billed	Billed	Unbilled	Unbilled	Total		c	E = estimated		
	Metered	Unmetered	Metered	Unmetered			ת נו	R = Based on recordings	Ja	
Residential	3404.80				3404.80	(R) From billing records	ords			
Commercial	538.32				538.32		ords			
20000000					00.00	0				
Fire Fighting					260.94	4				
Street Cleaning					00'0					
Hydrant Usage				100000	0.0	0.00 /E) E% of M/S				
Sewer Flushing				200.34	0.0	2 (=) 2.0 (1 ) (2				
W/M Cleaning					0.0					
Flushing					00.00	īc				
					00.00					
					0.0					
					0.00	0				
				7	00:00					
					0.0	0				
					0.0	100				
					0.0					
					00.00					
					0.0					
					0.00					
					0.0	6				
					00.00	0				
					0.00	0				
					0.00	0				
					00'0					
					0.00					
					0.0	-				
					00.00					
					0.00					
					00.00					
					0.00	0				
					00.00					
Authorised consumption sub-totals	20.42 44	000	000	IND OBC	MISO LOCK	T PAI				

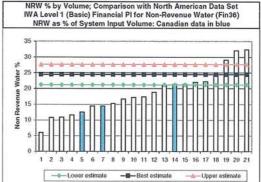
Components of Unauthorised Consumption	MI	Method of estimation
By-pass tampering	26.09	(E) 0.5% of WS
Hydrant Usage	26.09	26.09 (E) 0.5% of WS
Unauthorised consumption sub-total	52.19 M	MI
Unauthorised consumption =	1.000%	nsumption = 1,000% of Water Supplied, transfer this figure to Cell E23 of 'WaterBalance&Pis' Worksheet



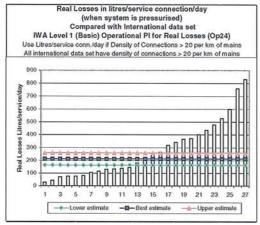


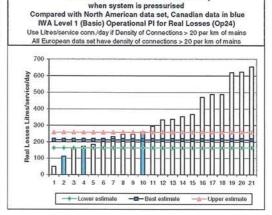


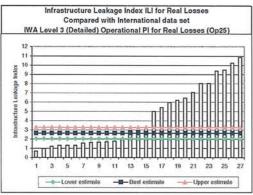


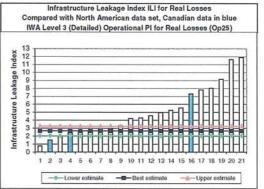


Real Losses in litres/service connection/day









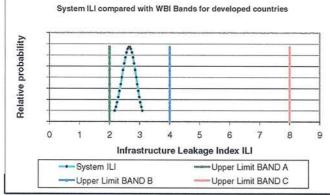
# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | Enter Licensee's name when issuing software

#### THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES

#### World Bank Institute (WBI) Guidelines

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

Developing Countries ILI range	All distances and a	BAND	Calculated ILI for this System	General description of Real Loss Management Performance Categories for Developed and Developing Countries
Less than 4	Less than 2	Α		Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement
4 to < 8	2 to < 4	В		Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance
8 to < 16	4 to < 8	С		Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
16 or more	8 or more	D		Very inefficient use of resources; leakage reduction programs imperative and high priority



WBI Recommendations for BANDS	A	В	С	D
Investigate pressure management options	Yes	Yes	Yes	
Investigate speed and quality of repairs	Yes	Yes	Yes	
Check economic intervention frequency	Yes	Yes		
Introduce/improve active leakage control		Yes	Yes	
Identify options for improved maintenance		Yes	Yes	
Assess Economic Leakage Level	Yes	Yes		
Review break frequencies		Yes	Yes	
Review asset management policy		Yes	Yes	Yes
Deal with deficiencies in manpower, training and communications			Yes	Yes
5-year plan to achieve next lowest band			Yes	Yes
Fundamental peer review of all activities				Yes

GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

Target ILI Range	This System ILI	Water Resources Considerations	Operational Considerations	Financial Considerations
1.0 - 3.0	2.7	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability
3.0 - 5.0		Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population
5.0 - 8.0		Water resources are plentiful, reliable, and easily abstracted	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages	Cost to purchase or obtain/treat water is low, as are rates charged to customers
Greater than 8.0		Although operational and financial considera utilization of water as a resource. Setting a tr target - is discouraged.		

Note: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalcs Standard software. This has allowed the development of the ELLCalcs standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

Important Footnote: the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The PressCalcs Standard Software provides more detailed information on this topic.

	'LEAKS' Suite of LEAKAGE E		ASS	SESSMI	ENT KNOV	V-HOW SOFTW	ARE	100 H	1. 4.112
	ER BALANCE AND PERFORMANCE INDICATORS PR		1 8	Standard	Version 1a	2nd Dec 2005	Ca	anada	Master.0000
	OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS					Calculated Values	From	m anoth	er Worksheet
Utility	Town of Fort Erie	01/01/2005	to	1/	1/2006	Number of Days in P	eriod	365	davs
System	Whole System	Calculatio	n by	Stev	e Genser	Date of calculat	ion =	7	-Sep-06

Total running costs as calculated below = 0.0 | SCx1000 | Transfer this figure to Cell L30 of WaterBalance&Pis' Worksheet

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA' Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1

900222 27 2, IWA Publishing: this report should be consulted for further guidance as necessary.

Operational Costs			Group total	2004/1000 CV 2004 (2004 2004 2004 2004 2004 2004 200
	Raw water	\$Cx1000	\$Cx1000	INCLUDES
Imported water	Treated water		0.0	BULK SUPPLY IMPORTS: total payments for imported raw water
	Raw water			BULK SUPPLY IMPORTS: total payments for imported treated water
150	Treatment		1 55 58	
Energy	Transmission		0.0	POWER: all energy costs for water supply electricity and fuel for motive machinery
	Distribution		E PAIL	20
	Outsourcing			Outsourcing of technical or administrative services, such as consultants, contractors undertakin operational tasks, meter reading and accounting fees
External services:	Software licences and IT support			Licence fees on computer software and technical support by software companies
Outsourcing	Associated		0.0	Costs of associated companies that are not included in other items
	Companies Third party			Operating costs of providing water services to third parties (other than the regulated water
	services			supply function) that are not included in other items
	Premises			Payments for leasing or renting premises
Lassian and Double	Vehicles			Payments for leasing or renting vehicles
Leasing and Rentals	Mobile Plant		0.0	Payments for leasing or renting mobile plant
	Fixed Plant			Payments for leasing or renting fixed plant
	Equipment			Payments for leasing or renting equipment
Purchases	Water treatment chemicals		0.0	All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants, transmission and distribution systems
Fucilases	Other than chemicals and energy		0.0	All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for
Taxes, levies and	energy			operation of sources, treatment plants,transmission and distribution systems
fees	All kinds		0.0	Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates
Exceptional earnings and losses	All kinds		0.0	Any exceptional income or expenditure from donations, investment subsidies, compensations of adjustments related to sales/writing off of fixed assets
	Other direct costs			Any other operating costs (but excluding interest and taxation, on an aggregated basis)
	General and support expenditures			The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded)
Other Operating Expenditures	Customer services		0.0	Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling.
	Scientific services			Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items
	Other business activities Doubtful debts		月	Costs directly associated with other business activities that are not included in previous items, except for cost depreciation
Name of the control o	Doublid debts			Charge/credit to the profit and loss account for bad and doubtful debts
Sum of Operational Costs	All the above operational costs		0.0	
Internal manpower costs	Employment costs		0.0	The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer
Capitalised cost of self-constructed assets	Negative allocation		0.0	The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets
Total Running Costs	Sum of Operational Internal Manpower C capitalised cost constructed a	osts, minus of self-	0.0	

Comments:	

Appendix G

PIFastCalc Output Grimsby

	WATER BALANCE AND PERFORMANCE INDICA	ATORS PRO	GRAM 'P	<b>IFastCalcs</b>	i'	Standard	Version 1a	2nd De	2005	C	anada
	ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD F	FORMAT, WITH	5% CONFID	DENCE LIMITS		Data entry	Defaults	Calculate	d Values	From anot	her Worksheet
	Note: Calculations should be based on a 12-month period for all asp	pects of the wor	ksheet to fo	unction correc	tly	Currency =	\$C	Volume units	MI	and	m <sup>3</sup>
Utility	Town of Grimsby But	ilk supply (BS) or I System (DS		DS		01/01/2005	to	01/01/2006		365	days
ystem	Whole System	Do most custom storage tank		No		Calculation by	Steve C	lenser	Date	4-	Dec-06
Process Reliability Band	WATER BALANCE CALCULATION	IONS			Volume in period	95% Confidence	Variance	FINANCIAL		ICE INDICATO	ORS FOR NON-
Pro	IWA Terminology				10,000	Limit as 4/- %	variance	% of System			as % of Syste
å	COMPONENTS OF WATER BALANCE				MI			Input Volume	Rur	nning Costs in	Period
	WOS: Volume from Own Sources (corrected for known systematic e	orrors)					0	0.0%	ė	fual /ater	E
A	WI: Water Imported (corrected for known systematic errors)				3219.6	3.0%	2429	100.0%	cost of te of No	Value of Individual Non Revenue Wate	of running system
	SIV: SYSTEM INPUT VOLUME				3219.6	3.0%	2429	100.0%	al co	of in	bu
	BACE:Water Exported						0	0.0%	sed marginal cial components Revenue Water	alue on R	500
	WS: WATER SUPPLIED = SIV - BACE				3219.6	3,0%	2429	100.0%	d ma comi	2 to	5
A/B	BACM1; Billed Authorised Consumption: Metered	Re	sidential		2092.2	1.5%	256	65.0%	Assessed marginal cost of individual components of Non- Revenue Water Resesed Unit Value of individu	onte U	1500
В	BACM2: Billed Authorised Consumption: Metered		ICI		735.1	1.5%	32	22.8%	Ased	Assessed Unit v	5
	BACM3: Billed Authorised Consumption: Metered						0	0.0%	=	Ass	*
	BACU: Billed Authorised Consumption:Unmetered						0	0.0%	\$C/m3	\$Cx1000	%
	NRW: NON-REVENUE WATER				392.3	26.0%	2717	12.2%	0.6811	267.2	8.4%
A	UACM: Unbilled Authorised Consumption: Metered		0.07%	of WS	2.1		0	0.1%	0.4460	0.9	0.0%
C	UACU: Unbilled Authorised Consumption; Unmetered:	Estimated as	1.170%	of WS	37.7	50.0%	92	1.2%	0.4460	16.8	0.5%
	WL WATER LOSSES				352.5	29.5%	2809	10.9%	0.7077	249.5	7.9%
	UC: Unauthorised Consumption:	Estimated as	1.500%	of WS	48.3	50.0%	152	1.5%	1.6600	80.2	2.5%
В	ALMUR1: Apparent Loss - meter under-registration:	Residential	0.50%	of BACM1	10.5	7.0%	0	0.3%	2.3200	24,4	0.8%
В	ALMUR2: Apparent Loss - meter under-registration:	ICI	1,00%	of BACM2	7.4	7.0%	0	0.2%	2.3200	17.2	0.5%
	ALMUR3: Apparent Loss - meter under-registration:			of BACM3 and UACM	0.0		0	0.0%		0.0	0.0%
D	ALDCD Customer meter data handling errors						0	0.0%		0.0	0.0%
	AL: Sum of APPARENT LOSSES				66.2	36.5%	152	2.1%	1.9399	121.8	3.8%
	RL: REAL LOSSES				286.3	37.3%	2961	8.9%	0.4460	127.7	4.0%
A	% of period system pressurized =	100.0%	365.0	days			Cost o	running syste	to an dead	3166.7	\$Cx1000

Process Reliability Band	SYSTEM INFRASTRUCTURE AND PRESSURE DA	.TA	Valid for UARL& ILI calc?	95% CLs as 4/- %
A	Lm: Mains Length, km	128.30	Yes	1.0%
A	Nh: Number of Fire Hydrants	841	U.	1.0%
В	Nb: Number of Separately Billed Properties	8449	Į.	2,0%
В	R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb)	1.000		2.0%
	Ns: No. of billed Service Connections	8449	d .	2,8%
C	Nu: Number of Unbilled Service Connections			
	Nt: Total Number of Service Conns (= Ns + Nu), mains to property line	8449	Yes	2.8%
	DC: Density of Connections/ km of mains = Ns/Lm	65.9		3,0%
В	Lp: Average pipe length, property line to meter (m)	10.2	1	2.4%
	Lp: Total pipe length, property line to meter (km)	86,18		3.7%
В	P: Average pressure when system pressurised (psi)	75.0	W075	5.0%
	P: Average pressure when system pressurised (m)	53.0	Yes	5,0%

Notes: If Lm and Lp are in	km	and pres	sure P is in	metres
UBL in litres/hour =	{20 x Lm +	1.25 x Nt +	33 x Lp) x	(P/50) <sup>1.5</sup>
UARL in litres/day =	(18 x Lm +	0.8 x Nt +	25 x Lp) x	Р
COMPONENT OF REAL LOSSES	MI per day	MI In period	\$Cx1000 in period	95% CLs as +/
UBL: UNAVOIDABLE BACKGROUND LEAKAGE	0.42	153	68.3	7.7%
UARL: UNAVOIDABLE ANNUAL REAL LOSSES	0.60	217	96.9	5,3%
CARL: CURRENT ANNUAL REAL LOSSES	0.78	286	127.7	37,3%
POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL	0.19	69	30.8	155.3%

IWA BEST PRACTICE PERFORMANCE INDI	CATOR	UNITS OF PERFORMANCE INDICATOR	Best estimate	95% CLs as +/- %	Lowest Estimate	Highest Estimate
Non Revenue Water Basic (IWA Level 1, F	in36)	% of System Input by Volume	12.2	26,2%	9.0	15.4
Non Revenue Water Basic (IWA Level 1, F	in37)	% of System Input by Value	8.4	26.2%	6.2	10.6
Apparent Losses (IWA Op23)	Best Op23 Pl >	% of Water Supplied (Distribution Systems)	2,1	36,6%	1.3	2.8
Appareix Cosses (IVA Op25)		% of System Input Volume (Bulk Supply Systems)	2.1	36,6%	1.3	2.8
Real Losses Basic (IWA Level 1, Op24)	Best Op24 Pt >	Litres/service connection/day, when system pressurised	93	37.4%	58	128
near cosses basic (IMA Cever 1, Op24)		m3/km of mains/day, when system pressurised	6.1	37,3%	3.8	8.4
Real Losses Detailed (IWA Level 3, Op	25)	Infrastructure Leakage Index ILI (non-dimensional)	1.32	37.6%	0.82	1.81

# Comments:

Region supplied calculated based on three meters, i.e., 6T1 - 6D1 - 6D2 with meter calibration reports dated as follows: 6T1 - August 15 and Nov. 2, 2005 6D1 - no calibration provided 6D2 - May 24, 2005

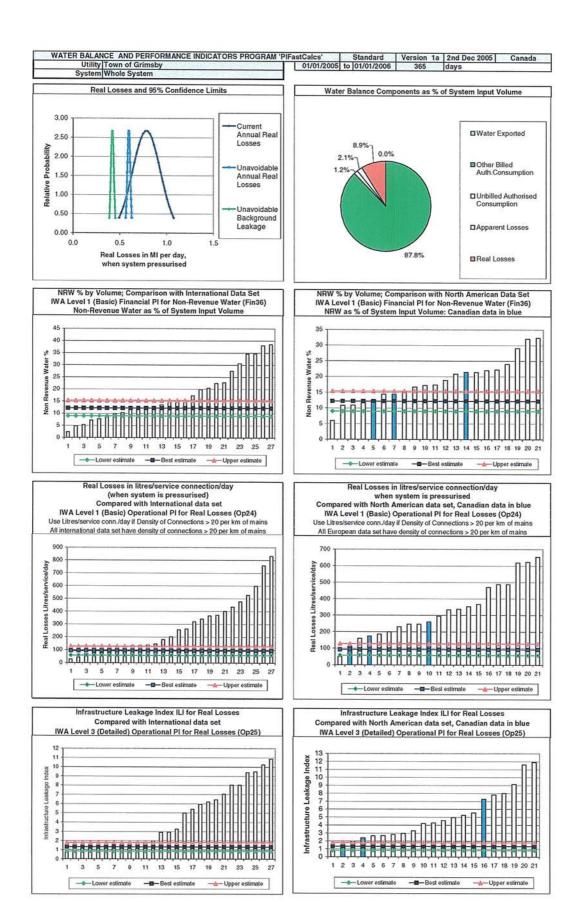
Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Water Rates: \$70.42 for the first 30.3 cubic meters; \$3.28 per 4.55 cubic meters in excess of 30.3 cubic meters
Purchase water from the region at \$.0446 per cubic meter
In 2004 ILI Survey quoted as \$1.54 per cubic meter applied to apparent losses therefore increase suggests \$1.67 per cubic meter.

Total length of watermain allow for 3 m per hydrant (i.e., 841 hydrants x 3m = 2.523 km)

Calculation by Stave General Information on sources of data and basis   Calculation by Stave General   Calculation by Calculation by Calculation Calculation   Calculation   Calculation Calculation   C		WAIEN	BALANCE	AND PE	REORMAL	ICE INDI	WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'	GRAM 'PIFast	Calcs'		
Intercept of Authorised Consumption   Components in Miled   Metered   Unbilled   Unbilled   One of the consumption   Components in Miled   Unbilled   Unbilled   Unbilled   One of the consumption   Components in Miled   Unbilled   Unbilled   One of the consumption   Components in Metered   Unmetered   One of the consumption   Components   C	DETAILED CALCULATION OF COMPONE	IENTS OF AU	THORISED AND	UNAUTHOR	RISED CONSU	APTION		Data entry	Calculated	Values	From another Worksheet
Motorised Consumption   Components in MI   Components in Motorised Consumption sub-totals   Components in Motorised Consumption sub-totals   Components in Motorised Consumption sub-total   Components in Mi   Components in Motorised Consumption sub-total   Components in Motorised Consumption sub-total   Components in Mi   Components in Mi   Components in Mi   Components in Mi   Components in Motorised Consumption sub-total   Components in Mi   C	Utility Town of Grimsby	DATE THE	871-1841-1	THOUSAND IN			ш	Ш		ays	
Components in Miled   Unbilled	System Whole System	267	CONTRACTOR OF		The second second		Calculation by	Steve Genser		إلـ	
Meteod   Unmetered   Unmeter			Components in	MI			Addi	tional information o	n sources of c	lata and ba	sis of estimates
10.000   0.0	Components of Authorised Consumption	Billed	Billed Unmetered	Unbilled	Unbilled Unmetered	Total		æ	E = estimatec Based on reco	rdings	
Cook						0.00	80% have remotes,	65% roll dial remote,	14 touch pad	remote, 1%	radio
10.00   2002.22   220.53   220.53   220.53   220.53   220.53   220.53   220.53   220.53   220.53   220.53   220.73   2						00.00	20% old imp gall wit	h no remote			
10.00   10.0						00:0		ards			
10,002.22   20						00:0	4.2% of bills estimal	pe			
100 80   1	esidential	2092.22				2092.22		lings			
110,80    110,80    100,	ommercial	320.53				320.53		lings			
10.31   10.3	dustrial	109.80				109.80	H = Based on recor	sbuilds			
Section   Sect	Sulutional	10.3				6.36	D = Based on recor	eginge inge			
SE 22.78   SE 27.78	- Samon	34 13				34 13		inds			
10   10   10   10   10   10   10   10	UMC	22.78				22.78		inds			
86.31   86.3	amilton-Wentworth	45.91				45.91	R = Based on recor	ings			
age (mobile meter)  10.00  2.12  2.15  2.1	a invoice	85.31				85.31		lings			
1.00   1.00	TOWN THE TOWN					00.00					
13 ct   13 c	ydrant Usage (mobile meter)			2.12		2.12	R = Based on record	lings, less Avertex			
13.64   13.6	ew Construction/Rehab				2.45	2.45	E = estimated; 6 job	s x 3/job x 500 gpm 3	c 1 hr.		
18.18   18.1	re/Training				13.64	13.64	E = estimated; 1 fire	/yr. 2,000 Imp. Gal; 7	raining 68 hrs/	yr @ 1,000	gpm = 3,000,000 lmp. Gal
1	ydrant Flushing				18.18	18.18	E = estimated; dead	end 20 locations x 6	Vyr. x 3,000 lmg	o Gal + 3,00	0,000 lmp. Gal
1,171%   1	ydroguard				2.95	2.95	E = estimated; 20 g	m x 6-4 hrs./day (50	% of this in win	iter)	
Authorised consumption sub-totals	ecreation				0.47	0.47	E = estimated; 3 pa	ks approx. 6 gpm x 2	hrs/day x 5 m	onths	
Authorised consumption sub-totals 2827.33 0.00 2.12 37.70  Authorised Unbilled Unmetered Consumption = 1.171%  1.171%  Authorised Consumption MI Estimated as 0.5% of overall usage 16.10 Estimated 16.10 Estima						0.00					
Authorised consumption sub-totals   2827.33   0.00   2.12   37.70						0.00					
Authorised consumption sub-totals   2827.33   0.00   2.12   37.70						0.00					
Authorised consumption sub-totals 2827.33 0.00 2.12 37.70  Authorised Unbilled Unmetered Consumption = 1.171%  16.10 Estimated as 0.5% of overall usage 16.10 Estimated						0000					
uthorised consumption sub-totals 2827.33 0.00 2.12 37.70  Authorised Unbilled Unmetered Consumption = 1.171%, as of Unauthorised Consumption MI Estimated as 0.5% of overall usage 16.10 Estimated 16.10 Estimat						000					
Authorised consumption sub-totals      Authorised Consumption        Authorised Consumption        MI						00.00					
Authorised consumption sub-totals 2827.33 0.00 2.12 37.70  Authorised Unbilled Unmetered Consumption = 1.171%  116.10 Estimated as 0.5% of overall usage 16.10 Estimated 16.10						00.00					
uthorised consumption sub-totals 2827.33 0.00 2.12 37.70  Authorised Unmetered Consumption = 1.171%  Authorised Consumption MI Estimated as 0.5% of overall usage 16.10 Estimated 16.10 E						00.00					
Authorised consumption sub-totals 2827.33 0.00 2.12 37.70  Authorised Unbilled Unmetered Consumption = 1.171%  age 16.10 Estimated as 0.5% of overall usage 16.10 Estimated as 0.5% of overall usage 16.10 Authorised consumption sub-total 32.20 Mi						0.00					
Authorised Consumption MI Estimated as 0.5% of overall usage  16.10 Estimated as 0.5% of overall usage 16.10 Estimated as 0.5% of overall usage 32.20 MI	II e			1011	37.70	2867 14	MI				
age  16.10 Estimated as 0.5% of overall usage 16.10 Estimated as 0.5% of overall usage 18.10 Annual usage 18.10 Estimated as 0.5% of overall usage 18.10 Annual usage 18.10 Annual usage		and Unbilled	Inmetered Con	- mortion -	1 1710/	of Water Sur	plied transfer this	forum to Call E21 of	WaterBalanc	a&Pie Wor	kehoot
age 16.10 Estimated as 0.5% of overall usage	TO THE STATE OF TH	Pallello Bas	50 50 50 50 50 50 50 50 50 50 50 50 50 5	- mondama	9/11/1	in and a	died, density and	in the second			TO T
age 16.10 16.10 14.10 14.10 16	omponents of Unauthorised Consumption						Method of	estimation			
16.10 uthorised consumption sub-total 32.20	ydrant Usade	16.10		5% of overall	usade						
32.20	y-passes	16.10	Estimated as 0.	5% of overall	usage						
32.20											
32.20											
	Unauthorised consumption sub-total		IVI								



