Appendix 1-D

Water Loss and Water Loss Audits

The TWDB established new requirements requiring water audit reporting for public utilities that provide potable water. Every five years public utilities must perform a water audit computing the utility's most recent annual water loss. This appendix provides the Executive Summary and water loss comparison by regional water planning area from the report prepared for the TWDB entitled, *An Analysis of Water Loss as Reported by Public Water Suppliers in Texas*.

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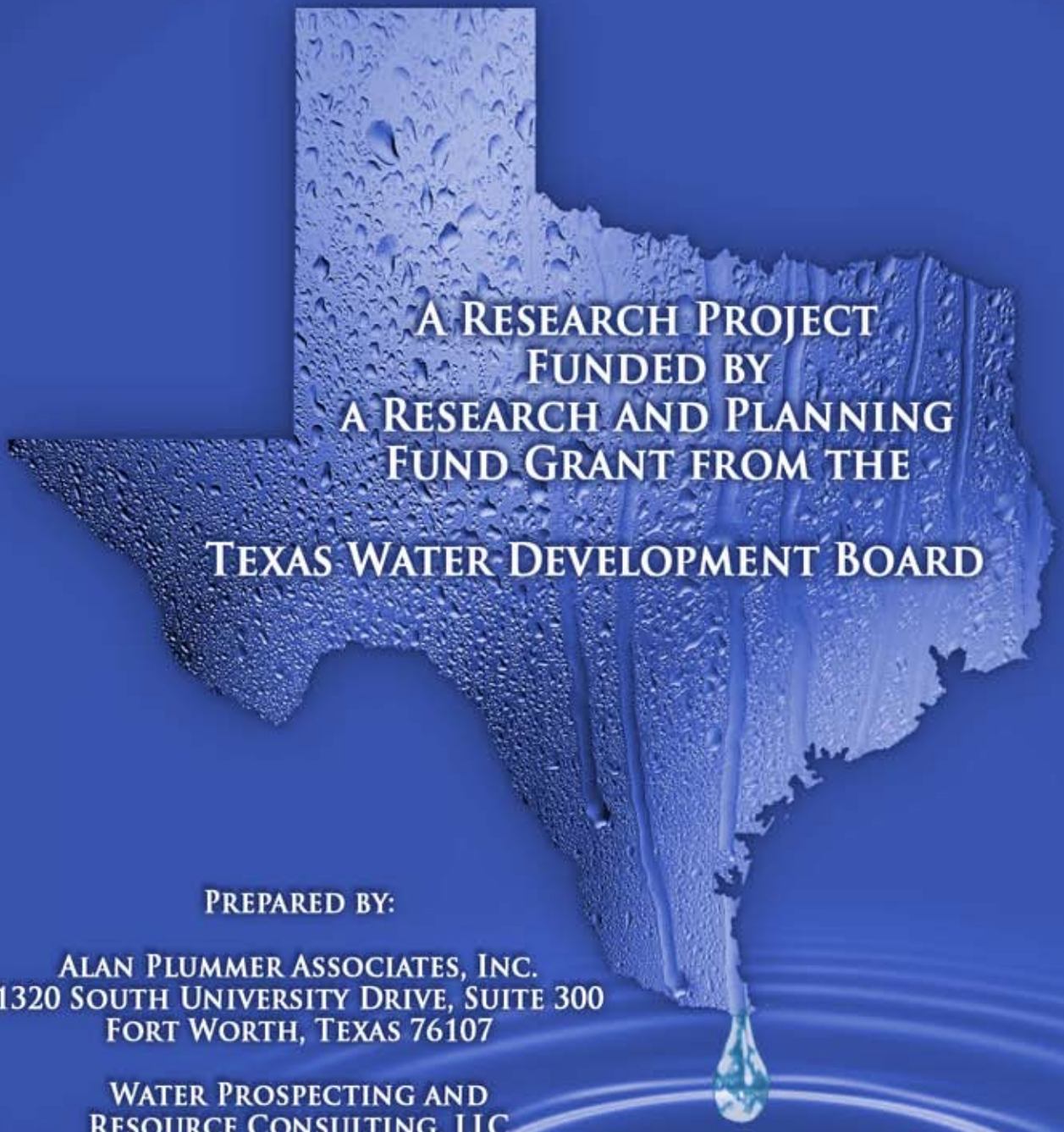
Final Report

An Analysis of Water Loss as Reported by Public Water Suppliers in Texas



A Research Project
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Texas Water Development Board

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January 24, 2007

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1 EXECUTIVE SUMMARY – ANALYSIS OF WATER LOSS

The first broad analysis of water loss for retail public utilities in Texas reveals that:

- Approximately half of retail public utilities in Texas reported their water loss data.
- Reporting utilities serve as much as 84 percent of the state's population.[1]
- A substantial amount of water (the balancing adjustment) was not attributed to any water use category, causing significant uncertainty in estimates of water loss and non-revenue water.
- Reporting utilities experienced total water loss[2] of 212,221 to 464,219 acre-feet per year,[3] or 5.6 to 12.3 percent[3] of all water entering the reporting systems. Based on the 2004 statewide average municipal water use of 150 gallons per capita per day,[A,4] equivalent water volumes could supply between 1.3 million and 2.7 million Texans.[5]
- Reporting utilities experienced non-revenue water[6] of 311,333 to 563,331 acre-feet per year,[3] or 8.3 to 15.0 percent[3] of all water entering the reporting systems.
- When extrapolated to all retail public utilities in Texas, the statewide value of total water loss is estimated to be between $152 million and $513 million per year.
- Reporting utilities may have underestimated their real water loss.