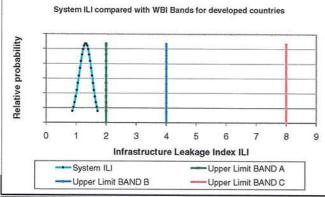
A STATE OF	'LEAKS'	Suite of LEA	KAGE EVALU	ATION and	ASSESSME	NT KNOW-HOW SOFTWARE					
WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'											
PIFastCalcs Standard Version 1a 2nd Dec 2005   Canada   Master.0000   Town of Grimsby											

# THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES

#### World Bank Institute (WBI) Guidelines

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

Countries	Developed Countries	BAND	Calculated ILI for this	General description of Real Loss Management Performance Categories for Developed and Developing  Countries
ILI range	ILI range		System	- Countries
Less than 4	Less than 2	Α	1.3	Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement
4 to < 8	2 to < 4	В		Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance
8 to < 16	4 to < 8	С		Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
16 or more	8 or more	D		Very inefficient use of resources; leakage reduction programs imperative and high priority



WBI Recommendations for BANDS	A	В	С	D
Investigate pressure management options	Yes	Yes	Yes	
Investigate speed and quality of repairs	Yes	Yes	Yes	
Check economic intervention frequency	Yes	Yes		
Introduce/improve active leakage control		Yes	Yes	
Identify options for improved maintenance		Yes	Yes	
Assess Economic Leakage Level	Yes	Yes		
Review break frequencies		Yes	Yes	
Review asset management policy		Yes	Yes	Yes
Deal with deficiencies in manpower, training and communications			Yes	Yes
5-year plan to achieve next lowest band			Yes	Yes
Fundamental peer review of all activities				Yes

GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been

developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed countries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

Target ILI Range	This System ILI	Water Resources Considerations	Operational Considerations	Financial Considerations
1.0 - 3.0	1.3	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability
3.0 - 5.0		management interventions (leakage	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population
5.0 - 8.0		Water resources are plentiful reliable and	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages	Cost to purchase or obtain/treat water is low, as are rates charged to customers
Greater than 8.0		Although operational and financial considera utilization of water as a resource. Setting a tatarget - is discouraged.		

Note: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalcs Standard software. This has allowed the development of the ELLCalcs standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

Important Footnote: the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The PressCalcs Standard Software provides more detailed information on this topic.

	'LEAKS' Suite of LEAKAGE I	EVALUATION and	ASS	SESSMI	ENT KNOV	V-HOW SOFTW	ARE		Y
	ER BALANCE AND PERFORMANCE INDICATORS P		1	Standard	Version 1a	2nd Dec 2005	C	anada	Master.0000
	OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYST	TEM RUNNING COSTS		Da	ta entry	Calculated Values	culated Values From a		er Worksheet
Utility	Town of Grimsby	01/01/2005	to	1/	1/2006	Number of Days in P	eriod	365	days
System	Whole System	Calculation	n by	A.N	I. Other	Date of calculat	tion =		

0		Sub-total	Group total				
Operational Costs	December	\$Cx1000	\$Cx1000	INCLUDES			
Imported water	Raw water		0.0	BULK SUPPLY IMPORTS: total payments for imported raw water			
				BULK SUPPLY IMPORTS: total payments for imported treated water			
Energy			0.0	POWER: all energy costs for water supply electricity and fuel for motive machinery			
	Treated water Raw water Treatment Software licences and IT support Outsourcing Associated Companies Third party services Treatment Treat	o, and the machinery					
	Distribution		SHIP OF H				
	Outsourcing			Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees			
External services:			0.0	Licence fees on computer software and technical support by software companies			
Outsourcing				Costs of associated companies that are not included in other items			
				Operating costs of providing water services to third parties (other than the regulated water			
				supply function) that are not included in other items			
			The Control of the				
Leasing and Rentals			0.0				
Locusing and richtels			0.0				
	Equipment						
<b>2</b> 30000000				SERVICES and which are required for operation of sources, treatment plants,transmission and			
Purchases	chemicals and		0.0	All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for			
Taura Indiana	energy						
	All kinds		0.0				
Exceptional earnings and losses	All kinds		0.0	Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets			
	Other direct costs			Any other operating costs (but excluding interest and taxation, on an aggregated basis)			
	support			The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded)			
Other Operating Expenditures	Customer services		0.0	Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling.			
	Scientific services			Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items			
				Costs directly associated with other business activities that are not included in previous items,			
	Doubtful debts			Charge/credit to the profit and loss account for bad and doubtful debts			
Sum of Operational Costs			0.0				
Internal manpower costs	Employment costs		0.0	The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer			
Capitalised cost of self-constructed assets	Negative allocation		0.0	The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets			
Total Running Costs	Sum of Operational Internal Manpower ( capitalised cos- constructed a	Costs, minus t of self-	0.0				

Comments:		

Appendix H

PIFastCalc Output Lincoln

_	WATER BALANCE AND PERFORMANCE INDICAT	ORS PRO	GRAM 'I	PIFastCalc	s'	Standard	Version 1a	2nd Dec	2005		Canada	
	ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FO					Data entry	Defaults	Calculated Values		From another Workshee		
	Note:Calculations should be based on a 12-month period for all asper	cts of the wor	rksheet to 1	function correc	tly	Currency =	\$C	Volume units	MI	and	m <sup>3</sup>	
Utility	Town of Lincoln Bulks	supply (BS) or System (D)		DS		01/01/2005	to	01/01/2006		365	days	
	Whole System Do	most custom storage tan		No		Calculation by	Steve	Genser	Date	4	Dec-06	
WATER BALANCE CALCULATIONS  WATER BALANCE COMPONENTS OF WATER BALANCE  COMPONENTS OF WATER BALANCE						95%		FINANCIAL PERFORMANCE			E INDICATORS FOR NON-	
유교	IWA Terminology				period	Confidence Limit as #/-%	Variance		REVENUE WATER		VALUE OF THE PARTY	
28	COMPONENTS OF WATER BALANCE				MI	Calling and Ale		% of System Input Volume	Calculated	Value of NRW nning Costs is	as % of System Period	
		Volume from Own Sources (corrected for known systematic errors)						0.0%	4	1 to 2		
A	WI: Water Imported (corrected for known systematic errors)				2604.7	3.0%	1589	100.0%	No.	Individual caue Water	system	
	SIV: SYSTEM INPUT VOLUME				2604.7	3.0%	1589	100.0%	Assessed marginal cost of Individual components of Non-Revenue Water	ind enu	of cost of running sys	
	BACE:Water Exported						0	0.0%		Value of Individ Non Revenue V		
	WS: WATER SUPPLIED = SIV - BACE				2604.7	3.0%	1589	100.0%	man	Nor	2	
A/B	BACM1: Billed Authorised Consumption: Metered		Total		2362.9	1.5%	327	90.7%	al co	Assessed Unit v	#	
	BACM2: Billed Authorised Consumption: Metered				-	200000	0	0.0%	Mide	pess	9	
	BACM3: Billed Authorised Consumption: Metered						0	0.0%	₹ P	d wo	¥t.	
	BACU: Billed Authorised Consumption:Unmetered				0.0			0.0%	\$C/m3	5Cx1000	*	
	NRW: NON-REVENUE WATER				241.8	35,5%	1916	9.3%	0.5216	126.1		
A	UACM: Unbilled Authorised Consumption: Metered		0.00%	of WS	102		0	0.0%	0.4460	0.0	3.6%	
D	UACU: Unbilled Authorised Consumption: Unmetered: E	stimated as	1.250%	of WS	32.6	100.0%	276	1,3%	0.4460	1 1 2 3 3 4	0.0%	
	WL WATER LOSSES		V 0.550		209.2	43.9%	2192	8.0%		14,5	0.4%	
D	UC: Unauthorised Consumption:	stimated as	0.250%	of WS	6.5	100.0%	11	0.3%	0.5334	111.6	3.2%	
B/C	ALMUR1: Apparent Loss - meter under-registration:	Total	0.60%	of BACM1	14.3	7.0%	0	0.5%	1.3260	18.9	0.2%	
	ALMUR2: Apparent Loss - meter under-registration:			of BACM2	0.0		0	0.0%	1,3260	0.0	0.0%	
å	ALMUR3: Apparent Loss - meter under-registration:			of BACM3 and UACM	0.0		0	0.0%	1.3260	0.0	0.0%	
D	ALDCD Customer meter data handling errors						0	0.0%	1.3260	0.0	0.0%	
	AL: Sum of APPARENT LOSSES				20.8	31.7%	11	0.8%	1.3260	ALTO COMPANY		
	RL: REAL LOSSES				188.5	48,8%	2204	7.2%	0.4460	27.5	0.8%	
						40.0.4	2204	1,270	0.4450	84.0	2.4%	

Process Reliability Band	SYSTEM INFRASTRUCTURE AND PRESSURE DA	TA	Valid for UARL& ILI cale?	95% CLs a: 4/- %	
Α	Lm: Mains Length, km	91.50	Yes	1.0%	
A	Nh: Number of Fire Hydrants	532		1.0%	
A/B	Nb: Number of Separately Billed Properties	5110		2.0%	
A/B	R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb)	1.000		2.0%	
	Ns: No. of billed Service Connections		2.8%		
C	Nu: Number of Unbilled Service Connections	0	-	717.07	
	Nt: Total Number of Service Conns (= Ns + Nu), mains to property line	5110	Yes	2.8%	
	DC: Density of Connections/ km of mains = Ns/Lm	55.8	0	3.0%	
В	Lp: Average pipe length, property line to meter (m)	10.2		2.4%	
	Lp: Total pipe length, property line to meter (km)	52.12	0	3.7%	
C	P: Average pressure when system pressurised (psi)	65,0	7.500	20.0%	
	P: Average pressure when system pressurised (m)	46.0	Yes	20.0%	

Notes: If Lm and Lp are in	km	and pres	sure P is in	metres
UBL in litres/hour =	(20 x Lm +	1.25 x Nt +	33 x Lp) x	(P/50) <sup>1.5</sup>
UARL in litres/day =	(18 x Lm +	0.8 x Nt +	25 x Lp) x	Р
COMPONENT OF REAL LOSSES	MI per day	MI In period	\$Cx1000 in period	95% CLs as +,
UBL: UNAVOIDABLE BACKGROUND LEAKAGE	0,21	77	34.3	30,1%
UARL: UNAVOIDABLE ANNUAL REAL LOSSES	0.32	118	52.7	20,1%
CARL: CURRENT ANNUAL REAL LOSSES	0.52	188	84.0	49.8%
POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL	0.19	70	31,4	135.0%

IWA BEST PRACTICE PERFORMANCE INDI	CATOR	UNITS OF PERFORMANCE INDICATOR	Best estimate	95% CLs as +/- %	Lowest Estimate	Highest Estimate
Non Revenue Water Basic (IWA Level 1, Fin36)		% of System Input by Volume	9.3	35,6%	6.0	12.6
Non Revenue Water Basic (IWA Level 1, F	in37)	% of System Input by Value	3.6	35.6%	2.3	4.9
Apparent Losses (IWA Op23)	Best Op23 Pl >	% of Water Supplied (Distribution Systems)	0.8	31,9%	0.5	1.1
		% of System Input Volume (Bulk Supply Systems)	0.8	31,9%	0.5	1.1
Real Losses Basic (IWA Level 1, Op24)	Best Op24 Ft >	Litres/service connection/day, when system pressurised	101	48.9%	52	150
(Construction of the Construction of the Const		m3/km of mains/day, when system pressurised	5.6	48,8%	2.9	8.4
Real Losses Detailed (IWA Level 3, Op :	25)	Infrastructure Leakage Index ILI (non-dimensional)	1.60	52.8%	0.75	244

# Comments:

Supply via Regional Municipality of Niagara meters 507 (Vineland), 508 (Vineland Service), and 601 (Beamsville). Calibration reports dated:

5D7; August 15 / November 2, 2005 5D8; August 15 / November 2, 2005 6D1; no report

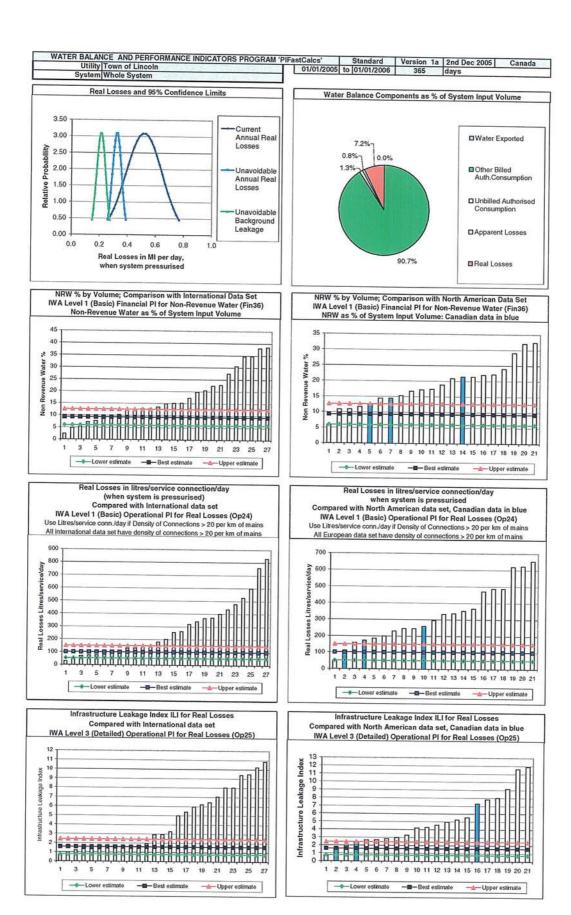
Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

No breakdown of consumption provided by the Town of Lincoln, i.e., quoted single value of billed authorized consumption for the year. Confidence reflects lack of information and possibility of lag

On sub-totals  One components in Miled Unmetered Consumption  On sub-totals	OHS PROGRAM 'PIFastCalcs'  Data entry Calculated Values	
Components in MI  Components in MI  Components in MI  Components in MI  Matered Unnetered Metered Unnetered Unnetered Unnetered Unnetered Unnetered Unnetered Unnetered Unnetered Consumption =   Consumption MI	y	
ionsumption Billed Unmetered Metered Unmetered Unmetered Unmetered Unmetered Unmetered Unmetered Unmetered Unmetered Unmetered Consumption =		From another Worksheet
	01/01/2005 to 01/01/2006 = 365 days Calculation by Steve Genser	Data   Pad July 2005
Motored   Unmetered   Unmete	) in the state of	and the party of t
Motered   Unmetered   Metered   Unmotered   Unmotere	Additional information on sources of data and basis of estimates  E = estimated	sasis of estimates
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =	R = Based on recordings	
on sub-totals   0.00   0.00   0.00   Onsumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unhilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals   0.00   0.00   0.00   Onsumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals   0.00   0.00   0.00   Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.000 0.000 0.000 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unibilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
On sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
on sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
On sub-totals 0.00 0.00 0.00 0.00 Authorised Unbilled Unmetered Consumption =		
Authorised Unbilled Unmetered Consumption =		
Sonsumption MI	0.000% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet	rksheet
	Method of estimation	
Unauthorised consumption sub-total 0.00 M		



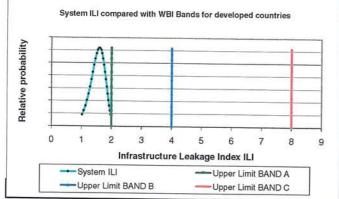
### 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' **PIFastCalcs** Standard Version 1a 2nd Dec 2005 Canada Master.0000

# THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES

# World Bank Institute (WBI) Guidelines

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs. which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

Developing Countries	Countries Countries BAND ILI for this		2011/10/2015	General description of Real Loss Management Performance Categories for Developed and Developing
ILI range	ILI range		System	Countries
Less than 4	Less than 2	Α	1.6	Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement
4 to < 8	2 to < 4	В	77	Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance
8 to < 16	4 to < 8	С		Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
16 or more	8 or more	D		Very inefficient use of resources; leakage reduction programs imperative and high priority



WBI Recommendations for BANDS	Α	В	С	D
Investigate pressure management options	Yes	Yes	Yes	
Investigate speed and quality of repairs	Yes	Yes	Yes	
Check economic intervention frequency	Yes	Yes		
Introduce/improve active leakage control		Yes	Yes	
Identify options for improved maintenance		Yes	Yes	
Assess Economic Leakage Level	Yes	Yes		
Review break frequencies		Yes	Yes	
Review asset management policy		Yes	Yes	Yes
Deal with deficiencies in manpower, training and communications			Yes	Yes
5-year plan to achieve next lowest band			Yes	Yes
Fundamental peer review of all activities				Yes

GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003 Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been

developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the

Target ILI Range	Water Resources Considerations	Operational Considerations	Financial Considerations
1.0 - 3.0	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop	infrastructure and/or additional water	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability
3.0 - 5.0	management.water conservation) are	demand as long as reasonable leakage management controls are in place	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population
5.0 - 8.0		Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages	Cost to purchase or obtain/treat water is low, as are rates charged to customers
Greater than 8.0	Although operational and financial considera utilization of water as a resource. Setting a ta target - is discouraged.	rions may allow a long-term ILI greater than arget level greater than 8.0 - other than as an	8.0, such a level of leakage is not an effective incremental goal to a smaller long-term

Note: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalcs Standard software. This has allowed the development of the ELLCalcs standard software to calculate short-term Economic Leakage Level for an active

Important Footnote: the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The PressCalcs Standard Software provides more detailed information on this topic.

	'LEAKS' Suite of LEAKAGE E	VALUATION and	ASS	ESSME	ENT KNOW	LHOW SOFTW	ADE		(College)
	ER BALANCE AND PERFORMANCE INDICATORS PR	ROGRAM 'PIFastCalcs'			Version 1a			nada	Master.0000
Heiliere	OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYST			Dat	a entry	Calculated Values			er Worksheet
		01/01/2005	to		/2006	Number of Days in P			days
System	Whole System	Calculatio	n by	Steve	Genser	Date of calculat	ion =	1:	2/4/2006

Total running costs as calculated below = 0.0 SCx1000 Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing; this report should be consulted for further guidance as necessary.

Onesetienelo			Group total	
Operational Costs	-	\$Cx1000	\$Cx1000	INCLUDES
Imported water	Raw water		0.0	BULK SUPPLY IMPORTS: total payments for imported raw water
	Treated water			BULK SUPPLY IMPORTS: total payments for imported treated water
	Raw water			
Energy	Treatment		0.0	POWER: all energy costs for water supply electricity and fuel for motive machinery
	Transmission			To the first difference of the first supply electricity and fuel for motive machinery
	Distribution			
	Outsourcing			Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees
External services:	Software licences and IT support		0.0	Licence fees on computer software and technical support by software companies
Outsourcing	Associated Companies		0.0	Costs of associated companies that are not included in other items
	Third party			Operating costs of providing water services to third parties (other than the regulated water
	services			supply function) that are not included in other items
	Premises		vinesta on the	Payments for leasing or renting premises
	Vehicles			Payments for leasing or renting premises
Leasing and Rentals			0.0	Payments for leasing or renting wernices
	Fixed Plant			Payments for leasing or renting mobile plant
	Equipment			Payments for leasing or renting fixed plant Payments for leasing or renting equipment
	TACK THE RESERVE TO SERVE THE RESERVE THE RES			All water treatment of reasing or renting equipment
	Water treatment chemicals			All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants, transmission and
Purchases	Other than		0.0	distribution systems
				All materials and consumables other than energy and water treatment chemicals for water
	chemicals and			supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for
	energy			operation of sources, treatment plants, transmission and distribution systems
Taxes, levies and fees	All kinds		0.0	Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates
Exceptional earnings and losses	All kinds		0.0	Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets
	Other direct costs			Any other operating costs (but excluding interest and taxation, on an aggregated basis)
	General and support expenditures			The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded)
Other Operating Expenditures	Customer services		0.0	Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling.
	Scientific services			Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items
	Other business activities			Costs directly associated with other business activities that are not included in previous items, except for cost depreciation
	Doubtful debts			Charge/credit to the profit and loss account for bad and doubtful debts
Sum of Operational Costs	All the above operational costs		0.0	government and promoting to be and and coupling debts
Internal manpower costs	Employment costs		0.0	The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer
Capitalised cost of self-constructed assets	Negative allocation		0.0	The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets
Total Running Costs	Sum of Operationa Internal Manpower C capitalised cost constructed a	osts, minus of self-	0.0	

Comments:	

Appendix I

PIFastCalc Output Niagara Falls

	WATER BALANCE AND PERFORMANCE INDIC					Standard	Version 1a	2nd De	c 2005		anada	
_	ANNUAL WATER BALANCE CALCULATION IN IWA STANDAR			A STATE OF THE STA		Data entry	Defaults	Calculate	Calculated Values From		another Worksheet	
	Note:Calculations should be based on a 12-month period for all	aspects of the wo	rksheet to f	function correc	tly	Currency =	sc	Volume units	MI	and	m <sup>3</sup>	
Utility	City of Niagara Falls	Bulk supply (BS) or System (D		DS		01/01/2004	to	01/01/2005	-	days		
	Whole System	Do most custom storage tar		No		Calculation by	Steve	Genser	Date	Dec-06		
WATER BALANCE CALCULATIONS  WATER BALANCE  IWA Terminology  COMPONENTS OF WATER BALANCE					Volume in period	95%		FINANCIAL		NCE INDICATO	ORS FOR NON-	
P III	IWA Terminology				3500000	Confidence Limit as #/- %	Variance	% of System	Calculated	Value of NDW	as % of System	
å	COMPONENTS OF WATER BALANCE				MI			Input Volume		inning Costs in		
	WOS: Volume from Own Sources (corrected for known systemati	c errors)					0	0.0%	2	ini		
A	WI: Water Imported (corrected for known systematic errors)				15872.7	3.0%	59025	100.0%	Assessed marginal cost of individual components of Non- Rovenue Water	Value of Individual Non Revenue Wate	eten Eten	
	SIV: SYSTEM INPUT VOLUME				15872.7	3.0%	59025	100.0%	1000	t ind	% of cost of running system	
	BACE:Water Exported						0	0.0%	sod marginal co al components Rovenue Water	Be o		
	WS: WATER SUPPLIED = SIV - BACE				15872.7	3.0%	59025	100,0%	omp onne	N S		
A/B	BACM1: Billed Authorised Consumption: Metered		Total		13243.6	1.5%	10273	83.4%	Rove	d Unit		
	BACM2: Billed Authorised Consumption: Metered						0	0.0%	Mid	Assessed U		
	BACM3: Billed Authorised Consumption: Metered						0	0.0%	- E	Asse		
A	BACU: Billed Authorised Consumption:Unmetered						0	0.0%	\$C/m3	\$Cx1000	94	
	NRW: NON-REVENUE WATER				2629.1	19.6%	69297	16,6%	0,0000	0.0	0.0%	
A	UACM: Unbilled Authorised Consumption: Metered		0.00%	of WS			0	0.0%		0.0	0.0%	
D	UACU: Unbilled Authorised Consumption: Unmetered:	Estimated as	1,250%	of WS	198.4	100.0%	10247	1,3%		0.0	0.0%	
	WL WATER LOSSES				2430.7	22.7%	79545	15.3%	0.0000	0.0	0.0%	
D	UC: Unauthorised Consumption:	Estimated as	0.250%	of WS	39.7	100.0%	410	0.3%	0.505.555	0,0	0.0%	
BVC	ALMUR1: Apparent Loss - meter under-registration:	Total	0.60%	of BACM1	79.9	7.0%	8	0.5%		0,0	0.0%	
	ALMUR2: Apparent Loss - meter under-registration:			of BACM2	0.0		0	0.0%		0.0	0.0%	
	ALMUR3: Apparent Loss - meter under-registration:		1	of BACM3 and UACM	0.0		0	0.0%		0.0	0.0%	
D	ALDCD Customer meter data handling errors		12				0	0.0%		0.0	0.0%	
	AL: Sum of APPARENT LOSSES				119.6	33,5%	418	0.8%	0.0000	0.0	0.0%	
	RL: REAL LOSSES				2311.1	24.0%	79963	14.6%	2,0000	0.0	0.0%	
A	% of period system pressurized =	100.0%	365.0	days			The second state of	running system		0.0	5Cx1000	

Process Reliability Band	SYSTEM INFRASTRUCTURE AND PRESSURE D	DATA	Valid for UARL& ILI calc?	95% CLs as 4/- %
A	Lm: Mains Length, km	498.00	Yes	1.0%
A	Nh: Number of Fire Hydrants	2775		1.0%
A/B	Nb: Number of Separately Billed Properties	27224		2.0%
A/B	R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb)	1.000		2.0%
- 1	Ns: No. of billed Service Connections	27224		2.8%
С	Nu: Number of Unbilled Service Connections			
	Nt: Total Number of Service Conns (# Ns + Nu), mains to property line	27224	Yes	2.8%
	DC: Density of Connections/ km of mains = Ns/Lm	54.7		3.0%
B/C	Lp: Average pipe length, property line to meter (m)	18.0		50.0%
	Lp: Total pipe length, property line to meter (km)	490.03		50,1%
В	P: Average pressure when system pressurised (psi)	93,5		20.0%
	P: Average pressure when system pressurised (m)	66,1	Yes	20.0%

ASSESSMENT OF UNAVOID POTENTIA	DABLE REAL	LOSSES, AN	D VOLUME AT	ND COST OF
Notes: If Lm and Lp are in	km	and pres	sure P is in	metres
UBL in litres/hour =	(20 x Lm	+ 1.25 x Nt +	33 x Lp) x	(P/50) <sup>1.5</sup>
UARL in litres/day =	(18 x Lm -	+ 0.8 x Nt +	25 x Lp) x	Р
COMPONENT OF REAL LOSSES	MI per day	MI In period	\$Cx1000 in period	95% CLs as 4/ %
UBL: UNAVOIDABLE BACKGROUND LEAKAGE	2.20	803		34.5%
UARL: UNAVOIDABLE ANNUAL REAL LOSSES	2.84	1037		24.6%
CARL: CURRENT ANNUAL REAL LOSSES	6,33	2311		24.0%
POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL	3.49	1274		47.9%

IWA BEST PRACTICE PERFORMANCE INDI	CATOR	UNITS OF PERFORMANCE INDICATOR	Best estimate	95% CLs as +/- %	Lowest Estimate	Highest Estimate
Non Revenue Water Basic (IWA Level 1, F	in36)	% of System Input by Volume	16.6	19.9%	13.3	19,9
Non Revenue Water Basic (IWA Level 1, F	in37)	% of System Input by Value		19.9%	161.050	
Apparent Losses (IWA Op23)	Best Op23 Pl >	% of Water Supplied (Distribution Systems)	0.8	33.6%	0.5	1.0
The state of the space		% of System Input Volume (Bulk Supply Systems)	0.8	33.6%	0.5	1.0
Real Losses Basic (IWA Level 1, Op24)	Best Op24 PI >	Litres/service connection/day, when system pressurised	233	24.1%	176	289
2000 (000 000 000 000 000 000 000 000 00		m3/km of mains/day, when system pressurised	12.7	24.0%	9.7	15.8
Real Losses Detailed (IWA Level 3, Op	25)	Infrastructure Leakage Index ILI (non-dimensional)	2.23	34.4%	1.46	2.99

Suppy via Regional Municipality of Niagara meters 1T1, 1T2, 1D1, 1D2, 1D3, and 1D4.

Accuracy reports provided for:

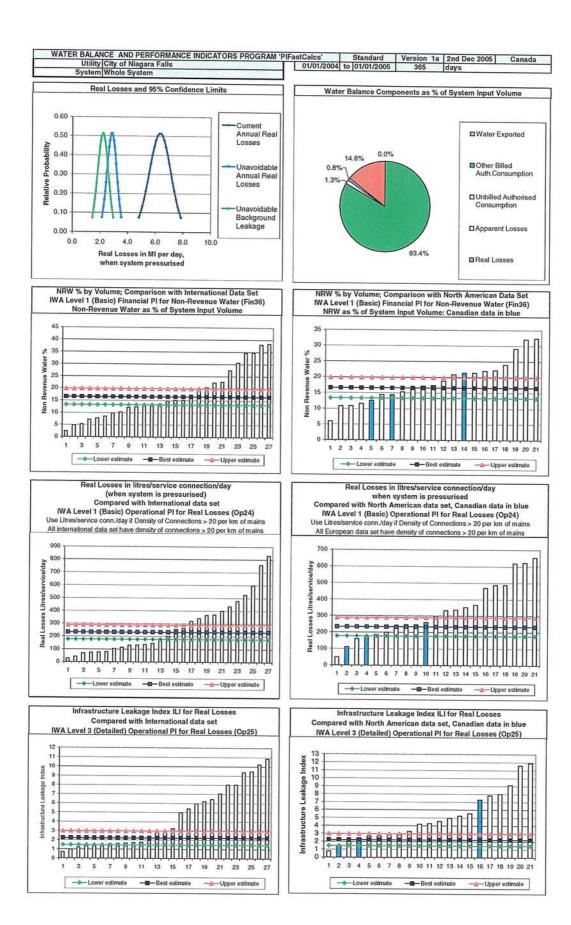
1D1 - May 4, 2005 and October 13, 2005 1D2 - May 4, 2005 1D3 - May 20, 2005 1D4 - May 4, 2005 tested and repaired: then replaced on October 13, 2005

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

No costs for operating the system provided.

Mat I		WATE	WATER BALANCE	AND PE	ERFORMAI	NCE INDI	CATORS PRC	AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'	Calcs'		
Matter of Line   1970   1970   1970   2   2   2   2   2   2   2   2   2	DETAILED CALCULATION OF COMPOR	NENTS OF A	JTHORISED AND	O UNAUTHO	RISED CONSU	MPTION		Data entry	Calculated Val		om another Worksho
State   Components in MI   Com	Utility City of Niagara Falls	BILL STREET					01/01/2004 to	ш			
Metered   Unmetered   Unbilled   Unbilled   Unbilled   Unmetered	System Wildle System						Calculation by			Da	te
Billed Unmotered Metered Unmotered Unmotered Unmotered Unmotered Unmotered Unmotered Unmotered Unmotered Unmotered Consumption =		Ш	Components in	MI			Addi	tional information or	n sources of data	and basis	of estimates
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	omponents of Authorised Consumption		Billed	Unbilled	Unbilled	Total		= 8	E = estimated	900	
0.00 0.00 0.00 0.00 Multiplied Unmetered Consumption =						00'0				C. C.	
0.00 0.00 0.00 0.00 MM lifed Unmetered Consumption =						00:00					
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00:00					
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00:00					
0.00 0.00 0.00 0.00 MM						0.00					
0.00 0.00 0.00 Multiplied Unmetered Consumption =						0.00					
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00.00					
0.00 0.00 0.00						000					
0.00 0.00 0.00 Multiplied Unmetered Consumption =						0000					
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						000					
0.00 0.00 0.00						0000					
0.00 0.00 0.00 Multiplied Unmetered Consumption =						00.0					
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00.00					
0.00 0.00 0.00 0.00 MI Munetered Consumption =						00.00					
0.00 0.00 0.00 Multiplied Unmetered Consumption =						00:00					
0.00 0.00 0.00 0.00 MI						00.00					
0.00 0.00 0.00 0.00 MI Munotered Consumption =						00.00					
0.00 0.00 0.00 Multiplied Unmetered Consumption =						00.00					
0.00 0.00 0.00 0.00 MI						00.00					
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00.00					
0.00 0.00 0.00 Nm eld Unbilled Unmetered Consumption =						0.00					
0.00 0.00 0.00 0.00 MI						0.00					
0.00 0.00 0.00 0.00 Nmetered Consumption =						00.00					
0.00 0.00 0.00 0.00 MI						00.00					
0.00 0.00 0.00 0.00 MI						0.00					
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						000					
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						000					
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00.00					
o.co   0.co   0.						00.0					
MI MI MINIBER Unmetered Consumption =	8	0.00	00:0	00.00	00:00	00:00	MI				
MI	Authorik	sed Unbilled	Unmetered Cons	= uoitduns	0.000%	of Water Sup	plied, transfer this	igure to Cell E21 of	WaterBalance&P	is' Workshe	oot
	nponents of Unauthorised Consumption						Mothod	an ideal			
							Depute	estilitation.			
Unauthorised consumption sub-totall 0.00 IMI	Unauthorised consumption sub-total		I KAI								



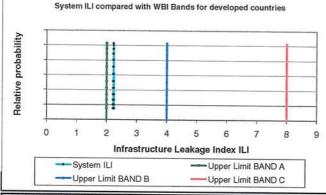
#### 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' **PIFastCalcs** Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | City of Niagara Falls

# THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES

## World Bank Institute (WBI) Guidelines

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

Countries	Developed Countries	BAND	Calculated ILI for this	General description of Real Loss Management Performance Categories for Developed and Developing  Countries
ILI range	ILI range		System	
Less than 4	Less than 2	Α		Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement
4 to < 8	2 to < 4	В	2.2	Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance
8 to < 16	4 to < 8	С		Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
16 or more	8 or more	D	10 8, 25, 15	Very inefficient use of resources; leakage reduction programs imperative and high priority



WBI Recommendations for BANDS	A	В	С	D
Investigate pressure management options	Yes	Yes	Yes	
Investigate speed and quality of repairs	Yes	Yes	Yes	
Check economic intervention frequency	Yes	Yes		
Introduce/improve active leakage control		Yes	Yes	
Identify options for improved maintenance		Yes	Yes	
Assess Economic Leakage Level	Yes	Yes		
Review break frequencies		Yes	Yes	
Review asset management policy		Yes	Yes	Yes
Deal with deficiencies in manpower, training and communications			Yes	Yes
5-year plan to achieve next lowest band			Yes	Yes
Fundamental peer review of all activities				Yes

GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003 Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and in

Target ILI Range	This System ILI	Water Resources Considerations	Operational Considerations	Financial Considerations
1.0 - 3.0	2.2	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability
3.0 - 5.0		Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population
5.0 - 8.0		Water resources are plentiful, reliable, and easily abstracted	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages	Cost to purchase or obtain/treat water is low, as are rates charged to customers
Greater than 8.0		Although operational and financial considera utilization of water as a resource. Setting a ta target - is discouraged.	tions may allow a long-term ILI greater than arget level greater than 8.0 - other than as an	8.0, such a level of leakage is not an effectiv incremental goal to a smaller long-term

Note: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalcs Standard software. This has allowed the development of the ELLCalcs standard software to calculate short-term Economic Leakage Level for an active

Important Footnote: the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The PressCalcs Standard Software provides more detailed information on this topic.

	'LEAKS' Suite of LEAKAGE I	EVALUATION and	ASS	ESSME	ENT KNOW	-HOW SOFTW	ΔRE	Tel es	S. F. L. 12.
	TEH BALANCE AND PERFORMANCE INDICATORS P	ROGRAM 'PIFastCalcs'			Version 1a		_	nada	Master.0000
1 lailia.	OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYST			Dat	a entry	Calculated Values	Fro	n anoth	er Worksheet
	City of Niagara Falls	01/01/2004	to		/2005	Number of Days in P	eriod	365	days
System	Whole System	Calculation	n by	Steve	Genser	Date of calculat	ion =	1	2/4/2006

Total running costs as calculated below = 0.0 | SCx1000 | Transfer this figure to Cell L30 of WaterBalance&Pis' Worksheet

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1

900222 27 2, IWA Publishing: this report should be consulted for further guidance as necessary.

Onesetian d Onese		Sub-total						
Operational Costs	Danumeter	\$Cx1000	\$Cx1000	INCLUDES				
Imported water	Raw water Treated water		0.0	BULK SUPPLY IMPORTS: total payments for imported raw water				
W. 157 HIDT	Raw water		1	BULK SUPPLY IMPORTS: total payments for imported treated water				
2724433.00.00.1	Treatment	ser support						
Energy	Transmission		0.0	POWER: all energy costs for water supply electricity and fuel for motive machiness				
120	Distribution			Sylvania in the state of the st				
	Outsourcing		SCX1000   BULK SUPPLY IMPORTS: total payments for imported raw water BULK SUPPLY IMPORTS: total payments for imported treated water					
e. v	Software licences	POWER: all energy costs for water supply electricity and fuel for motive costs of the cost						
External services:	and IT support		0.0	control lees on computer software and technical support by software companies				
Outsourcing	Associated			Costo of constitution of the constitution of t				
	Companies							
	Third party			Operating costs of providing water services to third parties (other than the regulated water				
	services			supply function) that are not included in other items				
	Premises		A THE WASHING	Payments for leasing or renting premises				
	Vehicles			Payments for leasing or renting vehicles				
Leasing and Rentals	Mobile Plant		0.0	Payments for leasing or renting mobile plant				
	Fixed Plant							
	Equipment							
	Wetertoon		UU.Saidelle	All water treatment chemicals for water supply that are not in HIDED AND CONTRACTED				
	Water treatment chemicals			SERVICES and which are required for operation of sources, treatment plants,transmission and				
Purchases	Other than		0.0					
	chemicals and			supply that are obtained by some than energy and water treatment chemicals for water				
	energy			supply, that are not in HIHED AND CONTHACTED SERVICES and which are required for				
Taxes, levies and			operation of sources, treatment plants, transmission and distribution systems  Any operating licences paid to a Government or municipal authority, abstraction cha authority rates  Any exceptional income or expenditure from donations, investment subsidies, comp					
fees	All kinds		0.0	Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates				
Exceptional earnings and losses	nal earnings  All kinds  All kinds  All kinds		Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets					
	Other direct costs			Any other operating costs (but excluding interest and taxation, on an aggregated basis)				
	General and support expenditures			The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded)				
Other Operating Expenditures	Customer services		0.0	Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling.				
	Scientific services			Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items				
	Other business activities			Costs directly associated with other business activities that are not included in previous items.				
	Doubtful debts			Charge/credit to the profit and loss account for bad and doubtful debts				
Sum of Operational Costs	All the above operational costs			g and the second of the second court of the se				
Internal manpower costs	Employment costs		0.0	The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer				
Capitalised cost of self-constructed assets	Negative allocation			The summation of the amounts in each of the above cost categories that have been incurred in				
Total Running Costs	Sum of Operationa Internal Manpower C capitalised cost constructed a	osts, minus of self-	0.0					

Comments:	