This research provides information necessary for the Texas Water Development Board (TWDB), Regional Water Planning Groups (RWPGs), and retail public utilities to direct planning and funding resources, to recover lost revenue through reduction of non-revenue water, and to achieve water savings through reduction of real loss.

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1 This percentage is uncertain because some utilities reported both retail and wholesale customer populations.

2 Total water loss includes real loss (water that was physically lost from the system, such as main breaks and leaks, customer service line breaks and leaks, and storage overflows) and apparent loss (water that was not accurately measured and billed to a customer, such as unauthorized consumption, customer meter under-registering, and billing adjustment and waivers).

3 The smaller number is the total reported by the utilities. The larger number is based on the assumption that the entire balancing adjustment is water loss.

4 References are denoted with letters and are presented in Chapter 17. Footnotes are denoted with numbers and are presented at the bottom of the same page.

5 However, it is not possible to recover all water loss.

6 Non-revenue water includes real loss, apparent loss, and unbilled authorized consumption. Unbilled authorized consumption includes water used for fire fighting, sewer flushing, etc.

1.A Introduction

Water loss minimization can be an important water conservation strategy for retail water suppliers. Historically, retail public utilities have lacked detailed knowledge about their water loss performance. This is due partially to a lack of careful water auditing and partially to inconsistent water loss reporting using non-uniform statistics, including the use of "unaccounted-for water" percentages to compare performance. As a result, utilities may not know whether their water losses are due to leaks, accounting practices, theft, metering problems, or other factors, and may have difficulty developing water loss minimization strategies.

To address the lack of information on water loss, the 78th Texas Legislature passed House Bill 3338, which required retail public utilities that provide potable water to "perform and file with the [Texas Water Development Board] a water audit computing the utility's most recent annual system water loss"[B] every five years. Under this authority, the Texas Water Development Board (TWDB) instituted new water audit reporting requirements[C] that require retail public utilities to carefully audit their system water use at least once every five years; to estimate system water use in standard, well defined categories; and to report their first set of water loss data to the TWDB by March 31, 2006.

The new water audit reporting requirements follow a methodology that is recommended by the International Water Association (IWA) and the American Water Works Association (AWWA) Water Loss Control Committee. This methodology relies on strictly defined water use categories (Table 1-1) and water loss performance indicators and is becoming the international water loss accounting standard. The IWA Water Loss Task Force (which included AWWA participation) developed this methodology from 1997 through 2000.[D] The first reference to the methodology's performance indicators was published in 2000.[E (cited in D)]

The U.S. Bureau of Reclamation (BOR) has designated a number of "hot spots" in the Western U.S. where existing water supplies are projected to be inadequate to meet the demands of people, farms, and the environment by the year 2025, including six hot spots in Texas.[F] As part of the Water 2025 Program, the BOR offered Challenge Grants to fund projects related to "water conservation, efficiency and markets and collaboration. Recognizing this program as an

opportunity to partner with the BOR, to leverage its existing budget, and to enhance conservation technical assistance, the TWDB applied for and received a Challenge Grant for two purposes: 1) to purchase 10 acoustical leak-detection units and make them available to public water suppliers, and 2) to perform an analysis of water loss in Texas, using water loss data provided by public water suppliers. The TWDB solicited proposals for the analysis of water loss and subsequently awarded a Research and Planning Fund Grant to the research team of Alan Plummer Associates, Inc., and Water Prospecting and Resource Consulting, LLC.

This executive summary describes the results of a research project to examine the reported water loss data for consistency, errors, omissions, and other quality control issues; to calculate water loss performance statistics; to compare water loss performance by utility location, type, and size; and to make recommendations for improving the water audit reporting process. The details of the data quality control are discussed in later chapters. A statewide summary of water loss performance, comparative analysis of water loss performance, and recommendations are presented below.

1.B Statewide Summary of Water Loss Performance

For reporting utilities, statewide totals for each water use category are shown in Table 1-1 (acre-feet), Table 1-2 (gallons), and Table 1-3 (percent of corrected input volume). The total reported corrected input volume[7] is 3,761,965 acre-feet over approximately one year. This figure includes retail water sales and wholesale water sales[8] for the reporting utilities.

The balancing adjustment in Table 1-1 through Table 1-3 is the water volume remaining after authorized consumption and total water loss are subtracted from the amount of water that entered the utility system (the corrected input volume). If a utility perfectly accounts for its water use, the balancing adjustment equals zero.