Appendix J

PIFastCalc Output Niagara-on-the-Lake

				PIFastCalc		Standard	Version 1a	2nd De	0 2005		Canada
	ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD	D FORMAT, WITH	95% CONFI	DENCE LIMITS		Data entry	Defaults	Calculate	d Values	From ano	ther Worksheet
	Note:Calculations should be based on a 12-month period for all	aspects of the wo	rksheet to f	function correc	tly	Currency =	\$C	Volume units	MI	and	m <sup>3</sup>
Utility	Town of Niagara-on-the-Lake	Bulk supply (BS) or System (D		DS		01/01/2005	to	01/01/2006		365	days
-	Whole System	Do most custon storage tar		No		Calculation by	Steve (	Genser	Date	4	Dec-06
Process Reliability Band	WATER BALANCE CALCULA	TIONS			Volume in period	95%	Supply to the same of the same	FINANCIAL		NCE INDICATO	ORS FOR NON-
Pro la la	IWA Terminology				1000000	Confidence Limit as +/- %	Variance	% of System	Calculated	Value of NRW	as % of System
	COMPONENTS OF WATER BALANCE				MI			Input Volume		nning Costs is	
	WOS: Volume from Own Sources (corrected for known systematic	c errors)					0	0.0%	ė	ator	
_	WI: Water Imported (corrected for known systematic errors)				3193.6	6.0%	9498	100.0%	100	Value of Individual Non Revenue Water	eystem
_	SIV: SYSTEM INPUT VOLUME				3183.6	6.0%	9498	100.0%	l cos	of Ind	60
_	BACE:Water Exported						0	0.0%	one ove	Value o	lean
_	WS: WATER SUPPLIED = SIV - BACE				3183.6	6.0%	9498	100.0%	sed marginal cial components Revenue Water	2 2	cost of running
B/C	BACM1: Billed Authorised Consumption: Metered		Total		3225.0	1.5%	609	101.3%	No.	D at	of cost
	BACM2: Billed Authorised Consumption: Metered					1	0	0.0%	Asso	Assessed marginal cost of individual components of Non Revanue Water Assessed Unit Value of Individual components of Non Revenue Wa	
_	BACM3: Billed Authorised Consumption: Metered						0	0.0%	Ē	Ass	28
D	BACU: Billed Authorised Consumption:Unmetered						0	0.0%	\$C/m3	\$Cx1000	*4
	NRW: NON-REVENUE WATER				-41.5	475,2%	10107	-1.3%	0,0000	0.0	0.0%
A	UACM: Unbilled Authorised Consumption: Metered		0.00%	of WS			0	0.0%	NI CONTRACTOR IN	0.0	0.0%
D	UACU: Unbilled Authorised Consumption: Unmetered:	Estimated as	1.250%	of WS	39.8	100.0%	412	1.3%		0,0	0.0%
1	WL WATER LOSSES				-81.3	-247.4%	10519	-2.6%	0.0000	0.0	0.0%
D	UC: Unauthorised Consumption:	Estimated as	0.250%	of WS	8.0	100.0%	16	0.3%		0.0	0.0%
B/C	ALMUR1: Apparent Loss - meter under-registration:	Total	0.60%	of BACM1	19.5	7.0%	0	0.6%		0.0	0.0%
ALMUR2: Apparent Loss - meter under-registration: of BACM:					0.0		0	0.0%		0.0	0.0%
1	ALMUR3: Apparent Loss - meter under-registration:			of BACM3 and UACM	0.0		0	0.0%		0.0	0.0%
D	ALDCD Customer meter data handling errors						0	0.0%		0.0	0.0%
4	AL: Sum of APPARENT LOSSES				27.4	29.4%	17	0,9%	0,0000	0,0	0.0%
F	RL: REAL LOSSES				-108.7	-185.1%	10536	-3.4%		0.0	0.0%
A	% of period system pressurized =	100,0%	365.0	days			Cost of	running system	in period -		\$Cx1000

Process Reliability Band	SYSTEM INFRASTRUCTURE AND PRESSURE DA	<u>TA</u>	Valid for UARL& ILI calc?	95% CLs as +/- %
Α	Lm: Mains Length, km	224.24	Yes	1.0%
A	Nh: Number of Fire Hydrants	1080	-	1.0%
A/B	Nb: Number of Separately Billed Properties	5306	9	2.0%
В	R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb)	1.000	J i	2,0%
	Ns: No. of billed Service Connections	5306	B ()	2.8%
C	Nu: Number of Unbitted Service Connections	0		
	Nt: Total Number of Service Conns (= Ns + Nu), mains to property line	5306	Yes	2.8%
	DC: Density of Connections/km of mains = Ns/Lm	23.7	E .	3.0%
В	Lp: Average pipe length, property line to meter (m)	8.5		25.0%
	Lp: Total pipe length, property line to meter (km)	45.10		25.2%
С	P: Average pressure when system pressurised (psi)	73.0	200	40.0%
	P: Average pressure when system pressurised (m)	51.6	Yes	40,0%

Notes: If Lm and Lp are in	km	and pres	sure P is in	metres
UBL in litres/hour =	(20 x Lm +	1.25 x Nt +	33 x Lp) x	(P/S0) <sup>1.5</sup>
UARL in litres/day =	(18 x Lm +	0.8 x Nt +	25 x Lp) x	P
COMPONENT OF REAL LOSSES	MI per day	MI In period	\$Cx1000 in period	95% CLs as +/
UBL: UNAVOIDABLE BACKGROUND LEAKAGE	0.32	116		60.1%
UARL: UNAVOIDABLE ANNUAL REAL LOSSES	0.49	177		40.1%
CARL: CURRENT ANNUAL REAL LOSSES	-0.30	-109		-185,1%
POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL	-0.78	-286		-74.6%

IWA BEST PRACTICE PERFORMANCE IND	CATOR	UNITS OF PERFORMANCE INDICATOR	Best estimate	95% CLs as +/- %	Lowest Estimate	Highest Estimate
Non Revenue Water Basic (IWA Level 1,	-In36)	% of System Input by Volume	-1.3	475.2%	4.9	-7.5
Non Revenue Water Basic (IWA Level 1,	Fin37)	% of System Input by Value		475.2%	STREET	
Apparent Losses (IWA Op23)	Best Op23 Pl >	% of Water Supplied (Distribution Systems)	0.9	30.0%	0.6	1.1
		% of System Input Volume (Bulk Supply Systems)	0.9	30.0%	0.6	1.1
Real Losses Basic (IWA Level 1, Op24)	Best Op24 Pt >	Litres/service connection/day, when system pressurised	-56	185,1%	48	-160
tion court (in ceres i, open)		m3/km of mains/day, when system pressurised	-1.3	185,1%	1.1	-3.8
Real Losses Detailed (IWA Level 3, Op	25)	Infrastructure Leakage Index ILI (non-dimensional)	-0.61	189,4%	0.66	-1.77

Water Supplied by Niagara Region from both Decew Falls system (505, 506 & 509) as well as Niagara Falls WTP (101, 102, 103, 104). Calibration reports provided as follows:

SD5, SD6 - May 20, 2005
SD9 - no report
1D1, 1D2 - May 4, and October 13, 2005
1D3 - August 10, and November 1, 2005
1D4 - May 4 and October 13, 2005 - problematic meter at its highest accounted for 6% of overall supply.

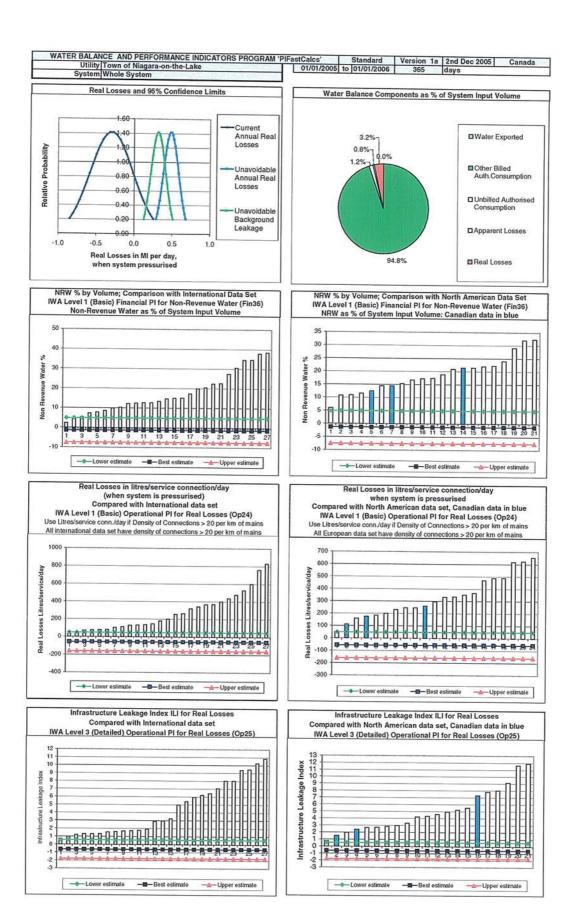
Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

No costs for operating the system provided.

Part		WATER	RAI ANCE	AND DE	PEDBMAN	JOH HOL	CATODO DDA	CONT. DIESE	les les		
Second Components   Material	DETAIL ED CALCIII ATION OF COMBON	MENTS OF A	TODICE ON		E CONTROLLE	NOE INDI	טחיו פחטואי	GRAIN PIFASI	Calcs		
Components in Material   Material   Unmetered   Unme	DEI AILED CALCOLATION OF COMPOR	NENIS OF AU	THORISED AND	UNAUTHOR	SISED CONSUM	APTION		Data entry	Calculated	Values	From another Workshe
Billied   Unmetered   Unbilled   Unmetered   Unmeter	System Whole System						01/01/2005 to Calculation by			ays	Date
Billied   Unbilled   Unbilled   Unbilled   Unbilled   Unbilled   Unbilled   Unbilled   Unbilled   Unmetered   0.00   0.			Componente in	MI						1	
Metered   Unmetered   Metered   Unmetered   Unmetere	Components of Authorised Consumption		Billed	Unbilled	Unbilled	Total	Addi	tional information o	n sources of c	lata and ba	asis of estimates
sub-totals sub-totals sub-totals sub-totals sub-totals sub-totals sub-totals sub-totals sub-totals		Metered	Unmetered	Metered	Unmetered	10000		æ	Based on reco	rdings	
sub-totals sub-totals  Sub-totals  Sub-totals  Sub-totals  Sub-totals  Sub-totals  Sub-totals  Sub-totals						00:0					
sub-totals 0.00 MI						00:00					
sub-totals  sub-totals  sub-totals  sub-totals  sub-total  sub-total  sub-total						00.0					
sub-totals						00.00					
aub-totals 0.00 0.00 0.00 sub-totals 0.00 MM						0.00					
sub-totals  Surb-totals  Surb-totals  Surb-totals  Surb-total  Surb-total  Surb-total  Surb-total  Surb-total						0.00					
sub-totals sumption MI sub-totals o.00 Authorised Unbilled Unmetered Consumption =						0.00					
sub-totals 0.00 0.00 0.00 authorised Unbilled Unmetered Consumption sub-total 0.00 MI						00.0					
sub-totals  Sub-totals  MI  Sub-totals  MI  Sub-totals  O,00 MI						00.0					
sub-totals  Sumption  MI  Sub-totals  O.00  O.00  O.00  O.00  O.00  Authorized Unbilled Unmetered Consumption = Supplied In Material Consumption = Supplied						00.0					
sub-totals 0.00 0.00 0.00 authorised Unbilled Unmetered Consumption sub-total 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.						0000					
sub-totals  Surbricials  Surption  MI  Sub-total  Sub-total  O,00 MI						00.0					
sub-totals 0.00 0.00 0.00 sub-totals 0.00 0.00 0.00 authorised Unbilled Unmetered Consumption = sup-total 0.00 Mi						0000					
sub-totals 0.00 0.00 0.00 authorised Unbilled Unmetered Consumption sub-total 0.00 MI						0000					
sub-totals  Surbriotal  Surbriotal  Surb-totals  Sub-total  Sub-total  Sub-total  O,00 MI						000					
sub-totals 0.00 0.00 0.00 sub-totals 0.00 0.00 0.00 authorised Unbilled Unmetered Consumption = supption of the consumption of						000					
sub-totals 0.00 0.00 0.00 authorised Unbilled Unmotered Consumption sumption MI						0000					
sub-totals 0.00 0.00 0.00 0.00 authorised Unbilled Unmetered Consumption = sub-total 0.00 MI						000					
sub-totals 0.00 0.00 0.00 sub-totals 0.00 MM						000					
sub-totals 0.00 0.00 0.00 authorised Unbilled Unmetered Consumption supplied In Institute Institution						000					
sub-totals 0.00 0.00 0.00 0.00 authorised Unbilled Unmetered Consumption =						000					
sub-totals 0.00 0.00 0.00  Authorised Unbilled Unmetered Consumption = sumption = sumption = sumption = sumption = sub-total 0.00 MI						000					
sub-totals 0.00 0.00 0.00 0.00 aub-totals 0.00 MI						000					
sub-totals 0.00 0.00 0.00 0.00 authorised Unbilled Unmetered Consumption = sumption MI						000					
aub-totals 0.00 0.00 0.00 authorised Unbilled Unmetered Consumption = sumption MI						000					
sub-totals 0.00 0.00 0.00 0.00 aumption = sumption MI						0000					
Authorised Unbilled Unmetered Consumption = sumption   MI						000					
Sumption MI Consumption MI Sub-totals 0.00 0.00 0.00 0.00 ann patient MI Sub-total 0.00 MI						0000					
Surh-totals 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.						00.0					
Authorised Unbilled Unmetered Consumption = sumption   MI					580	00:00					
Sumption MI Manupage Consumption = sumption MI MI Manupage MI	8	00'0	00'0	00.00	00:00	0.00	IV				
sumption MI sub-total 0.00 MI	Authoris	sed Unbilled L	Jnmetered Cons	umption =	0.000%	f Water Supp	olied, transfer this f	igure to Cell E21 of	WaterBalance	&Pis' Wor	ksheet
sub-total	nponents of Unauthorised Consumption						Mostock of	1			
sub-total							D POINGH	Ilonomia			
sub-total											
sub-total											
sub-total											
	Unauthorised consumption sub-total		MI IM								



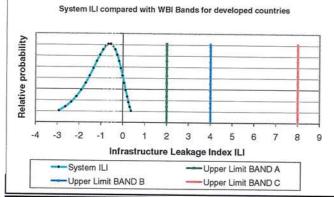
#### 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' **PIFastCalcs** Standard Version 1a 2nd Dec 2005 Canada Master.0000 Town of Niagara-on-the-Lake

# THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES

## World Bank Institute (WBI) Guidelines

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

Developing Countries	Developed Countries	BAND	Calculated ILI for this	General description of Real Loss Management Performance Categories for Developed and Developing
ILI range	ILI range		System	Countries
Less than 4	Less than 2	А	-0.6	Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement
4 to < 8	2 to < 4	В		Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance
8 to < 16	4 to < 8	С		Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
16 or more	8 or more	D		Very inefficient use of resources; leakage reduction programs imperative and high priority



WBI Recommendations for BANDS	A	В	С	D
Investigate pressure management options	Yes	Yes	Yes	
Investigate speed and quality of repairs	Yes	Yes	Yes	
Check economic intervention frequency	Yes	Yes		
Introduce/improve active leakage control		Yes	Yes	
Identify options for improved maintenance		Yes	Yes	
Assess Economic Leakage Level	Yes	Yes		
Review break frequencies		Yes	Yes	
Review asset management policy		Yes	Yes	Yes
Deal with deficiencies in manpower, training and communications			Yes	Yes
5-year plan to achieve next lowest band			Yes	Yes
Fundamental peer review of all activities				Yes

GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003 Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control

policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the

Target ILI Range	This System ILI	Water Resources Considerations	Operational Considerations	Financial Considerations
1.0 - 3.0	-0.6	unsound to develop	infrastructure and/or additional water	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability
3.0 - 5.0		management.water conservation) are	demand as long as reasonable leakage management controls are in place	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population
5.0 - 8.0				Cost to purchase or obtain/treat water is low, as are rates charged to customers
Greater than 8.0		Although operational and financial considera utilization of water as a resource. Setting a tatarget - is discouraged.	rions may allow a long-term ILI greater than arget level greater than 8.0 - other than as an	8.0, such a level of leakage is not an effectiv incremental goal to a smaller long-term

Note: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalcs Standard software. This has allowed the development of the ELLCalcs standard software to calculate short-term Economic Leakage Level for an active

Important Footnote: the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The PressCalcs Standard Software provides more detailed information on this topic.

	'LEAKS' Suite of LEAKAGE E	VALUATION and	455	SESSME	ENT KNO	M HOM COLLIN	ADE		
	ER BALANCE AND PERFORMANCE INDICATORS PI	ROGRAM 'PIFastCalcs'		Standard	Version 1a		1		Master.0000
Hattle	OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYST	EM RUNNING COSTS		Dat	a entry	Calculated Values			or Worksheet
	Town of Niagara-on-the-Lake Whole System	01/01/2005	to		1/2006	Number of Days in P			days
System	Whole System	Calculatio	n by	Steve	Genser	Date of calcula	ion =	12	2/4/2006

Total running costs as calculated below = 0.0 \$Cx1000 Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing: this report should be consulted for further guidance as necessary.

0		Sub-total	Group total	
Operational Costs	Demonstra	\$Cx1000	\$Cx1000	INCLUDES
Imported water	Raw water		0.0	BULK SUPPLY IMPORTS: total payments for imported raw water
	Treated water Raw water			BULK SUPPLY IMPORTS: total payments for imported treated water
W	Treatment		the supplier	
Energy	Transmission		0.0	POWER: all energy costs for water supply electricity and fuel for motive machinery
11000	Distribution		Marie Control	and the notice machinery
	Distribution			
	Outsourcing			Outsourcing of technical or administrative services, such as consultants, contractors undertaking
	Coffee Vice			operational tasks, meter reading and accounting fees
External services:	Software licences and IT support			Licence fees on computer software and technical support by software companies
Outsourcing			0.0	and technical support by software companies
Odisoulding	Associated			Costs of associated companies that are not included in other items
	Companies			
	Third party			Operating costs of providing water services to third parties (other than the regulated water
	services			supply function) that are not included in other items
	Premises			Payments for leasing or renting premises
Lancing and Doutel	Vehicles			Payments for leasing or renting vehicles
Leasing and Rentals			0.0	Payments for leasing or renting mobile plant
	Fixed Plant		THE STREET	Payments for leasing or renting fixed plant
	Equipment			Payments for leasing or renting equipment
	Water treatment			All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED
	chemicals			SERVICES and which are required for operation of sources, treatment plants, transmission and
Purchases	Otherston		0.0	distribution systems
	Other than		(2000)	All materials and consumables other than energy and water treatment chemicals for water
	chemicals and			supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for
Taxes, levies and	energy		THE BUSY	operation of sources, treatment plants, transmission and distribution systems
fees	All kinds		0.0	Any operating licences paid to a Government or municipal authority, abstraction charges, local
iees				authority rates
Exceptional earnings and losses	All kinds		0.0	Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets
	Other direct costs			Any other operating costs (but excluding interest and taxation, on an aggregated basis)
	General and			
	support			The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs
	expenditures			excluded)
				Costs directly associated with customer services that are not included in previous items, related
Other Operating	Customer services		0.0	to customer accounting, reading of meters, debt revovery, costs of disconnections,
Expenditures				customers'enquiries and complaints handling.
				Costs directly associated with scientific and laboratory services and with the monitoring of quality
1	Scientific services			that are not included in previous items
	Other business			Costs directly associated with other business activities that are not included in previous items.
	activities			except for cost depreciation
	Doubtful debts			Charge/credit to the profit and loss account for bad and doubtful debts
Sum of Operational	All di L		ATTAWASTINE	overgote date the profit and loss account for bad and doubtful debts
Costs	All the above	- 1	0.0	
Costs	operational costs	- 1		
Internal manpower				The arm of the total
costs	Employment costs		0.0	The sum of the total manpower costs of permanent and temorary personnel, including
				employment-related social costs and benefits paid by the employer
Capitalised cost of	Negative			The summation of the amounts in each of the above cost categories that have been incurred in
self-constructed	allocation		0.0	the construction of new or rehabilitated assets
assets				and defined of them of remadilitated assets
	Sum of Operational	costs and	15V 6 3 5 5 7	
Total Running	Internal Manpower Co			
Costs	capitalised cost of		0.0	

C	Comments:	

Appendix K

PIFastCalc Output Pelham

	WATER BALANCE AND PERFORMANCE INDICA					Standard	Version 1a	2nd De	c 2005	(	Canada
	ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD F	ORMAT, WITH	95% CONFI	DENCE LIMITS		Data entry	Defaults	Calculate	d Values	From and	ther Worksheet
	Note: Calculations should be based on a 12-month period for all asp	pects of the wo	rksheet to f	unction correc	tiy	Currency =	\$C	Volume units	MI	and	m <sup>3</sup>
Utility	Town of Pelham But	lk supply (BS) or System (D		DS		01/01/2005	to	01/01/2006	*	365	days
System	Whole System D	Do most custon storage tar		No		Calculation by	Steve	Genser	Date	8	-Feb-07
Process lability Band	WATER BALANCE CALCULATION	ONS			Volume in period	95%	CONFICUENCY.	FINANCIAL		ICE INDICATI	ORS FOR NON-
Proces	IWA Terminology				ponou	Confidence Limit as +/- %	Variance	% of System	Calandaria		
Bel	COMPONENTS OF WATER BALANCE				MI			Input Volume	Rui	nning Costs i	as % of Syste n Period
	WOS: Volume from Own Sources (corrected for known systematic er	rrors)					0	0.0%	-	7 5	
A	WI: Water Imported (corrected for known systematic errors)				1722.2	3.0%	695	100.0%	Non	Nidu W	mots
	SIV: SYSTEM INPUT VOLUME				1722.2	3.0%	695	100.0%	Assessed marginal cost of individual components of Non- Revenue Water	Value of Individual Non Revenue Wate	cost of running system
	BACE:Water Exported						0	0.0%	sed marginal c ral components Revenue Water	Be	n in
	WS: WATER SUPPLIED = SIV - BACE				1722.2	3.0%	695	100.0%	omp	2 8	- 5
A/B	BACM1: Billed Authorised Consumption: Metered	To	tal Billed		1440.4	1.5%	122	83,6%	Reve	ute o	100
	BACM2: Billed Authorised Consumption: Metered						0	0.0%	lvidt	ndividual components of Non- Revenue Water Assessed Unit Value of Individual components of Non Revenue Water	2
	BACM3: Billed Authorised Consumption: Metered						0	0.0%	Ē		
A	BACU: Billed Authorised Consumption:Unmetered						0	0.0%	\$C/m3	5Cx1000	*
	NRW: NON-REVENUE WATER	REVENUE WATER					816	16.4%	0,4637	130.7	12.7%
A	UACM: Unbilled Authorised Consumption: Metered		0,00%	of WS			0	0.0%	0,4460	0.0	0.0%
D	UACU: Unbilled Authorised Consumption: Unmetered:	Estimated as	1.250%	of WS	21.5	100.0%	121	1.3%	0,4460	9,6	0.9%
	WL WATER LOSSES				260.3	23.1%	937	15.1%	0.4652	121.1	11,7%
D	UC: Unauthorised Consumption:	Estimated as	0.250%	of WS	4.3	100.0%	5	0.3%	0.8300	3.6	0.3%
	ALMUR1: Apparent Loss - meter under-registration:	otal Billed	0.60%	of BACM1	8.7	7.0%	0	0,5%	0.8300	7.2	0.7%
	ALMUR2: Apparent Loss - meter under-registration:			of BACM2	0.0		0	0.0%		0.0	0.0%
	ALMUR3: Apparent Loss - motor under-registration:			of BACM3 and UACM	0.0		0	0.0%		0.0	0.0%
	ALDCD Customer meter data handling errors						0	0.0%	0.8300	0.0	0.0%
	AL: Sum of APPARENT LOSSES				13.0	33,4%	5	0.8%	0.8300	10.8	1.0%
	RL: REAL LOSSES				247.3	24.3%	942	14.4%	0.4460	110.3	10.7%
	% of period system pressurized =	100.0%	365.0	days			247	running system	780100	1031.7	\$Cx1000

Process Reliability Band	SYSTEM INFRASTRUCTURE AND PRESSURE DA	TA	Valid for UARL& ILI calc?	95% CLs as 4/- %
A	Lm: Mains Longth, km	68,66	Yes	- 1.0%
A	Nh: Number of Fire Hydrants	438		1,0%
A/B	Nb: Number of Separately Billed Properties	4237	- 1	2.0%
A/B	R: Ratio of billod Service Connections (Ns, main to property line) to Billod Props (Nb)	1.000		2.0%
	Ns: No. of billed Service Connections	4237	U (	2,8%
C	Nu: Number of Unbilled Service Connections	4		25.0%
	Nt: Total Number of Service Conns (= Ns + Nu), mains to property line	4241	Yés	2,8%
	DC: Density of Connections/ km of mains = Ns/Lm	61.8		3.0%
В	Lp: Average pipe length, property line to meter (m)	10.2		2,4%
	Lp: Total pipe length, property line to meter (km)	43,22		3.7%
A/B	P: Average pressure when system pressurised (psi)	69,0		5.0%
	P: Average pressure when system pressurised (m)	48.8	You	5.0%

Notes: If Lm and Lp are in	km	and pres	sure Pisin	motros
UBL in litres/hour =	(20 x Lm +	1.25 x Nt +	33 x Lp) x	(P/50) <sup>1.5</sup>
UARL in litres/day =	(18 x Lm +	0.8 x Nt +	25 x Lp) x	Р
COMPONENT OF REAL LOSSES	MI per day	MI In period	\$Cx1000 in period	95% CLs as +/
UBL: UNAVOIDABLE BACKGROUND LEAKAGE	0.19	68	30,5	7.7%
UARL: UNAVOIDABLE ANNUAL REAL LOSSES	0.28	102	45.3	5.3%
CARL: CURRENT ANNUAL REAL LOSSES	0.68	247	110.3	24,3%
POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL	0.40	146	65.0	41.5%

IWA BEST PRACTICE PERFORMANCE INC	CATOR	UNITS OF PERFORMANCE INDICATOR	Bost estimate	95% CLs as +/- %	Lowest Estimate	Highest Estimate
Non Revenue Water Basic (IWA Level 1,	Fin36)	% of System Input by Volume	16.4	20.1%	13,1	19.7
Non Revenue Water Basic (IWA Level 1,	Fin37)	% of System Input by Value	12.7	20.1%	10.1	15.2
Apparent Losses (IWA Op23)	Best Opz3 Pt 5	% of Water Supplied (Distribution Systems)	0.8	33.6%	0.5	1.0
		% of System Input Volume (Bulk Supply Systems)	0.8	33.6%	0.5	1.0
Real Losses Basic (IWA Level 1, Op24)	Best Op24 PI >	Litres/service connection/day, when system pressurised	160	24.5%	121	199
, open		m3/km of mains/day, when system pressurised	9.9	24.3%	7.5	12.3
Real Losses Detailed (IWA Level 3, O	25)	Infrastructure Leakage Index ILI (non-dimensional)	2.43	24.9%	1.83	3.04

Comment	a.
COMMITTEE	-

Region billing equation = 3D1 + 3D2

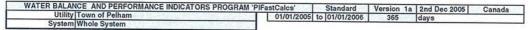
No Calibration Reports.

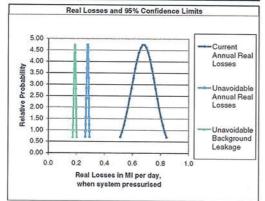
Process Reliability Bands:

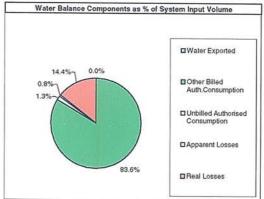
A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

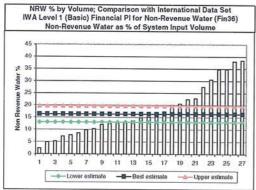
Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

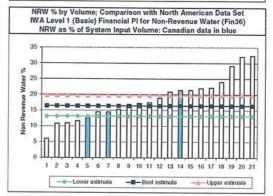
	WATER	BALANCE	AND PI	ERFORMA	ICE INDI	WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'	GRAM 'PIFas	tCalcs'	ľ	
DETAILED CALCULATION OF COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION	VENTS OF AU	THORISED AND	DUNAUTHO	RISED CONSU	APTION		Data entry	Calculated Values	Values	From another Worksheet
Utility Town of Pelham						o1/01/2005 to	- 01/01/2008	365   45	conin and	TOTAL STREET,
System Whole System	Contract of					Calculation by	1 1	- -	2	Date
3 200 00 2000		Components in	MI			Addi	Additional information on sources of data and basis of estimates	on sources of da	ata and ba	isis of estimates
Components of Authorised Consumption	Billed	Billed	Unbilled	Unbilled	Total		a a	E = estimated	rdinge	
					00.00			Dog III Dog	chin	
					0000					
					0.00					
					00.00					
					00'0					
					00.00					
					0000					
					00.00					
					0.00					
					00.00					
					0000					
					0000					
					00.00					
					00:00					
					0.00					
					0.00					
					00.0					
					00:00					
					00:00					
			A		00.00				ì	
					0.00					
					00.00					
					000				ľ	
					0.00					
					00.00					
					800					
Authorised consumption sub-totals	00.0	00.00	00.0	00.00	0.00 M	W.				
Authoris	sed Unbilled L	Authorised Unbilled Unmetered Consumption =	= noitdwns	0.000%	of Water Sup	olied, transfer this	0.000% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet	f 'WaterBalance	&Pis' Wo	rksheet
Components of Unauthorised Consumption	IW					Method of	Method of estimation			
Unauthorised consumption sub-total	MI 00.00	M								

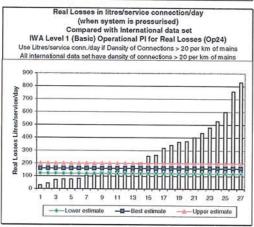


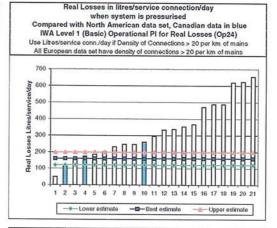


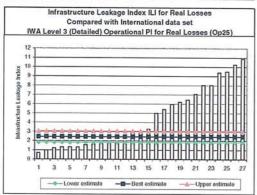


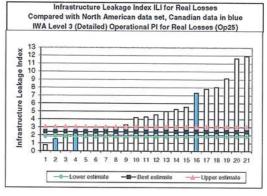












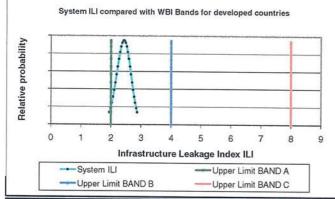
# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | Town of Pelham

# THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES

# World Bank Institute (WBI) Guidelines

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

	Developed Countries	BAND	Calculated ILI for this	General description of Real Loss Management Performance Categories for Developed and Developing
ILI range	ILI range		System	Countries
Less than 4	Less than 2	А		Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement
4 to < 8	2 to < 4	В		Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance
8 to < 16	4 to < 8	С		Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
16 or more	8 or more	D		Very inefficient use of resources; leakage reduction programs imperative and high priority



WBI Recommendations for BANDS	A	В	С	D
Investigate pressure management options	Yes	Yes	Yes	
Investigate speed and quality of repairs	Yes	Yes	Yes	
Check economic intervention frequency	Yes	Yes		
Introduce/improve active leakage control		Yes	Yes	
Identify options for improved maintenance		Yes	Yes	
Assess Economic Leakage Level	Yes	Yes		
Review break frequencies		Yes	Yes	
Review asset management policy		Yes	Yes	Yes
Deal with deficiencies in manpower, training and communications			Yes	Yes
5-year plan to achieve next lowest band			Yes	Yes
Fundamental peer review of all activities				Yes

GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed countries, the

Target ILI Range	This System ILI	Water Resources Considerations	Operational Considerations	Financial Considerations
1.0 - 3.0	2.4	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop	infrastructure and/or additional water	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability
3.0 - 5.0		Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population
5.0 - 8.0		Water resources are plentiful, reliable, and easily abstracted	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages	Cost to purchase or obtain/treat water is low, as are rates charged to customers
Greater than 8.0		Although operational and financial considera utilization of water as a resource. Setting a to target - is discouraged.	tions may allow a long-term ILI greater than arget level greater than 8.0 - other than as an	8.0, such a level of leakage is not an effectiv incremental goal to a smaller long-term

Note: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalcs Standard software. This has allowed the development of the ELLCalcs standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

Important Footnote: the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The PressCalcs Standard Software provides more detailed information on this topic.

	'LEAKS' Suite of LEAKAGE E	VALUATION and	ASS	ESSME	ENT KNOW	LHOW SOFTW	ADE	
	ER BALANCE AND PERFORMANCE INDICATORS PR	ROGRAM 'PIFastCalcs'			Version 1a		Canada	Master,0000
Hattiere	OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYST		Dat	a entry	Calculated Values		ther Worksheet	
	Town of Pelham	01/01/2005	to	1/	/2006	Number of Days in P		
System	Whole System	Calculation	n by	Steve	Genser	Date of calculat	ion =	7-Sep-06

Total running costs as calculated below = 0.0 | SCx1000 | Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1

900222 27 2, IWA Publishing: this report should be consulted for further guidance as necessary.

Operational Costs		Sub-total \$Cx1000	Group total \$Cx1000	INCLUDES
	Raw water	COXIOCO	Company Committee	BULK SUPPLY IMPORTS: total payments for imported raw water
Imported water	Treated water		0.0	BULK SUPPLY IMPORTS: total payments for imported raw water
	Raw water			DOCK SOFFET IMPORTS, total payments for imported treated water
F	Treatment			KUTAN PANGAMATATA - ALAI MAN IN MININ MININ MININ MANANAN MANANANAN
Energy	Transmission		0.0	POWER: all energy costs for water supply electricity and fuel for motive machinery
	Distribution			
	Outsourcing			Outsourcing of technical or administrative services, such as consultants, contractors undertaking
	Software licences			operational tasks, meter reading and accounting fees
External services: Outsourcing	and IT support		0.0	Licence fees on computer software and technical support by software companies
Cuisourcing	Associated Companies			Costs of associated companies that are not included in other items
	Third party			Operating costs of providing water services to third parties (other than the regulated water
	services			supply function) that are not included in other items
	Premises			Payments for leasing or renting premises
	Vehicles			Payments for leasing or renting vehicles
Leasing and Rentals	Mobile Plant		0.0	Payments for leasing or renting mobile plant
	Fixed Plant			Payments for leasing or renting fixed plant
	Equipment			Payments for leasing or renting equipment
				All water treatment changed for terming equipment
	Water treatment			All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED
	chemicals			SERVICES and which are required for operation of sources, treatment plants,transmission and
Purchases	Other than		0.0	distribution systems
	1501000000000000			All materials and consumables other than energy and water treatment chemicals for water
	chemicals and			supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for
Taxes, levies and				operation of sources, treatment plants,transmission and distribution systems
Taxes, levies and fees	All kinds		0.0	Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates
Exceptional earnings and losses	All kinds		0.0	Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets
	Other direct costs			Any other operating costs (but excluding interest and taxation, on an aggregated basis)
	General and			
	support expenditures		6	The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded)
0.1				Costs directly associated with customer services that are not included in previous items, related
Other Operating Expenditures	Customer services		0.0 t	to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling.
	Scientific services			Costs directly associated with scientific and laboratory services and with the monitoring of quality
	Other business			that are not included in previous items  Costs directly associated with other business activities that are not included in previous items,
	activities			except for cost depreciation
	Doubtful debts		RESERVED ST	Charge/credit to the profit and loss account for bad and doubtful debts
ATT BOX OF TO	Dodbildi debis			Charge/credit to the profit and loss account for bad and doubtful debts
Sum of Operational Costs	All the above operational costs		0.0	
Internal manpower costs	Employment costs		0.0	The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer
Capitalised cost of self-constructed assets	Negative allocation		0.0	The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets
Total Running Costs	Sum of Operationa Internal Manpower C capitalised cost constructed a	osts, minus of self-	0.0	

Comments:			

Appendix L

PIFastCalc Output Port Colborne

	WATER BALANCE AND PERFORMANCE INDICAT					Standard	Version 1a	2nd De	2005		anada
_	ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FO	HTIW, TAMPO	95% CONFI	DENCE LIMITS	I)	Data entry	Defaults	Calculate	d Values	From ano	ther Worksheet
	Note:Calculations should be based on a 12-month period for all aspe	cts of the wor	ksheet to f	unction correc	tly	Currency =	\$C	Volume units	MI	and	m <sup>3</sup>
Utility	Town of Port Celborne Bulk	supply (BS) or System (DS		DS		01/01/2005	to	01/01/2006	-	365	days
	Whole System Do	most custom storage tan		No		Calculation by	Steve	Genser	Date	4	Dec-06
Process Reliability Band	WATER BALANCE CALCULATION	NS.			Volume in	95%		FINANCIAL		NCE INDICATO	ORS FOR NON-
Pro	IWA Terminology				#300000	Confidence Limit as +/- %	Variance	% of System	Calculated	Value of NRW	as % of Syste
<u>e</u>	COMPONENTS OF WATER BALANCE				MI			Input Volume	Ru	nning Costs is	Period
	WOS: Volume from Own Sources (corrected for known systematic error	ors)					0	0.0%	ė	ater	-
A	WI: Water Imported (corrected for known systematic errors)				3909.0	3.0%	3580	100.0%	ssed marginal cost of ual components of Non- Revenue Water	Value of Individual Non Revenue Wate	of running system
	SIV: SYSTEM INPUT VOLUME				3909.0	3.0%	3580	100.0%	Assessed marginal cost of dividual components of No Revenue Water	of Inc	D D
	BACE:Water Exported						0	0,0%	one wa	n n	lu i
	WS: WATER SUPPLIED = SIV - BACE				3909.0	3.0%	3580	100.0%	em o	2 2	2
A/B	BACM1: Billed Authorised Consumption: Metered	Residential 1546.9 1.5% 140					140	39.6%	See Rov	a a c	of cost
	BACM2: Billed Authorised Consumption: Metered	922.9	1.5%	50	23.6%	Assor	Assessed Unit of Components of It	223			
	BACM3: Billed Authorised Consumption: Metered						0	0.0%	2	Ass	2,
	BACU: Billed Authorised Consumption:Unmetered			0	0.0%	\$C/m3	\$Cx1000	%			
	NRW: NON-REVENUE WATER					8.4%	3770	36.8%	0.4616	664.3	0.0%
A	UACM: Unbilled Authorised Consumption: Metered		0.00%	of WS			0	0,0%	0.4460	0.0	0.0%
В	UACU: Unbilled Authorised Consumption: Unmetered:	Estimated as	6.700%	of WS	261.9	50.0%	4464	6.7%	0.4460	116.8	0.0%
	WL WATER LOSSES				1177.3	15,1%	8234	30.1%	0.4651	547,5	0.0%
C	UC: Unauthorised Consumption:	Estimated as	0.250%	of WS	9.8	50.0%	6	0.3%	0.7560	7.4	0.0%
В	ALMUR1: Apparent Loss - meter under-registration: Re	sidential	0.50%	of BACM1	7.8	7.0%	0	0.2%	1.5810	12.3	0.0%
В	ALMUR2: Apparent Loss - meter under-registration: Lar	rge Users	1.00%	of BACM2	9.3	7.0%	0	0.2%	1.5810	14.7	0.0%
	ALMUR3: Apparent Loss - meter under-registration:			of BACM3 and UACM	0.0		0	0.0%	1.5810	0.0	0.0%
D	ALDCD Customer meter data handling errors						0	0.0%	1.5810	0.0	0.0%
	AL: Sum of APPARENT LOSSES				26.9	18,5%	6	0.7%	1.2809	34,4	0.0%
	RL: REAL LOSSES				1150.4	15.5%	8240	29.4%	0.4460	513,1	0.0%
HL: HEAL LOSSES  ** of period system pressurized = 100.0% 365.0 days						THE ROLL OF THE PARTY OF THE PA	THE PERSON NAMED IN	manager and the same	201100	910,1	0.0.0

Process Reliability Band	SYSTEM INFRASTRUCTURE AND PRESSURE DA	MA	Valid for UARL& ILI calc?	95% CLs as 4/- %
A	Lm: Mains Length, km	138.00	Yes	1.0%
A	Nh: Number of Fire Hydrants	591		1.0%
A/B	Nb: Number of Separately Billed Properties	5807		2.0%
A/B	R: Ratio of billed Service Connections (Ns. main to property line) to Billed Props (Nb)	1,040		2.0%
	Ns: No, of billed Service Connections	6039		2.8%
В	Nu: Number of Unbilled Service Connections	28	1 3	10.0%
	Nt: Total Number of Service Conns (= Ns + Nu), mains to property line	6067	Yes	2.8%
	DC: Density of Connections/ km of mains = Ns/Lm		3.0%	
В	Lp: Average pipe length, property line to meter (m)	10.2		2.4%
	Lp: Total pipe length, property line to meter (km)	61.60		3.7%
A	P: Average pressure when system pressurised (psi)	58.0		2.0%
	P: Average pressure when system pressurised (m)	41.0	Yes	2,0%

Notes: If Lm and Lp are in	km	and press	sure P is in	metres
UBL in litres/hour =	(20 x Lm +	1.25 x Nt +	33 x Lp) x	(P/50) <sup>1,5</sup>
UARL in litres/day =	(18 x Lm +	0,8 x Nt +	25 x Lp) x	P
COMPONENT OF REAL LOSSES	MI per day	MI In period	SCx1000 in period	95% CLs as +/
UBL: UNAVOIDABLE BACKGROUND LEAKAGE	0.22	81	36.0	3,4%
UARL: UNAVOIDABLE ANNUAL REAL LOSSES	0.36	133	59.3	2.6%
CARL: CURRENT ANNUAL REAL LOSSES	3,15	1150	513.1	15.5%
POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL	2.79	1018	453.8	17.5%

IWA BEST PRACTICE PERFORMANCE INDI	CATOR	UNITS OF PERFORMANCE INDICATOR	Best estimate	95% CLs as +/- %	Lowest Estimate	Highest Estimate
Non Revenue Water Basic (IWA Level 1, F	in36)	% of System Input by Volume	36.8	8.9%	33.5	40.1
Non Revenue Water Basic (IWA Level 1, F	in37)	% of System Input by Value		8.9%		
Apparent Losses (IWA Op23)	Best Op23 Pt >	% of Water Supplied (Distribution Systems)	0.7	18.7%	0.6	0.8
		% of System Input Volume (Bulk Supply Systems)	0.7	18.7%	0.6	0.8
Real Losses Basic (IWA Level 1, Op24)	Best Op24 PI >	Litres/service connection/day, when system pressurised	519	15.7%	438	601
The Copies Clark (IIIA Cerei I, Op24)		m3/km of mains/day, when system pressurised	22.8	15.5%	19.3	26.4
Real Losses Detailed (IWA Level 3, Op	25)	Infrastructure Leakage Index ILI (non-dimensional)	8.66	15.7%	7.30	10.02