[7] Corrected input volume is the amount of water that was actually delivered to a utility, including water that was not measured by the master meter(s).

[8] A retail water sale is the sale of water to the end user. A wholesale water sale is the sale of water to a utility that resells the water.

Table 1-1: Statewide Totals of Reported Water Loss* (acre-feet)

<table>
<tr><td rowspan="8">Corrected input volume
(3,758,484)</td><td rowspan="4">Authorized consumption
(3,294,265)</td><td rowspan="2">Billed authorized consumption
(3,195,153)</td><td>Billed metered consumption
(3,190,972)</td><td rowspan="2">Revenue water
(3,195,153)</td></tr>
<tr><td>Billed unmetered consumption
(4,181)</td></tr>
<tr><td rowspan="2">Unbilled authorized consumption
(99,112)</td><td>Unbilled metered consumption
(52,698)</td><td rowspan="6">Non-revenue water
(311,333)</td></tr>
<tr><td>Unbilled unmetered consumption
(46,414)</td></tr>
<tr><td rowspan="5">Water losses
(212,221)</td><td rowspan="3">Apparent losses
(109,310)</td><td>Unauthorized consumption
(10,770)</td></tr>
<tr><td>Customer meter under-registering
(87,218)</td></tr>
<tr><td>Billing adjustment and waivers
(11,322)</td></tr>
<tr><td rowspan="3">Real losses
(102,910)</td><td>Main breaks and leaks
(83,529)</td></tr>
<tr><td>Storage overflows
(3,341)</td></tr>
<tr><td>Customer service line breaks and leaks
(16,040)</td></tr>
<tr><td colspan="4">Balancing Adjustment**
(251,998)</td></tr>
</table>

* Over approximately one year. Most utilities reported data for calendar or fiscal year 2005.

** Balancing adjustment is the corrected input volume minus authorized consumption minus total water loss. If all water is fully attributed to the various potential uses, balancing adjustment is zero. Balancing adjustment may consist of underestimated real loss, apparent loss, or authorized consumption. Without further refinement of a utility's water audit, there is no accurate *ad hoc* method for determining the actual water use for water that has been allocated to balancing adjustment.

Table 1-2: Statewide Totals of Reported Water Loss* (gallons)

<table>
<tr><td rowspan="10">Corrected input volume
(1,224,705,675,107)</td><td rowspan="4">Authorized consumption
(1,073,439,695,489)</td><td rowspan="2">Billed authorized consumption
(1,041,143,853,511)</td><td>Billed metered consumption
(1,039,781,485,415)</td><td rowspan="2">Revenue water
(1,041,143,853,511)</td></tr>
<tr><td>Billed unmetered consumption
(1,362,368,096)</td></tr>
<tr><td rowspan="2">Unbilled authorized consumption
(32,295,841,978)</td><td>Unbilled metered consumption
(17,171,730,325)</td><td rowspan="7">Non-revenue water
(101,448,133,344)</td></tr>
<tr><td>Unbilled unmetered consumption
(15,124,111,653)</td></tr>
<tr><td rowspan="6">Water losses
(69,152,291,366)</td><td rowspan="3">Apparent losses
(35,618,824,222)</td><td>Unauthorized consumption
(3,509,318,446)</td></tr>
<tr><td>Customer meter under-registering
(28,420,204,130)</td></tr>
<tr><td>Billing adjustment and waivers
(3,689,301,646)</td></tr>
<tr><td rowspan="3">Real losses
(33,533,467,144)</td><td>Main breaks and leaks
(27,218,129,878)</td></tr>
<tr><td>Storage overflows
(1,088,723,441)</td></tr>
<tr><td>Customer service line breaks and leaks
(5,226,613,826)</td></tr>
<tr><td colspan="4">Balancing Adjustment**
(82,113,688,252)</td></tr>
</table>

* Over approximately one year. Most utilities reported data for calendar or fiscal year 2005.

** Balancing adjustment is the corrected input volume minus authorized consumption minus total water loss. If all water is fully attributed to the various potential uses, balancing adjustment is zero. Balancing adjustment may consist of underestimated real loss, apparent loss, or authorized consumption. Without further refinement of a utility's water audit, there is no accurate *ad hoc* method for determining the actual water use for water that has been allocated to balancing adjustment.