## Comments:

Region billing equation = 4T1 + 4T2

Loop Calibration Reports dated October 28, 2005 highlight the following errors:

22.9 % of full scale = +26.7% error 45.8 % of full scale = + 0.1% error 76.4 % of full scale = no error 91.6 % of full scale = no error

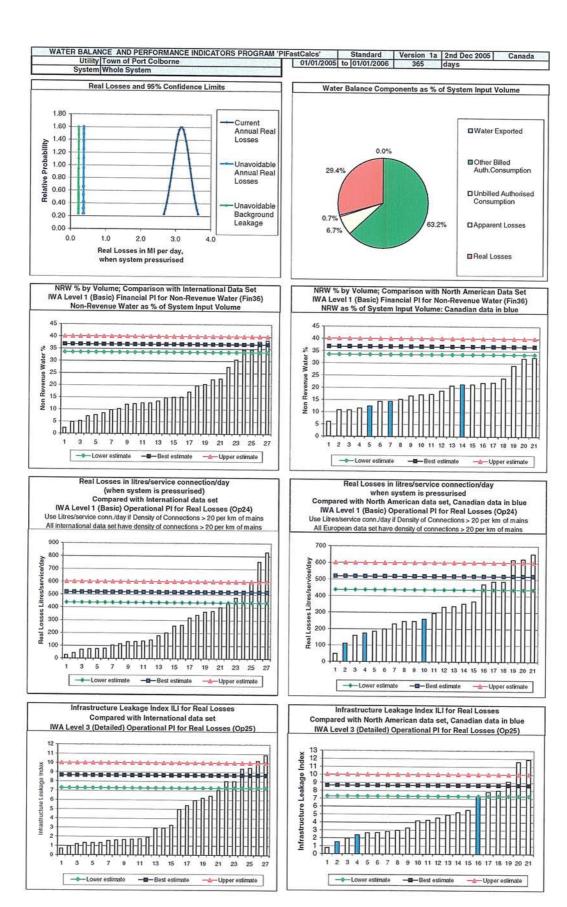
A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

Total length of watermain allow for 3 m per hydrant (i.e., 591 hydrants x 3m = 1.773 km)

The state of the s	EAKS' St	lite of LEA!	KAGE EV	ALUATION	and AS	SESSMENT K	'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE	WARE		
	WATER	BALANCE	AND PE	ERFORMAI	NCE INDI	CATORS PRO	WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'	cs,		
DETAILED CALCULATION OF COMPON	VENTS OF AU	DE COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION	UNAUTHO	RISED CONSU	MPTION		Data entry C	Calculated Values	I POS	From another Worksheet
Utility Town of Port Colborne System Whole System						01/01/2005 to	01/01/2006 =	365 days		
		Components in MI	MI			to nonsinons	include delian		n n	04/12/2006
Components of Authorised Consumption	Billed	Billed	Unbilled	Unbilled	Total	Add	Additional information on sources of data and basis of estimates  E = estimated  B = Raced on conciliate	E = estimated	nd basis o	of estimates
Residential	1546.89				1546.89	R = 4 month billing cycle				
Large Users						•				
PC General #52598	22.78				22.78		eads			
PC General #52605	5,85				5.85	R = monthly meter reads	eads			
Piccan Holdings #52670	2.27				2.27	R = monthly meter reads	eads			
Riccan Holdings #53695	5 C				1.41	H = monthly meter reads	eads			
City of PC #54396	1.00				100	R = monthly meter reads	eads			
City of PC #54403	5.40				5.40	R = monthly meter reads	eads			
City of PC #54586	0.64				0.64	R = monthly meter reads	eads			
City of PC #54635	5.04				5.04	R = monthly meter reads	eads			
nco #54734	23.63				23.63	R = monthly meter reads	eads			
TCO #54708	19.42				19.42	R = monthly meter reads	eads			1111
Doctor #57004	26.64				26.64	R = monthly meter reads	eads			
Parion #64816	20.1				00.00	H = monthly meter reads	eads			
Begion #64874	0.45				10.43	H = monthly meter reads	eads			
Robin Hood	36.18				26.76	H = monthly meter reads	eads			
Mermaid Ent	52.10				50.00	R = monthly meter reads	ado			
PC Poultry	284.53				284 53	284.53 R = monthly meter reads	ands			
20 #55435	0.11				0.11	R = monthly meter reads	ads			
H2O #64501	0.11					R = monthly meter reads	eads			
John Boys #55443	9.20				9.20	R = monthly meter reads	ands			
John Boys #64501	3.81					R = monthly meter reads	ads			
Sunshine Tracking #55451	7.62					R = monthly meter reads	eads			
KNT Water Haulage #55477	22.27					H = monthly meter reads	sads			
KNT Water Haufage	1 20				36.64	H = monthly meter reads	aads			
Canada Starch #63694	38 60					D = monthly meter reads	sads			
Canada Starch #63701	242.40					A = monthly meter re	ande			
Jim Buccione #64056	16.70					R = monthly meter reads	spes			
Jim Buccione #64155	2.40				2.40	R = monthly meter reads	ads			
Chamber Water Haul #64072	8.78					R = monthly meter reads	ads			
Chamber Water Haul #64121	1.83				1.83	R = monthly meter reads	ads			
JBL #64139	90.0					R = monthly meter reads	ads			
JBL #64147	9.64				9.64	R = monthly meter reads	ads			
Aqualine Water #64866	20.26					R = monthly meter reads	ads			
Aqualine Water #65517	0.27					R = monthly meter reads	ads			
Unbilled Authorized Consumption					00.00					
Hydrant Flushing				0.01	100	= astimated				
Fire Fighting				0.04	0.04	E = estimated				
fatermain Breaks				0.77	0.77	E = estimated				
Frozen Services				0.03	0.03	E = estimated				
Water Quality				60.0	60.0	= estimated				
Public Works				00.00	00.0	E = estimated				
ares St. Water main				00.0	00.0	E = estimated				

Water main repairs  Bulk Water Station  Authorised consumption sub-totals 2469.81 0.00 0.00  Authorised Unbilled Unmetered Consumption = By-pass tampering Estimated based on five hour	0.06
d consumption sub-totals 2469.81 Authorised Unbilled I	0.01
d consumption sub-totals 2469.81 Authorised Unbilled I	
d consumption sub-totals 2469.81 Authorised Unbilled hauthorised Consumption	107
Authorised Unbilled I	0.00 1.04 24/0.84 MI
nauthorised Consumption MI	Ntion = 0.026% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet
	Method of estimation
	Estimated based on five houshold per year
Unauthorised consumption sub-total 0.00 MI	
Unauthorised consumption = 0.000% of Water Supplied. 1	0.000% of Water Supplied, transfer this figure to Cell F23 of WaterBalance Die Workshoot



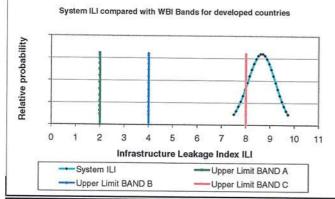
#### 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' **PIFastCalcs** Standard Version 1a 2nd Dec 2005 Canada Master.0000 Town of Port Colborne

# THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES

# World Bank Institute (WBI) Guidelines

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs. which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

Developing Countries			Calculated ILI for this	General description of Real Loss Management Performance Categories for Developed and Developing
ILI range	ILI range		System	Countries
Less than 4	Less than 2	Α		Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement
4 to < 8	2 to < 4	В	ENTER THE PROPERTY OF	Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance
8 to < 16	4 to < 8	С	ME LES	Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
16 or more	8 or more	D	8.7	Very inefficient use of resources; leakage reduction programs imperative and high priority



WBI Recommendations for BANDS	A	В	С	D
Investigate pressure management options	Yes	Yes	Yes	
Investigate speed and quality of repairs	Yes	Yes	Yes	
Check economic intervention frequency	Yes	Yes		
Introduce/improve active leakage control		Yes	Yes	
Identify options for improved maintenance		Yes	Yes	
Assess Economic Leakage Level	Yes	Yes		
Review break frequencies		Yes	Yes	
Review asset management policy		Yes	Yes	Yes
Deal with deficiencies in manpower, training and communications			Yes	Yes
5-year plan to achieve next lowest band			Yes	Yes
Fundamental peer review of all activities				Yes

GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003 Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the

Target ILI Range	This System ILI	Water Resources Considerations	Operational Considerations	Financial Considerations
1.0 - 3.0		disould to develop	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability
3.0 - 5.0		Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population
5.0 - 8.0		Water resources are plentiful, reliable, and easily abstracted	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages	Cost to purchase or obtain/treat water is low, as are rates charged to customers
Greater than 8.0	8.7	Although operational and financial considera utilization of water as a resource. Setting a to target - is discouraged.	titions may allow a long-term ILI greater than arget level greater than 8.0 - other than as an	8.0, such a level of leakage is not an effectiv incremental goal to a smaller long-term

Note: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalcs Standard software. This has allowed the development of the ELLCalcs standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

Important Footnote: the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The PressCalcs Standard Software provides more detailed information on this topic.

11/1/	'LEAKS' Suite of LEAKAGE I	VALUATION and	ASS	ESSME	NT KNOW	LHOW SOFTW	\ DE		
	ER BALANCE AND PERFORMANCE INDICATORS P	ROGRAM 'PIFastCalcs'			Version 1a	2nd Dec 2005			Master.0000
T NATION .	OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYST		Dat	a entry	Calculated Values			er Worksheet	
	Town of Port Colborne Whole System	01/01/2005	to		/2006	Number of Days in P			days
System	Whole System	Calculatio	n by	Steve	Genser	Date of calculation =		12	2/4/2006

Total running costs as calculated below = 0.0 SCx1000 Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing: this report should be consulted for further guidance as necessary.

0			Group total		
Operational Costs		\$Cx1000	\$Cx1000	INCLUDES	
Imported water	Raw water		0.0	BULK SUPPLY IMPORTS: total payments for imported raw water	
	Treated water Raw water		(Majeser)	BULK SUPPLY IMPORTS: total payments for imported treated water	
	Treatment		Harry Sallier		
Energy	Transmission		0.0	POWER: all energy costs for water supply electricity and fuel for motive machinery	
	Distribution			57 The second of the lact the machinery	
				Outpassed and the shall be a little of the sha	
	Outsourcing			Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees	
External services:	Software licences and IT support		0.0	Licence fees on computer software and technical support by software companies	
Outsourcing	Associated Companies		0.0	Costs of associated companies that are not included in other items	
	Third party services			Operating costs of providing water services to third parties (other than the regulated water	
	Premises			supply function) that are not included in other items	
	Vehicles			Payments for leasing or renting premises	
Leasing and Rentals	Mobile Plant			Payments for leasing or renting vehicles	
Leasing and Heritals	Fixed Plant		0.0	Payments for leasing or renting mobile plant	
5	Equipment			Payments for leasing or renting fixed plant	
				Payments for leasing or renting equipment	
Purchases	Water treatment chemicals			All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems	
Purchases	Other than chemicals and		0.0	All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for	
Taxes, levies and	energy			operation of sources, treatment plants,transmission and distribution systems	
fees	All kinds		0.0	Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates	
Exceptional earnings and losses	All kinds		0.0	Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets	
	Other direct costs			Any other operating costs (but excluding interest and taxation, on an aggregated basis)	
	General and support expenditures			The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded)	
Other Operating Expenditures	Customer services			Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling.	
	Scientific services			Costs directly associated with scientific and laboratory services and with the monitoring of that are not included in previous items	
	Other business activities			Costs directly associated with other business activities that are not included in previous items, except for cost depreciation	
	Doubtful debts			Charge/credit to the profit and loss account for bad and doubtful debts	
Sum of Operational Costs	All the above operational costs		0.0		
Internal manpower costs	Employment costs		0.0	The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer	
Capitalised cost of self-constructed assets	Negative allocation			The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets	
Total Running Costs	Sum of Operational Internal Manpower C capitalised cost constructed as	osts, minus of self-	0.0		

ı	Comments:	-
ı		
ı		
ı		
ı		
ı		
ı		
ı		ı
ı		ı
ı		1

Appendix M

PIFastCalc Output St. Catharines

	WATER BALANCE AND PERFORMANCE IND					Standard	Version 1a	2nd De	2005	1	anada
	ANNUAL WATER BALANCE CALCULATION IN IWA STANDA	ARD FORMAT, WITH	95% CONFI	DENCE LIMITS		Data entry	Defaults	Calculate	d Values	From ano	ther Worksheet
	Note:Calculations should be based on a 12-month period for a	II aspects of the wo	rksheet to f	unction correc	tly	Currency =	sc	Volume units	MI	and	m <sup>3</sup>
Utility	City of St. Catharines	Bulk supply (BS) or System (D		DS		01/01/2004	to	01/01/2005	-	365	days
ystem	Whole System	Do most custon storage tar		No		Calculation by	Steve	Genser	Date	4	Dec-06
Process Reliability Band	WATER BALANCE CALCUI	LATIONS		1	Volume in period	95%		FINANCIAL		NCE INDICATE UE WATER	ORS FOR NON-
Pro	IWA Terminology					Confidence Limit as +/- %	Variance	% of System	Calculated	Value of NOV	as % of System
å	COMPONENTS OF WATER BALANCE				MI	Contract Contract		Input Volume		nning Costs i	
	WOS: Volume from Own Sources (corrected for known systema	atic errors)					0	0.0%	é	ator	
A	WI: Water Imported (corrected for known systematic errors)				21823.7	3.0%	111580	100,0%	Assessed marginal cost of individual components of Non- Revenue Water	Value of Individual Non Revenue Wate	at o
	SIV: SYSTEM INPUT VOLUME			_	21823.7	3.0%	111580	100.0%	l cos	Ven.	lg sy
	BACE:Water Exported						0	0.0%	sed marginal c tal components Rovenue Water	200	alou.
	WS: WATER SUPPLIED = SIV - BACE				21823.7	3.0%	111580	100.0%	omp	Assessed Unit Va	of cost of running system
A	BACM1: Billed Authorised Consumption: Metered		Cycles		17067.9	1.5%	17062	78.2%	Rov		1500
A	BACM2: Billed Authorised Consumption: Metered	Bulk Mete	ring & Indus	strial	2409.6	1.5%	340	11.0%	PINI		2
	BACM3: Billed Authorised Consumption: Metered						0	0.0%	Ē		32
	BACU: Billed Authorised Consumption:Unmetered						0	0.0%	\$C/m3		196
	NRW: NON-REVENUE WATER				2346.2	30,0%	128982	10,8%	0.4626	1085.4	0.0%
A	UACM: Unbilled Authorised Consumption: Metered		0.00%	of WS	0.0		0	0.0%	0.4460	0.0	0.0%
D	UACU: Unbilled Authorised Consumption: Unmetered:	Estimated as	1.250%	of WS	272.8	100.0%	19372	1.3%	0.4460	121.7	0.0%
	WL WATER LOSSES				2073.4	36.4%	149353	9.5%	0.4648	963.7	0.0%
D	UC: Unauthorised Consumption:	Estimated as	0.250%	of WS	\$4.6	100,0%	775	0.3%	0.4460	24.3	0.0%
В	ALMUR1: Apparent Loss - meter under-registration:	Cycles	0,50%	of BACM1	85.8	7.0%	9	0.4%	0.8000	68.6	0.0%
В	ALMUR2: Apparent Loss - meter under-registration:	Bulk Metering & Industrial	1.00%	of BACM2	24.3	7.0%	1	0.1%	0.8000	19.5	0.0%
	ALMUR3: Apparent Loss - meter under-registration:			of BACM3 and UACM	0.0		0	0.0%	0.8000	0.0	0.0%
D	ALDCD Customer meter data handling errors						0	0.0%	0.8000	0.0	0.0%
	AL: Sum of APPARENT LOSSES				164.7	33,3%	785	0.8%	0.6827	112.4	0.0%
	RL: REAL LOSSES				1908.7	39.7%	149138	8,7%	0.4460	851,3	0.0%
Α	% of period system pressurized =	100.0%	365.0		1000000000	000000000000000000000000000000000000000		296.79	0,4400	851.3	0.0%

Process Reliability Band	SYSTEM INFRASTRUCTURE AND PRESSURE I	DATA	Valid for UARL& ILI calc?	95% CLs as e/- %
A	Lm: Mains Length, km	541.40	Yes	1.0%
A	Nh: Number of Fire Hydrants	3803		1.0%
В	Nb: Number of Separately Billed Properties	41210	1	2.0%
В	R: Ratio of billed Service Connections (Ns. main to property line) to Billed Props (Nb)	1.000	1	2.0%
	Ns: No. of billed Service Connections	41210	1	2.8%
С	Nu: Number of Unbilled Service Connections	0		
	Nt: Total Number of Service Conns (= Ns + Nu), mains to property line	41210	Yes	2.8%
	DC: Density of Connections/ km of mains = Ns/Lm	76.1		3.0%
В	Lp: Average pipe length, property line to meter (m)	7.0	1	50.0%
	Lp: Total pipe length, property line to meter (km)	288.47	1	50.1%
С	P: Average pressure when system pressurised (psi)	65.0		25.0%
	P: Average pressure when system pressurised (m)	46.0	Yes	25.0%

Notes: If Lm and Lp are in	km	and pres	sure P is in	metres
UBL in litres/hour =	(20 x Lm +	1.25 x Nt +	33 x Lp) x	(P/50) <sup>1.5</sup>
UARL in litres/day =	(18 x Lm +	0.8 x Nt +	25 x Lp) x	P
COMPONENT OF REAL LOSSES	MI per day	MI in period	\$Cx1000 in period	95% CLs as +/
UBL: UNAVOIDABLE BACKGROUND LEAKAGE	1.52	555	247.7	38.6%
UARL: UNAVOIDABLE ANNUAL REAL LOSSES	2.29	837	373.5	26,1%
CARL: CURRENT ANNUAL REAL LOSSES	5.23	1909	851.3	39.7%
POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL	2.94	1071	477.8	73.5%

IWA BEST PRACTICE PERFORMANCE INDICATOR  Non Reverus Water Basic (IWA Level 1, Fin36)  Non Reverus Water Basic (IWA Level 1, Fin37)  Apparent Losses (IWA Op23)  Best Op23 PI >  Real Losses Basic (IWA Level 1, Op24)	UNITS OF PERFORMANCE INDICATOR	Best estimate	95% CLs as 4/- %	Lowest Estimate	Highest Estimate	
Non Revenue Water Basic (IWA Level 1, F	in36)	% of System Input by Volume	10.8	30.2%	7.5	14.0
Non Revenue Water Basic (IWA Level 1, F	in37)	% of System Input by Value	LOTIDAL	30.2%	(BARKIM)	
Apparent Losses //WA On 23\	Best Op23 PI >	% of Water Supplied (Distribution Systems)	33.6%	0.5	1.0	
The state of the s		% of System Input Volume (Bulk Supply Systems)	0.8	33.5%	0.5	1.0
Real Losses Basic (IWA Level 1 On24)	Best Op24 PI >	Litres/service connection/day, when system pressurised	127	39.8%	76	177
Real Losses Basic (IWA Level 1, Op24)		m3/km of mains/day, when system pressurised	9.7	39.7%	5.8	13.5
Real Losses Detailed (IWA Level 3, Op :	26)	Infrastructure Leakage Index ILI (non-dimensional)	2.28	47.5%	1.20	3.36

Region Billing Equation = (5T1+5T2+5T3+5T4+5T5)-5D1-5D2-5D3-5D4-5D5-5D6-5D7-5D8-5D9

5T1, 5T2, 5T3 - June 30 & November 1, 2005 5T4 - no report 5T5 - June 30, 2005

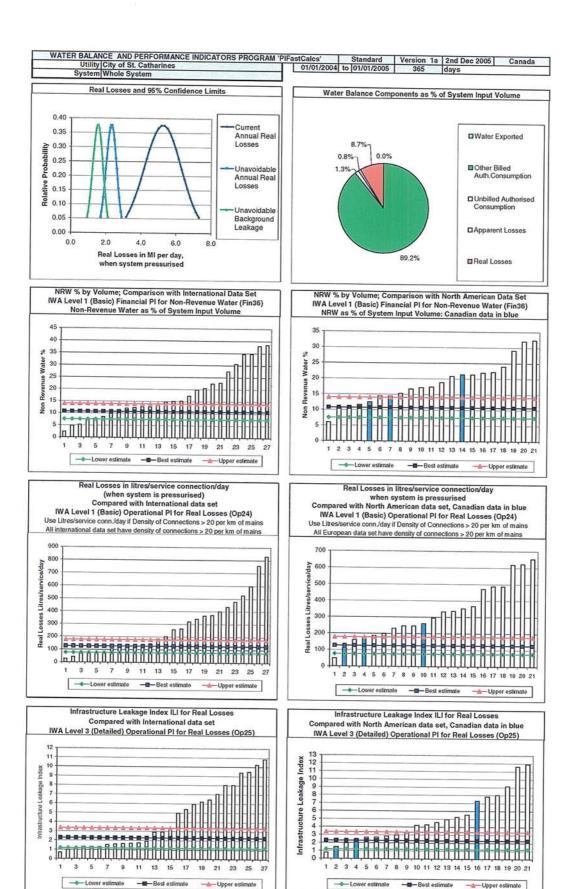
5D1, 5D2, 5D5, 5D6 - May 20, 2005 5D3 - May 24, 2005 5D7 & 5D8 - August 15 & November 2, 2005 5D9 no report

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

Allowance for 3m hydrant lead for each hydrant built in to kilometers of water main.