Table 1-3: Statewide Percentages of Reported Water Loss*

<table>
<tr><td rowspan="8">Corrected input volume
(100.0)</td><td rowspan="3">Authorized consumption
(87.6)</td><td rowspan="2">Billed authorized consumption
(85.0)</td><td>Billed metered consumption
(84.9)</td><td rowspan="2">Revenue water
(85.0)</td></tr>
<tr><td>Billed unmetered consumption
(0.1)</td></tr>
<tr><td rowspan="2">Unbilled authorized consumption
(2.6)</td><td>Unbilled metered consumption
(1.4)</td><td rowspan="6">Non-revenue water
(8.3)</td></tr>
<tr><td>Unbilled unmetered consumption
(1.2)</td></tr>
<tr><td rowspan="5">Water losses
(5.6)</td><td rowspan="3">Apparent losses
(2.9)</td><td>Unauthorized consumption
(0.3)</td></tr>
<tr><td>Customer meter under-registering
(2.3)</td></tr>
<tr><td>Billing adjustment and waivers
(0.3)</td></tr>
<tr><td rowspan="3">Real losses
(2.7)</td><td>Main breaks and leaks
(2.2)</td></tr>
<tr><td>Storage overflows
(0.1)</td></tr>
<tr><td>Customer service line breaks and leaks
(0.4)</td></tr>
<tr><td colspan="4">Balancing Adjustment**
(6.7)</td></tr>
</table>

* Over approximately one year. Most utilities reported data for calendar or fiscal year 2005.

** Balancing adjustment is the corrected input volume minus authorized consumption minus total water loss. If all water is fully attributed to the various potential uses, balancing adjustment is zero. Balancing adjustment may consist of underestimated real loss, apparent loss, or authorized consumption. Without further refinement of a utility's water audit, there is no accurate *ad hoc* method for determining the actual water use for water that has been allocated to balancing adjustment.

Some or all of the balancing adjustment is due to underestimation of real and apparent water losses. Without further refinement of a utility's water audit, there is no accurate *ad hoc* method for determining the actual water use for water that has been allocated to balancing adjustment. Therefore, for a given water loss performance indicator, a range of potential values are presented. One end of the range is calculated directly from the reported water loss data, and the other end of the range is based on the assumption that all of the balancing adjustment is unreported water loss (either real or apparent, depending on the performance indicator). The balancing adjustment may be a positive quantity or a negative quantity.

Assuming the real loss is valued at the marginal production water cost and that apparent loss and the balancing adjustment are valued at the retail water cost, the estimated value of total water loss in Texas is between $152 million and $513 million per year.[9] Adding the value of unbilled authorized consumption to these totals gives an estimated value of non-revenue water in Texas between $253 million and $635 million. To increase the reliability and narrow the range of these estimates, the production and retail water costs must be more uniformly reported, and utilities must refine their water accounting, thereby reducing the balancing adjustment.

Statewide median and average water loss performance indicators are shown in Table 1-4. Generally speaking, the balancing adjustment is too large in relation to other quantities to draw reliable conclusions about water loss trends. From all reported data, balancing adjustment was 6.7 percent of total corrected input volume, while real loss was 2.7 percent, and apparent loss was 2.9 percent. On average, therefore, the balancing adjustment is larger than sum of the real and apparent losses. Given similar statistics, an individual utility would not be able to determine whether its best strategy is to reduce real loss or to reduce apparent loss.

The screening-level infrastructure leakage index (SLILI) is the real loss divided by the theoretical unavoidable annual real loss. In theory, the SLILI should not be less than one, because the real loss should not be less than the unavoidable real loss. However, the statewide median SLILI is 0.22 when calculated from reported data. In addition, the statewide median real loss is 3.6 gallons per connection per day, which is only about 23 percent of the lowest identified

[9] This estimate is not fully reliable, because up to 10 percent of the reported production and retail water costs were modified as discussed in Chapters 3.B.13 and 3.B.14. Not all non-revenue water can be recovered.

Table 1-4: Statewide Summary of Reported Water Loss Data

Statistic or Performance Indicator	Units	Median from Reported Data	Median With Balancing Adjustment Assumption	Average from Reported Data	Average With Balancing Adjustment Assumption
Absolute Value of Balancing Adjustment/Corrected Input Volume[10]	%	2.6	2.6	7.1	7.1
Real Loss per Mile of Main Per Day	gal/mi/day	77	233	204	417
Real Loss per Service Connection per Day	gal/conn/day	3.6	18.8	14	51
Apparent Loss per Service Connection per Day	gal/conn/day	6.4	17.5	15	51
Non-Revenue Water/Corrected Input Volume	%	7.3	13.4	8.3	15.0
Value of Real Loss per Mile of Main Per Day	$/mi/day	0.12	0.31	0.24	0.49
Value of Real Loss per Service Connection per Day	$/conn/day	0.004	0.018	0.010	0.040
Value of Apparent Loss per Service Connection per Day	$/conn/day	0.018	0.046	0.042	0.140
Screening-Level Infrastructure Leakage Index (SLILI)[11]	--	0.22	2.04	1.08	4.10

[10] The average of the absolute value balancing adjustment as a percentage of corrected input volume does not match the balancing adjustment percentage shown in Table 9-3, because the balancing adjustment is a negative quantity for some utilities.

[11] Calculation of the Screening-Level Infrastructure Leakage Index was performed only for utilities with 5,000 or more connections and 32 or more connections per mile of main. See discussion in Chapter 5.C.

real loss for a North American system (16 gal/conn/day for Halifax Central, shown in Table 7-1).