CONTRACTOR CONTRACTOR SERVICES	WATER	BALANCE	AND P	ERFORMAI	NCE INDI	CATORS PRC	WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'	Calcs'		
	NENTS OF AU	F COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION	UNAUTHO	RISED CONSUL	MPTION		Data entry	Calculated Values	Values	From another Worksheet
Utility City of St. Catharines	THE WINE	The state of the s		The state of the s		01/01/2004 to	01/01/2005 =	365	davs	
System Whole System	Heat Committee							П	ľ	Date 04/12/2006
	38	Components in MI	MI			Add	Additional information on sources of data and basis of estimates	n sources of	data and ba	asis of estimates
Components of Authorised Consumption	Billed	Billed Unmetered	Unbilled	Unbilled	Total		000	E = estimated	ordings	
Section A	3153.17				3153.17				0	
Section B	1449.65				1449.65					
Section C	1783.46				1783.46					
Section D	1548.20				1548.20					
Section E	2590.82				2590.82					
Section F	2002.50				2002.50					
Section G	1506.47				1506.47					
Section H	1612.77				1612.77					
Section   /Section	358.17				358.17					
Section IC (Bull: Motor)	25.77				55.77					
scion ( Cour water)	26.33				26.33					
Manual Billing Adjustmente	2222.82				2222.82					
anda biing Adramenta	205.70				205.70					
Veer End Accurate					00.00					
a Elia Accidais					0.00					
Cacito	24.040				0.00					
Section K	040.10				843.15					
otton I	457.05				16.5					
	08.701				15/.95					
partial section accrual	2627 10				00.0					
ravarsa onaning accural	2007.18				2637.19					
and the second	-5503.94		Ī		-2203.94					
176 flat rata crietomore					00.0					
O Hat rate customers					00.0					
					00.0					
					0.00					
					000					
					00.0					
			Ī		0000					
					000					
Authorised consumption sub-totals	19952.69	0.00	00'0	00'0	19952.69 M	The state of the s				
85	ised Unbilled U	Authorised Unbilled Unmetered Consumption =	umption =	0.000%	Water Sup	olied, transfer this	0.000% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet	'WaterBalanc	e&Pis' Wor	ksheet
	L									
Components of Unauthorised Consumption	M					Method of	Method of estimation			
Unauthorised consumntion enhants	000	NAI .								



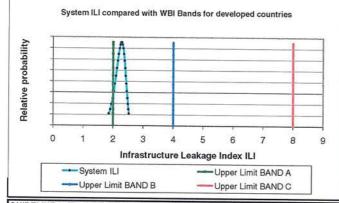
# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | City of St. Catharines

# THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES

### World Bank Institute (WBI) Guidelines

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

Developing Countries			1.75	General description of Real Loss Management Performance Categories for Developed and Developing
ILI range	ILI range		System	Countries
Less than 4	Less than 2	Α		Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement
4 to < 8	2 to < 4	В	2.3	Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance
8 to < 16	4 to < 8	С		Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
16 or more	8 or more	D		Very inefficient use of resources; leakage reduction programs imperative and high priority



target - is discouraged.

Greater

than 8.0

WBI Recommendations for BANDS	Α	В	C	D
Investigate pressure management options	Yes	Yes	Yes	
Investigate speed and quality of repairs	Yes	Yes	Yes	
Check economic intervention frequency	Yes	Yes		
Introduce/improve active leakage control		Yes	Yes	
Identify options for improved maintenance		Yes	Yes	
Assess Economic Leakage Level	Yes	Yes		
Review break frequencies		Yes	Yes	
Review asset management policy		Yes	Yes	Yes
Deal with deficiencies in manpower, training and communications			Yes	Yes
5-year plan to achieve next lowest band			Yes	Yes
Fundamental peer review of all activities				Yes

GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage).

Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed countries, the

ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive. Target ILI This Water Resources Considerations Operational Considerations **Financial Considerations** Range System IL Operating with system leakage above this Water resources are costly to develop or Available resources are greatly limited and evel would require expansion of existing purchase; ability to increase revenues via 1.0 - 3.023 are very difficult and/or environmentally infrastructure and/or additional water water rates is greatly limited because of unsound to develop resources to meet the demand regulation or low ratepayer affordability Water resources are believed to be sufficient Water resources can be developed or Existing water supply infrastructure to meet long-term needs, but demand purchased at reasonable expense; periodic capability is sufficient to meet long-term 3.0 - 5.0 management interventions (leakage water rate increases can be feasibly demand as long as reasonable leakage management, water conservation) are imposed and are tolerated by the customer management controls are in place included in the long-term planning population Superior reliability, capacity and integrity of Water resources are plentiful, reliable, and Cost to purchase or obtain/treat water is 5.0 - 8.0 the water supply infrastructure make it easily abstracted ow, as are rates charged to customers relatively immune to shortages

Note: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalcs Standard software. This has allowed the development of the ELLCalcs standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective

utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term

Important Footnote: the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The PressCalcs Standard Software provides more detailed information on this topic.

	'LEAKS' Suite of LEAKAGE E	VALUATION and	ASS	ESSME	ENT KNOV	V-HOW SOFTW	ARE		S. Carle
	ER BALANCE AND PERFORMANCE INDICATORS PI	ROGRAM 'PIFastCalcs'			Version 1a			anada	Master.0000
Hallia	OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS			Dat	a entry	Calculated Values	From another We		
	City of St. Catharines	01/01/2004	to	1/	/2005	Number of Days in P			days
System	Whole System	Calculation	on by	Steve	Genser	Date of calculat	ion =	1:	2/4/2006

Total running costs as calculated below = 0.0 SCx1000 Transfer this figure to Cell L30 of WaterBalance&Pis' Worksheet

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the WA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing; this report should be consulted for further guidance as necessary.

Operational Costs		Sub-total	Group total	
Operational Costs	Raw water	\$Cx1000	\$Cx1000	INCLUDES
Imported water	Treated water		0.0	BULK SUPPLY IMPORTS: total payments for imported raw water
	Raw water	_		BULK SUPPLY IMPORTS: total payments for imported treated water
a <u>ss</u> acedates	Treatment			
Energy	Transmission		0.0	POWER: all energy costs for water supply electricity and fuel for motive machinery
	Distribution			and the state of t
	- president a transport		Education of the Control	Outcourging of technical or administrative and the control of the control of technical or administrative and the control of the control of technical or administrative and the control of the control of technical or administrative and the control or administrative and the control of technical or administrati
	Outsourcing			Outsourcing of technical or administrative services, such as consultants, contractors undertakin operational tasks, meter reading and accounting fees
External services:	Software licences			Licence fees on computer software and technical support by software companies
	and IT support		0.0	and technical support by software companies
Outsourcing	Associated			Costs of accognited companies that are not included in the
	Companies			Costs of associated companies that are not included in other items
	Third party			Operating costs of providing water services to third parties (other than the regulated water
	services		TANK BE	supply function) that are not included in other items
	Premises			Payments for leasing or renting premises
Lancing and Destate	Vehicles			Payments for leasing or renting vehicles
Leasing and Rentals	Mobile Plant		0.0	Payments for leasing or renting mobile plant
	Fixed Plant			Payments for leasing or renting fixed plant
	Equipment		Transfer of	Payments for leasing or renting equipment
	Water treatment			All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED
	chemicals			SERVICES and which are required for operation of sources, treatment plants, transmission and
Purchases			0.0	distribution systems
, 3,31,4333	Other than		0.0	All materials and consumables other than energy and water treatment chemicals for water
	chemicals and			supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for
	energy			operation of sources, treatment plants, transmission and distribution systems
Taxes, levies and fees	All kinds		0.0	Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates
Exceptional earnings and losses	All kinds		0.0	Any exceptional income or expenditure from donations, investment subsidies, compensations of adjustments related to sales/writing off of fixed assets
	Other direct costs			Any other operating costs (but excluding interest and taxation, on an aggregated basis)
	General and support expenditures			The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded)
Other Operating Expenditures	Customer services		0.0	Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections,
Expenditures				customers'enquiries and complaints handling.
	Scientific services			Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items
1	Other business			Costs directly associated with other business activities that are not included in previous items,
	activities			except for cost depreciation
	Doubtful debts			Charge/credit to the profit and loss account for bad and doubtful debts
	The second secon			Charge/credit to the profit and loss account for bad and doubtful debts
Sum of Operational Costs	All the above operational costs		0.0	
Internal manpower costs	Employment costs		0.0	The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer
Capitalised cost of self-constructed assets	Negative allocation		0.0	The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets
Total Running Costs	Sum of Operationa Internal Manpower C capitalised cost constructed a	Costs, minus of self-	0.0	ň.

ı	Comments:	
ı		
ı		
ı		
ı		
ı		
ı		
ı		
ı		

Appendix N

PIFastCalc Output Thorold

_	WATER BALANCE AND PERFORMANCE IN					Standard	Version 1a	2nd De	c 2005		Canada
	ANNUAL WATER BALANCE CALCULATION IN IWA STAND					Data entry	Defaults	Calculate	d Values	From ano	ther Worksheet
	Note:Calculations should be based on a 12-month period for	all aspects of the wo	rksheet to f	function correc	tly	Currency =	sc	Volume units	1M	and	m <sup>3</sup>
Utility	City of Thorold	Bulk supply (BS) or System (D		DS		01/01/2005	to	01/01/2006	-	365	days
-	Whole System	Do most custon storage tai		No		Calculation by	Steve	Genser	Date	4	Dec-06
Process Reliability Band	WATER BALANCE CALC	ULATIONS			Volume in period	95%		FINANCIAL		NCE INDICATE	ORS FOR NON-
Pro	IWA Terminolog	у			1000	Confidence Limit as +/- %	Variance	% of System	Calculated	Value of MRM	as % of Syste
8	COMPONENTS OF WATER BALANCE				MI	19/20/20/20/20		Input Volume		nning Costs is	
	WOS: Volume from Own Sources (corrected for known system	natic errors)					0	0.0%	2	ator	
A	WI: Water Imported (corrected for known systematic errors)				3187.3	3.0%	2380	100.0%	Assessed marginal cost of individual components of Non- Revenue Water	Individual onue Water	running system
	SIV: SYSTEM INPUT VOLUME				3187.3	3.0%	2380	100,0%	te of	Value of Individ	73 6
A	BACE:Water Exported						0	0.0%	sod marginal c al components Revenue Water	Be o	nin
	WS: WATER SUPPLIED a SIV - BACE				3187.3	3.0%	2380	100,0%	man omp	N S	of cost of ru
B/C	BACM1: Billed Authorised Consumption: Metered	Resid	ential (- 705	14)	1670.5	1.5%	163	52.4%	Rove	Assessed Unit v	
B/C	BACM2: Billed Authorised Consumption: Metered	10	1 (- 30%)		715.9	1.5%	30	22.5%	pivi		
	BACM3: Billed Authorised Consumption: Metered						0	0.0%	- P		at .
	BACU: Billed Authorised Consumption:Unmetered						0	0.0%	\$C/m3	\$Cx1000	*6
	NRW: NON-REVENUE WATER				800.8	12.4%	2573	25,1%	0.4850	388.4	14.7%
A	UACM: Unbilled Authorised Consumption: Metered		0.00%	of WS			0	0.0%	0.4460	0.0	0.0%
D	UACU: Unbilled Authorised Consumption: Unmetered:	Estimated as	1,250%	of WS	39.8	100.0%	413	1,3%	0.4460	17.8	0.7%
	WL WATER LOSSES				761.0	14,1%	2987	23.9%	0.4870	370.6	14,0%
D	UC: Unauthorised Consumption:	Estimated as	0.250%	of WS	8.0	100.0%	17	0.3%	1,7690	14.1	0.5%
B/C	ALMUR1: Apparent Loss - meter under-registration:	Residential (~ 70%)	0.50%	of BACM1	8.4	7.0%	0	0.3%	1.7690	14.8	0.6%
B/C	ALMUR2: Apparent Loss - meter under-registration:	ICI (~ 30%)	1.00%	of BACM2	7.2	7.0%	0	0.2%	1.7690	12.8	0.5%
10.0	ALMUR3: Apparent Loss - meter under-registration:			of BACM3 and UACM	0.0		0	0.0%	1.7690	0.0	0.0%
D	ALDCD Customer meter data handling errors						0	0.0%	1.7690	0.0	0.0%
	AL: Sum of APPARENT LOSSES				23,6	33.9%	17	0.7%	1.7690	41.7	1.6%
	RL: REAL LOSSES				737.4	14.6%	3003	23.1%	0.4460	328,9	12.4%
A	% of period system pressurized =	100.0%	365.0	days			Cost o	running system		2648.4	\$Cx1000

Process Reflability Band	SYSTEM INFRASTRUCTURE AND PRESSURE DA	ATA .	Valid for UARL& ILI calc?	95% CLs as 4/- %
A	Lm: Mains Length, km	90.60	Yes	1.0%
Α	Nh: Number of Fire Hydrants	600		1.0%
В	Nb: Number of Separately Billed Properties	6269		2.0%
В	R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb)	1.000		2.0%
	Ns: No. of billed Service Connections	6269	0	2.8%
В	Nu: Number of Unbilled Service Connections	25		10.0%
	Nt: Total Number of Service Conns (= Ns + Nu), mains to property line	6294	Yes	2.8%
	DC: Density of Connections/ km of mains = Ns/Lm	69.5		3.0%
В	Lp: Average pipe length, property line to meter (m)	10.2	7	2.4%
	Lp: Total pipe length, property line to meter (km)	63,94		3.7%
Α	P: Average pressure when system pressurised (psi)	62,0	112000	1.0%
	P: Average pressure when system pressurised (m)	43,8	Yes	1.0%

Notes: If Lm and Lp are in	km	and pres	sure P is in	metres
UBL in litres/hour =	(20 x Lm	+ 1.25 x Nt +	33 x Lp) x	(P/50) <sup>1.5</sup>
UARL in litres/day =	(18 x Lm	+ 0.8 x Nt +	25 x Lp) x	Р
COMPONENT OF REAL LOSSES	MI per day	MI in period	SCx1000 in period	95% CLs as +/
UBL: UNAVOIDABLE BACKGROUND LEAKAGE	0.23	85	37.9	2.4%
UARL: UNAVOIDABLE ANNUAL REAL LOSSES	0.36	132	59.0	2.1%
CARL: CURRENT ANNUAL REAL LOSSES	2.02	737	328.9	14.6%
POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL	1,66	605	269.9	17.8%

IWA BEST PRACTICE PERFORMANCE INC	ICATOR	UNITS OF PERFORMANCE INDICATOR	Best estimate	95% CLs as +/- %	Lowest Estimate	Highest Estimate
Non Revenue Water Basic (IWA Level 1,	Fin36)	% of System Input by Volume	25.1	12,8%	21,9	28,3
Non Revenue Water Basic (IWA Level 1,	Fin37)	% of System Input by Value	14.7	12.8%	12.8	16.5
Apparent Losses (IWA Op23)	Best Op23 Pt >	% of Water Supplied (Distribution Systems)	0.7	34.1%	0.5	1.0
,,		% of System Input Volume (Bulk Supply Systems)	0.7	34.1%	0.5	1.0
Real Losses Basic (IWA Level 1, Op24)	Best Op24 PI >	Litres/service connection/day, when system pressurised	321	14.8%	273	369
The second control of		m3/km of mains/day, when system pressurised	22.3	14.6%	19.0	25.6
Real Losses Detailed (IWA Level 3, Op	25)	Infrastructure Leakage Index ILI (non-dimensional)	5,58	14.7%	4.76	6.40

### Comments:

Region billing equation = 1D4+5D1-5D2+5D3+5D4; Calibration reports as follows:

SD1 & SD2 - May 20
SD3 - May 24
SD4 - No report
SD4 - No report
SD4 - No report for May 4 illustrates the meter was significantly under-registering and was repaired.
- calibration report on Oct. 13 illustrates the meter was again under-registering and was repaired.

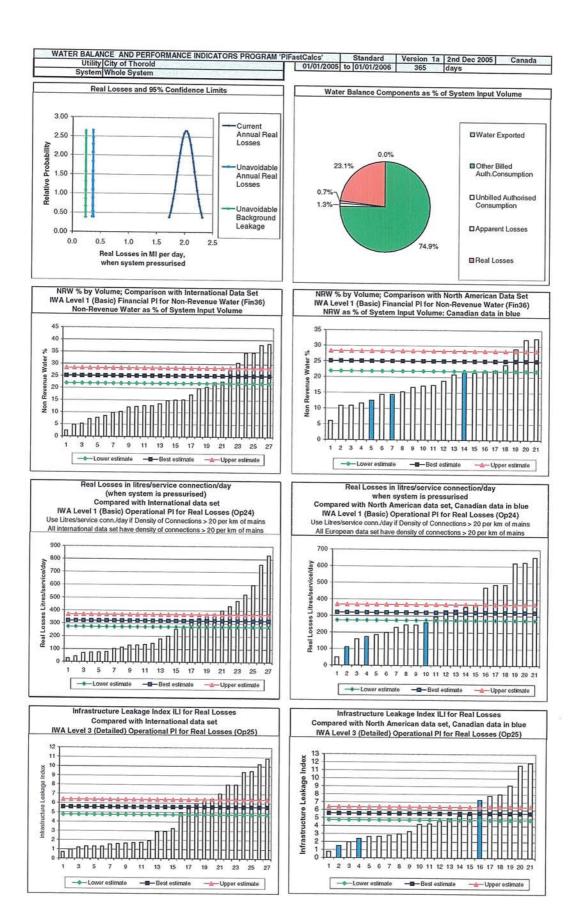
Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

Total length of watermain allow for 3 m per hydrant

Part		WATER	BALANCE	AND PE	ERFORMAI	NCE INDI	WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'	GRAM 'PIFast	tCalcs'	A THE PARTY OF THE
Canicipation by   Canicipati	DETAILED CALCULATION OF COMPON	ENTS OF AU	THORISED AND	UNAUTHOR	RISED CONSU	MPTION		Data entry	Calculated Values	From another Workshe
Billed   Unmetered   Unmeter	Utility City of Thorold System Whole System			W			Calculation by		5	
Metered   Unmetered   Unmete		1		The second second			(a journancino			Date
Metered Unmetered Consumption =	ombonents of Authorised Consumption	700	Components in	MI		Total	Add	tional information o	n sources of data and	basis of estimates
0.00   MI		Metered	Unmetered	Metered	Unmetered	lotai		# #	E = estimated Based on recordings	
0.00  Output  MI  MI  MI  MI  MI  MI  MI  MI  MI  M						0.00			0	
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00.0				
0.00 MI						00.00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00:00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00.00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						0000				
0.00 MI						000				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00'0				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00.0				
0.00 MI		3	3			00.0				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00:00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00.0				
0.00 0.00 MI						00:00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00:00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00:00				
0.00 000 0.00 MI						00.00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						0.00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						0.00				
0.00 0.00 MI						0.00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						0.00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						0.00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						0.00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						0.00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00.0				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						0.00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						00.00				
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0						0.00				
0.00   0.				Ī		0000				
0.00   0.						00:00				
MI M	S	0.00	00:0	00.0	00:00	00:00	IW			
MI (1000) [MI (1000) [MI (1000) [MI (1000) [MI (1000) [MI (100) [MI (1000) [M	Authoris	ed Unbilled U	Inmetered Cons	umption =	0.000%	of Water Sup	plied, transfer this	igure to Cell E21 of	'WaterBalance&Pis' W	orksheet
0.00 MI	oponents of Unauthorised Consumption	IW					Mothod of	noitemitee		
sub-total										
sub-total										
sub-total										
sub-total										
	Unauthorised consumption sub-total	00:0	MI							



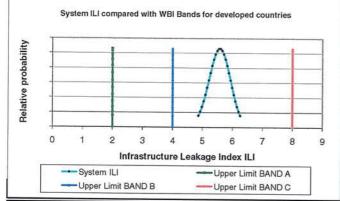
# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | City of Thorold

# THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES

### World Bank Institute (WBI) Guidelines

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

Developing Countries	Developed Countries	BAND	Calculated ILI for this	General description of Real Loss Management Performance Categories for Developed and Developing
ILI range	ILI range		System	Countries
Less than 4	Less than 2	Α		Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement
4 to < 8	2 to < 4	В	Size s	Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance
8 to < 16	4 to < 8	С	5.6	Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
16 or more	8 or more	D		Very inefficient use of resources; leakage reduction programs imperative and high priority



WBI Recommendations for BANDS	A	В	С	D
Investigate pressure management options	Yes	Yes	Yes	
Investigate speed and quality of repairs	Yes	Yes	Yes	
Check economic intervention frequency	Yes	Yes		
Introduce/improve active leakage control		Yes	Yes	
Identify options for improved maintenance		Yes	Yes	
Assess Economic Leakage Level	Yes	Yes		
Review break frequencies		Yes	Yes	
Review asset management policy		Yes	Yes	Yes
Deal with deficiencies in manpower, training and communications			Yes	Yes
5-year plan to achieve next lowest band			Yes	Yes
Fundamental peer review of all activities				Yes

GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed countries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

Target ILI Range	This System ILI	Water Resources Considerations	Operational Considerations	Financial Considerations
1.0 - 3.0		Available resources are greatly limited and are very difficult and/or environmentally unsound to develop	infrastructure and/or additional water resources to meet the demand	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability
3.0 - 5,0		management interventions (leakage management water conservation) are	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population
5.0 - 8.0	5.6			Cost to purchase or obtain/treat water is low, as are rates charged to customers
Greater than 8.0		Although operational and financial considera utilization of water as a resource. Setting a target air discouraged	itions may allow a long-term ILI greater than a arget level greater than 8.0 - other than as an	8.0, such a level of leakage is not an effectiv incremental goal to a smaller long-term

Note: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalcs Standard software. This has allowed the development of the ELLCalcs standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

Important Footnote: the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The PressCalcs Standard Software provides more detailed information on this topic.