Even assuming that the balancing adjustment is unreported real loss, the statewide median SLILI is only 2.04, and the statewide median real loss is 18.8 gal/conn/day. Compared to the American Water Works Association (AWWA) guidelines for ILI goals (Table 7-3) and real loss performance by North American utilities (Table 7-1), these statistics seem to indicate that at least half of reporting utilities have excellent real loss control. However, most utilities in Texas practice real loss control in a reactive way (rather than a proactive way), so it is surprising that half of the reporting utilities have such excellent real loss performance, particularly in comparison to other North American utilities.

Because the actual statewide median SLILI value is so low (somewhere between 0.22 and 2.04), it appears that most reporting utilities have underestimated actual real loss. Furthermore, from comparison to AWWA guidelines and real loss performance by other North American utilities, it appears likely that the actual real loss is underestimated even if the balancing adjustment is treated as real loss. Real loss estimation problems notwithstanding, at least 8 to 30 percent of Texas utilities with more than 5,000 connections and 32 or more connections per mile of main have an SLILI greater than 3.0 (Appendix C).

1.C Comparative Analysis of Water Loss Performance

Water loss performance was also compared on the basis of utility location, type, size, water source, and connection density. The primary findings of the comparative analysis are similar to the findings in the statewide summary: the balancing adjustment is too large to allow identification of trends in the water loss data, and real loss appears to be underestimated. Other findings from the comparative analysis are discussed further in the conclusions and recommendations section (Chapter 1.D).

1.D Recommendations

This report, the first broad analysis of water loss and water loss accounting for retail public utilities in Texas, provides information necessary for the TWDB, RWPGs, and retail public utilities to direct planning and funding resources, to recover lost revenue through reduction of

non-revenue water, and to achieve water savings through reduction of real loss. However, the size of the balancing adjustment results in significant uncertainty in the water loss performance indicators. Recommendations for improving water loss performance and water loss accounting are presented below in the following categories: water loss performance, regional water planning, and TWDB actions.

1.D.1 Water Loss Performance

Recommendations regarding balancing adjustment, real loss, connection density, non-revenue water, and the value of total water loss are discussed below.

Balancing Adjustment

Recommendation #1: Utilities should refine their water audits until the balancing adjustment is small in comparison to the other quantities of interest (*e.g.*, real and apparent water loss) so that reliable conclusions about water loss trends can be drawn. It may be tempting to change the volumes in some water use categories for the sole purpose of eliminating the balancing adjustment. This is not a legitimate way to reduce balancing adjustment: it only disguises the real issues, making it harder to identify what strategies a utility should pursue in the future. To legitimately reduce balancing adjustment, a utility should refine its estimates for each water use category by implementing more accurate measurement and/or estimation procedures.

Recommendation #2: Although utilities are only required to report their water audits every five years, utilities should implement annual or biennial programs to develop the data necessary to gradually reduce the uncertainty in their water audits and should review their water audits annually or biennially. Programs should target the water audit categories with the most uncertain water volume estimates.

Real Loss

Recommendation #3: Because it appears that utilities have underestimated real loss, utilities should refine their water audits to better estimate their actual real loss. This may involve confirmation of existing information (*e.g.*, calibration of production and consumption meters),

additional analysis of existing information, and collection of new information (*e.g.*, flow monitoring in District Metered Areas).

Recommendation #4: Utilities should determine their economic level of leakage (ELL) and should use the ELL as a goal for real loss. Prior to determining an ELL, utilities should strive for a maximum ILI of 3.0 (Table 7-3). Utilities with an SLILI greater than 3.0 and other utilities with significant real loss in comparison to other North American utilities (Table 7-1) should consider implementing real loss control measures.

Water Loss Performance and Connection Density

Recommendation #5: Average real loss per mile of main per day increases with increasing connection density,[12] and average non-revenue water percentage decreases with increasing connection density (Figure I-2 in Appendix I). Reasons for these trends should be identified. Future analysis of water loss performance should consider connection density as an independent variable, along with utility location, type, and size.

Non-Revenue Water

Recommendation #6: Utilities should determine their economic target level for non-revenue water and strive to reduce their non-revenue water to the economic target level. In particular, utilities in Regions I and J should consider steps to recover lost revenue from unbilled authorized consumption, and utilities in Harris, Hidalgo, Nueces, Tarrant, and Travis Counties should consider steps to reduce non-revenue water.

Statewide Value of Total Water Loss

Recommendation #7: The estimated total value of total water loss in Texas is between $152 million and $513 million per year. To increase the reliability and narrow the range of this estimate, the production and retail water costs should be reported in consistent units, and utilities must refine their water accounting, thereby reducing the balancing adjustment.

[12] The number of service connections per mile of main.

1.D.2 Regional Water Planning

Recommendation #8: RWPGs should use the research results to estimate potential water savings from system water audits and water loss prevention strategies and should update the regional water plans as appropriate.

Recommendation #9: The TWDB should work to align the regional water planning cycle and the water audit reporting cycle so that up-to-date water loss data is used in developing the regional water plans.