U.S.	'LEAKS' Suite of LEAKAGI	E EVALUATION and A	ASS	ESSME	ENT KNOV	V-HOW SOFTW	ARF		100
	ER BALANCE AND PERFORMANCE INDICATORS	S PROGRAM 'PIFastCalcs'		tandard			_	anada	Master,0000
	OPTIONAL DATA ENTRY SHEET FOR ANNUAL ST City of Thorold		,	Dat	a entry	Calculated Values	Fro	m anoth	er Worksheet
		01/01/2005	to		1/2006	Number of Days in P	eriod	365	days
System	Whole System	Calculatio	n by	Steve	Genser	Date of calculat	ion =	1	2/4/2006

Total running costs as calculated below = 0.0 SCx1000 Transfer this figure to Cell L30 of WaterBalance&Pis' Worksheet

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing: this report should be consulted for further guidance as necessary.

[a			Group total	
Operational Costs		SCx1000	\$Cx1000	INCLUDES
Imported water	Raw water		0.0	BULK SUPPLY IMPORTS: total payments for imported raw water
	Treated water			BULK SUPPLY IMPORTS: total payments for imported treated water
	Raw water			
Energy	Treatment		0.0	POWER: all energy costs for water supply electricity and fuel for motive machinery
	Transmission		President Control	The first and one regy cooks for water supply electricity and item for motive machinery
	Distribution			
	Outsourcing			Outsourcing of technical or administrative services, such as consultants, contractors undertakin operational tasks, meter reading and accounting fees
External services:	Software licences and IT support		0.0	Licence fees on computer software and technical support by software companies
Outsourcing	Associated Companies			Costs of associated companies that are not included in other items
	Third party services			Operating costs of providing water services to third parties (other than the regulated water supply function) that are not included in other items
	Premises			Payments for leasing or renting premises
	Vehicles			Payments for leasing or renting vehicles
Leasing and Rentals	Mobile Plant		0.0	Payments for leasing or renting mobile plant
177	Fixed Plant			Payments for leasing or renting fixed plant
	Equipment			Payments for leasing or renting fixed plant
				All water treatment chemicals for water and but he had a second to the second s
	Water treatment chemicals			All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems
Purchases	Other than chemicals and		0.0	All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for
	energy			operation of sources, treatment plants, transmission and distribution systems
Taxes, levies and fees	All kinds		0.0	Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates
Exceptional earnings and losses	All kinds		0.0	Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets
	Other direct costs			Any other operating costs (but excluding interest and taxation, on an aggregated basis)
	General and support expenditures			The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded)
Other Operating Expenditures	Customer services		0.0	Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling.
	Scientific services			Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items
	Other business activities			Costs directly associated with other business activities that are not included in previous items, except for cost depreciation
	Doubtful debts			Charge/credit to the profit and loss account for bad and doubtful debts
Sum of Operational Costs	All the above operational costs		0.0	
Internal manpower costs	Employment costs		0.0	The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer
Capitalised cost of self-constructed assets	Negative allocation			The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets
Total Running Costs	Sum of Operationa Internal Manpower C capitalised cost constructed a	osts, minus of self-	0.0	

Comments:		

**Appendix O** 

PIFastCalc Output West Lincoln

	WATER BALANCE AND PERFORMANCE INC					Standard	Version 1a	2nd De	2005		Canada			
	ANNUAL WATER BALANCE CALCULATION IN IWA STANDA			111111111111111111111111111111111111111		Data entry	Defaults	Calculate	d Values	From and	ther Worksheet			
	Note:Calculations should be based on a 12-month period for a	Il aspects of the wo	rksheet to	function correc	tty	Currency =	\$C	Volume units	MI	and	m <sup>3</sup>			
Utility	Township of West Lincoln	Bulk supply (BS) or System (D		DS		01/01/2005	to	01/01/2005		365	days			
	Whole System	Do most custon storage tai		No		Calculation by	Steve	Genser	Date	4	Dec-06			
Process lability Band	WATER BALANCE CALCUI	ATIONS			Volume in period	95%		FINANCIAL		ICE INDICATO	ORS FOR NON-			
Proces Reliability	IWA Terminology				period	Confidence Limit as +/- %	Variance	% of System	Calandarad	V. I				
36	COMPONENTS OF WATER BALANCE				MI			Input Volume		value of NHV nning Costs i	as % of Syste n Period			
	WOS: Volume from Own Sources (corrected for known systema	tic errors)					0	0.0%	4	ator.				
A	WI: Water Imported (corrected for known systematic errors)				827.4	3.0%	160	100.0%	No.	Individual enuo Water	eyetom			
	SIV: SYSTEM INPUT VOLUME				827.4	3.0%	160	100.0%	o ate o	Value of Individ Non Revenue V	Ás D			
	BACE:Water Exported						0	0.0%	onor Wat	n Be	cost of running			
	WS: WATER SUPPLIED = SIV - BACE				827.4	3.0%	160	100.0%	am o	N N	10			
A/B	BACM1: Billed Authorised Consumption: Metered	Resi	dential / ICI		558.8	1.5%	18	67.5%	Rev	Accessed Unit	cost			
A	BACM2: Billed Authorised Consumption: Metered	Bul	k metering		162,7	1.5%	2	19.7%	Asse	Asse	Assessed marginal cost of individual components of Non-Revenue Water	Asse	9000	5
	BACM3: Billed Authorised Consumption: Metered						0	0.0%	Ē	Acc	35			
BACU: Billed Authorised Consumption:Unmetered							0	0.0%	\$C/m3	\$Cx1000	%			
NRW: NON-REVENUE WATER						24.8%	180	12.8%	0.4598	48.7	13,1%			
A	UACM: Unbilled Authorised Consumption: Metered			0	0.0%	0,4460	0.0	0.0%						
D	UACU: Unbilled Authorised Consumption: Unmetered:	Estimated as	1.250%	of WS	10.3	100.0%	28	1,3%	0.4460	4.6	1,2%			
	WL WATER LOSSES				95.6	29.6%	208	11.6%	0,4613	44,1	11,8%			
C	UC: Unauthorised Consumption:	Estimated as	0.020%	of WS	0.2	50.0%	0	0.0%		0.0	0.0%			
B/C	ALMUR1: Apparent Loss - meter under-registration:	Residential / ICI	0.60%	of BACM1	2.8	7.0%	0	0.3%	0,7919	2.2	0.6%			
	ALMUR2: Apparent Loss - meter under-registration:	Bulk metering	1.00%	of BACM2	1.6	7.0%	0	0.2%	0,7919	1.3	0.3%			
1000	ALMUR3: Apparent Loss - meter under-registration:			of BACM3 and UACM	0.0		0	0.0%	0.7919	0.0	0.0%			
D	ALDCD Customer meter data handling errors						0	0.0%	0.7919	0.0	0.0%			
	AL: Sum of APPARENT LOSSES				4.6	5,2%	0	0.6%	0.7635	3,5	0.9%			
	RL: REAL LOSSES				91.0	31.1%	208	11.0%	0.4460	40.6	10.9%			
A	% of period system pressurized =	100.0%	365.0	days			Cost o	running system	193155	372.8	5Cx1000			

Process Reliability Band	SYSTEM INFRASTRUCTURE AND PRESSURE DA	ATA	Valid for UARL& ILI calc?	95% CLs as +/- %
Α	Lm: Mains Length, km	28.53	No	1.0%
Α	Nh: Number of Fire Hydrants	175		1.0%
В	Nb: Number of Separately Billed Properties	1765	7	2.0%
В	R: Ratio of billed Service Connections (Ns. main to property line) to Billed Props (Nb)	1.000		2.0%
	Ns: No. of billed Service Connections	1755		2.8%
В	Nu: Number of Unbilled Service Connections	6	1	16,0%
	Nt: Total Number of Service Conns (= Ns + Nu), mains to property line	1761	No	2.8%
	DC: Density of Connections/ km of mains = Ns/Lm	61.7		3.0%
В	Lp: Average pipe length, property line to meter (m)	9.0	i i	11.0%
	Lp: Total pipe length, property line to meter (km)	15.80		11,4%
В	P: Average pressure when system pressurised (psi)	62,0	8/24	10.0%
	P: Average pressure when system pressurised (m)	43.8	Yes	10.0%

Notes: If Lm and Lp are in	km	and pres	sure P is in	metres
UBL in litres/hour =	(20 x Lm +	1.25 x Nt +	33 x Lp) x	(P/S0) <sup>1,5</sup>
UARL in litres/day =	(18 x Lm +	0.8 x Nt +	25 x Lp) x	Р
COMPONENT OF REAL LOSSES	MI per day	MI in period	\$Cx1000 in period	95% CLs as +/
UBL: UNAVOIDABLE BACKGROUND LEAKAGE	0.06	24	10.6	15.3%
UARL: UNAVOIDABLE ANNUAL REAL LOSSES	0.10	37	16.5	10.3%
CARL: CURRENT ANNUAL REAL LOSSES	0.25	91	40.6	31,1%
POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL	0.15	54	24.0	52,9%

WA BEST PRACTICE PERFORMANCE INC	ROTADI	UNITS OF PERFORMANCE INDICATOR	Best estimate	95% CLs as +/- %	Lowest Estimate	Highest Estimate
Non Revenue Water Basic (IWA Level 1,	Fin36)	% of System Input by Volume	12.8	25.0%	9.6	16.0
Non Revenue Water Basic (IWA Level 1,	Fin37)	% of System Input by Value	13.1	25.0%	9.8	16.3
Apparent Losses (IWA Op23)	Best Op23 PI >	% of Water Supplied (Distribution Systems)	0.6	6.0%	0.5	0.6
		% of System Input Volume (Bulk Supply Systems)	0.6	6.0%	0.5	0.6
Real Losses Basic (IWA Level 1, Op24)	Best Op24 PI >	Litres/service connection/day, when system pressurised	142	31.2%	97	186
The second control of the second of the seco		m3/km of mains/day, when system pressurised	8.7	31.1%	6.0	11.5
Real Losses Detailed (IWA Level 3, Op	25)	Infrastructure Leakage Index ILI (non-dimensional)	2,45	32.7%	1.65	3.26

Water supplied via Regional Municipality of Niagara's Grimsby Water Treatment Plant via Mudstreet.

Meter (ID 6D2). Meter Calibration Report dated May 24, 2005.

AM Billing Data broken into Quantities Metered each month combines monthly reads and quarterly reads. Second catagory is Bulk Metering with monthly record.

Process Reliability Bands:

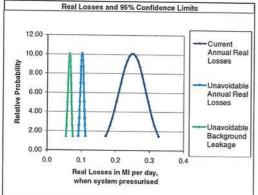
- A actual data
  B calculated based on actual data
  C calculated estimate
  D no data / default

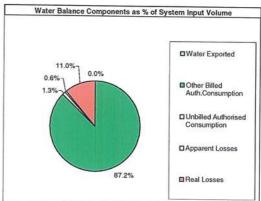
Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

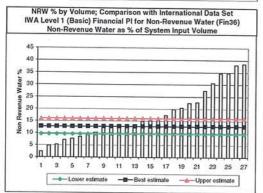
Total length of watermain allow for 3 m per hydrant

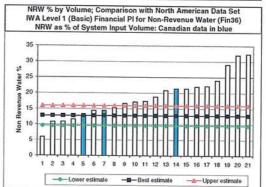
	WATE	3 BALANCE	AND PI	ERFORMA	NCE INDI	CATORS PRC	WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs	tCalcs'		
	NENTS OF A	JTHORISED AN	O UNAUTHO	RISED CONSU	MPTION		Data entry	Calculate	Calculated Values	From another Worksheet
Utility Township of West Lincoln						01/01/2005 to	01/01/2006 =	365	days	
system whole system				S 00 00		Calculation by	Steve Genser			Date 2nd July 2005
		Components in MI	MI		0 18	Add	Additional information on sources of data and basis of estimates	n sources o	f data and be	asis of estimates
Components of Authorised Consumption	Billed	Billed	Unbilled	Unbilled Unmetered	Total		000	E = estimated	ted	
Quantities Metered					0.00				200	
January	0.113	m			0.11	R = Based on recordings	dinas			
February	0.148	8			0.15		ilings			
March	139.669				139.67		dings			
April	0.175				0.18		Sings			
May	0.239				0.24		dings			
life	137.622				137.62		dings			
August	0.862				0.20		dings			
September	172.256				172.26	R = Based on recordings	Spings			
October	0.208				021		- Finds			
November	0.402				0.40		linds			
December	106.889				106.89		lings			
					00.00					
bulk Metering	0				00.0					
Sahuary	9.118				9.12		lings			
March	13 706				11.22	H = Based on recordings	lings			
April	8.730				B 73		Shings			
May	21.174				21.17		ings			
June	21.061				21.06		ings			
July	20.726				20.73		lings			
August	13.009				13.01		ings			
September	8.567				8.57	R = Based on recordings	ings			
October	15,538						ings			
November	7.196				7.20	R = Based on recordings	ings			
December	12.613				12.61	R = Based on recordings	lings			
					0.00					
					0000					
					00:00					
Authorised consumption sub-totals	721.45	00'0	0.00	00.00	721.45	W				
Authorik	sed Unbilled	Authorised Unbilled Unmetered Consumption =	= uoitduns	0.000%	of Water Sup	plied, transfer this	0.000% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet	WaterBalar	ce&Pis' Wor	ksheet
Components of Unauthorised Consumption	IW					Method of estimation	estimation			
Hydrant (contractors not metered)	0.08	Felimated								
By-passes or theft	0.08	Estimated								
Insufficient concumption only total	0.47									
olidadillosed collodillosidil sub-total		IMI								

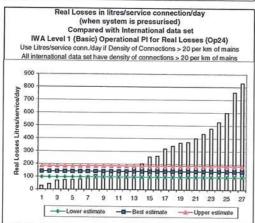


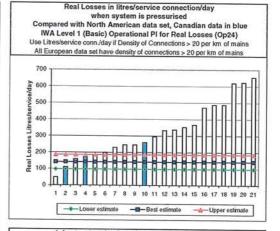


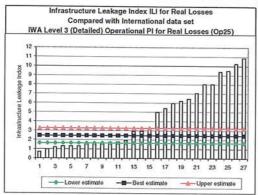


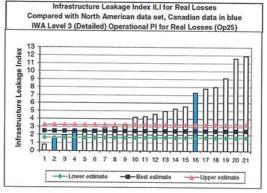












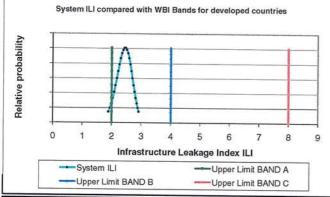
#### 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' PIFastCalcs Standard Version 1a 2nd Dec 2005 Canada Master.0000 Township of West Lincoln

# THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES

## World Bank Institute (WBI) Guidelines

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs. which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

Developing Countries	Developed Countries	BAND	Calculated ILI for this	General description of Real Loss Management Performance Categories for Developed and Developing
ILI range	ILI range		System	Countries
Less than 4	Less than 2	Α		Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement
4 to < 8	2 to < 4	В	2.5	Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance
8 to < 16	4 to < 8	С		Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
16 or more	8 or more	D		Very inefficient use of resources; leakage reduction programs imperative and high priority



WBI Recommendations for BANDS	Α	В	С	D
Investigate pressure management options	Yes	Yes	Yes	
Investigate speed and quality of repairs	Yes	Yes	Yes	
Check economic intervention frequency	Yes	Yes		
Introduce/improve active leakage control		Yes	Yes	
Identify options for improved maintenance		Yes	Yes	
Assess Economic Leakage Level	Yes	Yes		
Review break frequencies		Yes	Yes	
Review asset management policy		Yes	Yes	Yes
Deal with deficiencies in manpower, training and communications			Yes	Yes
5-year plan to achieve next lowest band			Yes	Yes
Fundamental peer review of all activities				Yes

GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive

Target ILI Range	This System ILI	Water Resources Considerations	Operational Considerations	Financial Considerations
1.0 - 3.0	2.5	unsound to develop	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability
3.0 - 5.0		management.water conservation) are	demand as long as reasonable leakage management controls are in place	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population
5.0 - 8.0		easily abstracted		Cost to purchase or obtain/treat water is low, as are rates charged to customers
Greater than 8.0		Although operational and financial considera utilization of water as a resource. Setting a ta target - is discouraged.	tions may allow a long-term ILI greater than arget level greater than 8.0 - other than as an	8.0, such a level of leakage is not an effective incremental goal to a smaller long-term

Note: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalcs Standard software. This has allowed the development of the ELLCalcs standard software to calculate short-term Economic Leakage Level for an active eakage control policy of regular survey

Important Footnote: the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The PressCalcs Standard Software provides more detailed information on this topic.

2016	'LEAKS' Suite of LEAKAGE	EVALUATION and	ASS	ESSM	ENT KNOW	LHOW COETW	ADE		
WAT	EN BALANCE AND PERFORMANCE INDICATORS	PROGRAM 'PIFastCalcs'		tandard	Version 1al		_		1.
	OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS							anada	Master.0000
Utility	Utility Township of West Lincoln 01/01/2005				ta entry				er Worksheet
	Whole System	1/2/10/10/10	to		1/1/2006 Number of Da		eriod	365	days
	- The state of the	Calculatio	n by	Stev	e Genser	Date of calculat	ion =	1:	2/4/2006

Total running costs as calculated below = 0.0 | SCx1000 | Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 | Substate | Crown tests | Cro

Operational Costs		\$Cx1000	Group total	
a contract of the contract of	Raw water	\$CX1000	\$Cx1000	INCLUDES
Imported water	Treated water		0.0	BULK SUPPLY IMPORTS: total payments for imported raw water
	Raw water		A STORES LO	BULK SUPPLY IMPORTS: total payments for imported treated water
-	Treatment			
Energy	Transmission		0.0	POWER: all energy costs for water supply electricity and fuel for motive machinery
	Distribution			
	Outsourcing			Outsourcing of technical or administrative services, such as consultants, contractors undertakin operational tasks, meter reading and accounting fees
External services:	Software licences and IT support		0.0	Licence fees on computer software and technical support by software companies
Outsourcing	Associated Companies		0.0	Costs of associated companies that are not included in other items
	Third party services			Operating costs of providing water services to third parties (other than the regulated water supply function) that are not included in other items
	Premises		THE RESERVE OF STREET	Payments for leasing or renting premises
	Vehicles			Payments for leasing or renting premises
Leasing and Rentals			0.0	Payments for leasing or renting mobile plant
	Fixed Plant			Payments for leasing or renting fixed plant
	Equipment			Payments for leasing or renting equipment
	Water treatment chemicals			All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants, transmission and distribution systems
Purchases	Other than chemicals and energy		0.0	All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for
Taxes, levies and fees	All kinds		0.0	operation of sources, treatment plants, transmission and distribution systems  Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates
Exceptional earnings and losses	All kinds		0.0	Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets
	Other direct costs			Any other operating costs (but excluding interest and taxation, on an aggregated basis)
	General and support expenditures			The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded)
Other Operating Expenditures	Customer services		0.0	Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling.
	Scientific services			Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items
	Other business activities			Costs directly associated with other business activities that are not included in previous items, except for cost depreciation
	Doubtful debts			Charge/credit to the profit and loss account for bad and doubtful debts
Sum of Operational Costs	All the above operational costs		0.0	
Internal manpower costs	Employment costs		0.0	The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer
Capitalised cost of self-constructed assets	Negative allocation		0.0	The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets
Total Running Costs	Sum of Operational Internal Manpower C capitalised cost constructed as	osts, minus of self-	0.0	

Comments:	