1.D.3 TWDB Actions to Enhance Water Loss Accounting and Prevention

The TWDB should consider the following general actions to enhance water loss accounting and prevention in Texas:

Recommendation #10: To provide a more comprehensive picture of water loss in Texas, the TWDB should consider extending water auditing requirements to include wholesale utilities that provide raw or potable water. This may require additional authorization from the Legislature.

Recommendation #11: The TWDB should continue to promote water loss prevention to retail public utilities, focusing on the retail public utilities that have the greatest need for water loss reduction.

Recommendation #12: To make the water loss data more comprehensive, the TWDB should continue to seek water audit data from retail public utilities that have not reported.

Recommendation #13: The TWDB should continue to provide equipment, education, and financial assistance to help retail public utilities achieve improved water loss accounting and water loss performance.

Recommendation #14: To minimize the impact of balancing adjustment on the water loss analysis, the TWDB should consider devoting additional personnel and/or resources to assisting utilities with refinement of their water audits.

Recommendation #15: The TWDB should convey the findings, conclusions, and recommendations of this research effort to stakeholders through workshops or other means of communication.

In addition, the water loss reporting process should be revised to help assure data quality and to make the maximum use of reported water loss data. Additional recommendations regarding data quality control and the water loss reporting process are presented in Chapter 16.

10 COMPARATIVE ANALYSIS BY REGIONAL WATER PLANNING AREA

Water loss results were compared across the 16 regional water planning areas in Texas (Figure 10-1). The distribution of reporting utilities and the total corrected input volume is shown by region in Figure 10-2. As discussed in the previous chapter, wholesale water sales are included in the corrected input volume multiple times, so the total corrected input volume does not necessarily reflect total retail water use.

Regional statistics and water loss performance indicators are presented in the following sections.

10.A Regional Statistics

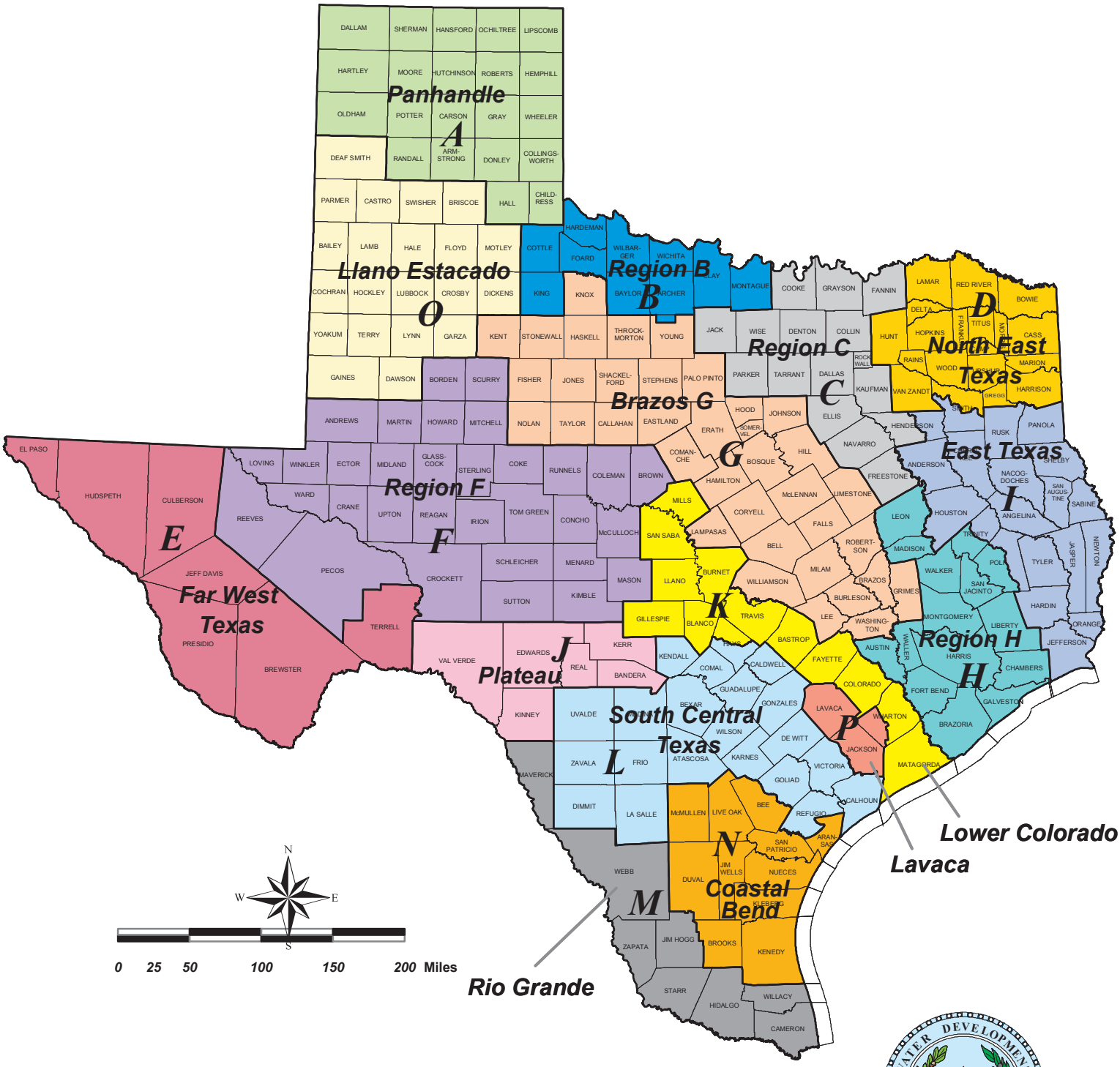
Several additional regional average quantities can be derived from the reported data (Table 10-1). The ranges of the regional averages are:

- Master meter accuracy: 95.7 – 100.3 percent
- Customer meter accuracy: 94.1 – 99.5 percent
- Production water cost: $0.34 – $2.02 per thousand gallons
- Retail water cost: $0.94 – $5.13 per thousand gallons
- Service connections per mile of main: 14.6 – 89.6
- Reporting period: 346.7 – 383.5 days

10.B Regional Water Loss Performance Indicators

The average reported non-revenue water as a percentage of corrected input volume for each region is shown in Figure 10-3. Regions I and J have the highest average non-revenue water percentage (ranging from approximately 19 percent to as much as 27 percent). These regions also had the highest reported average unbilled authorized water use, at 5.5 percent and 9.4 percent of corrected input volume, respectively, compared to the statewide reported average of 2.6 percent. Utilities in Regions I and J should consider steps to recover lost revenue from unbilled authorized consumption. This will reduce the non-revenue water percentage in these regions.

*Figure 10-1: Regional Water Planning Areas in Texas**



* Texas Water Development Board,
Available URL: http://www.twdb.state.tx.us/mapping/maps/pdf/sb1_groups_8x11.pdf,
accessed November 2006.

Figure 10-2: Distribution of Reporting Utilities by Regional Water Planning Area

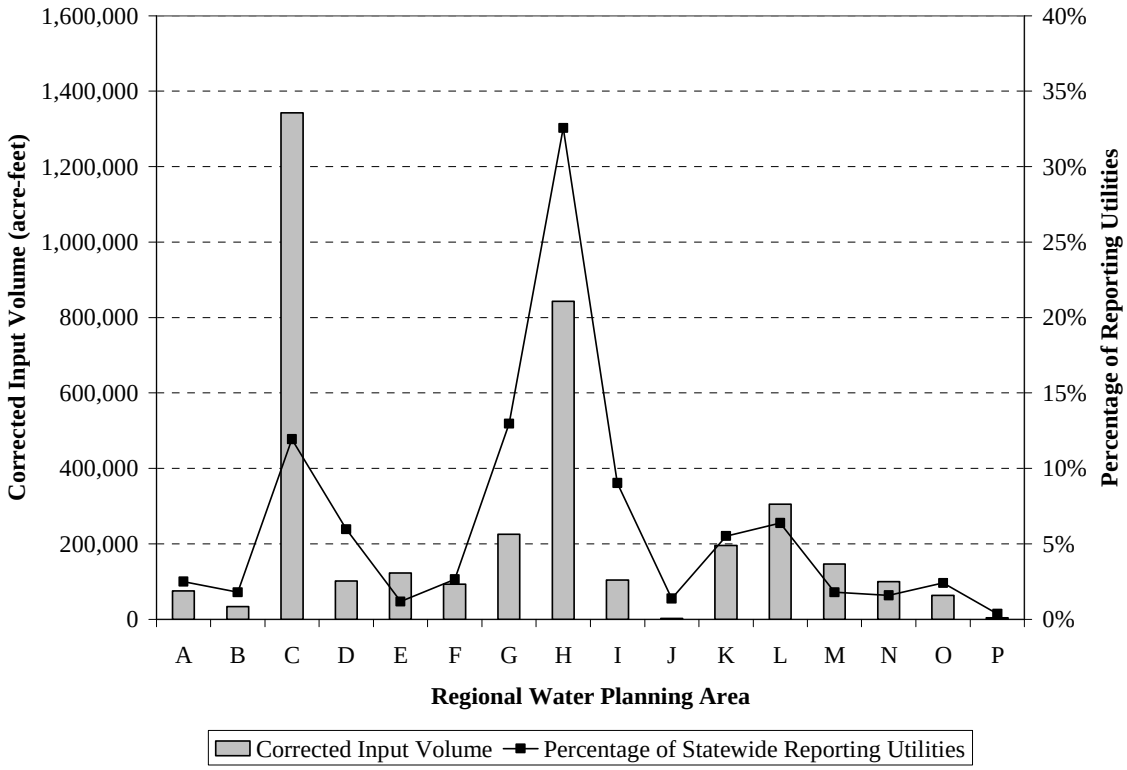
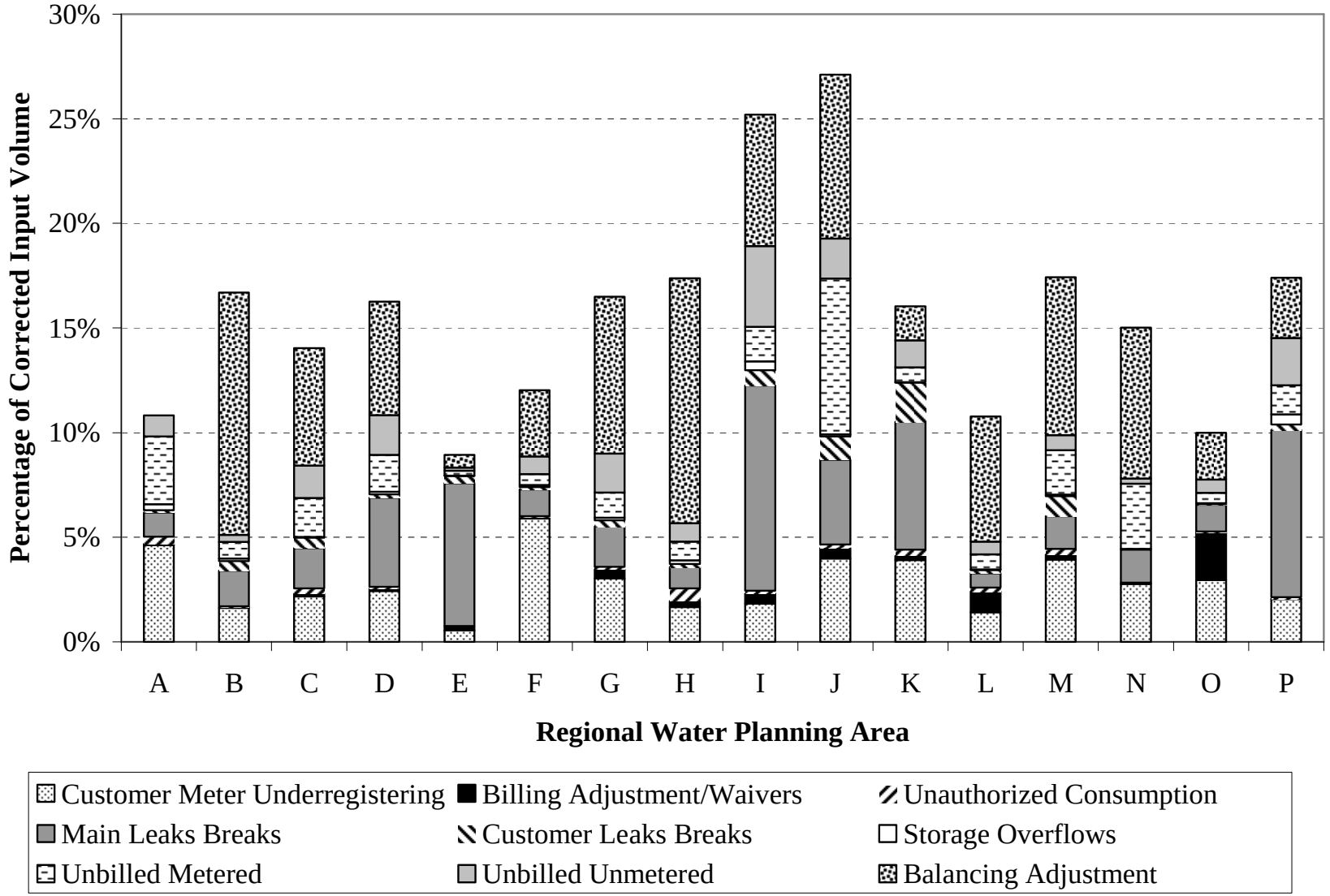


Table 10-1: Regional Average Quantities

Region	Master Meter Accuracy	Customer Meter Accuracy	Production Water Cost ($/1,000 gallons)	Retail Water Cost ($/1,000 gallons)	Service Connections per Mile of Main	Reporting Period
A	98.0%	95.4%	$0.70	$1.89	40.2	362.8
B	98.4%	98.4%	$1.70	$3.11	22.3	365.4
C	99.7%	97.8%	$0.90	$2.60	51.2	366.0
D	99.0%	97.6%	$1.51	$3.96	14.6	383.5
E	99.4%	99.5%	$0.61	$2.52	73.9	346.7
F	99.1%	94.1%	$2.02	$2.66	29.6	372.1
G	98.5%	97.0%	$1.42	$2.85	19.5	363.0
H	98.4%	98.3%	$0.80	$2.38	89.6	363.4
I	99.8%	98.2%	$0.34	$2.68	19.2	363.5
J	97.9%	96.0%	$0.91	$3.09	27.9	360.7
K	100.3%	96.1%	$0.57	$2.89	38.8	360.0
L	99.6%	98.6%	$1.20	$5.13	50.0	364.6
M	99.3%	96.1%	$0.72	$1.81	38.2	364.2
N	95.7%	97.2%	$1.62	$2.46	38.7	364.1
O	98.5%	97.0%	$0.86	$1.64	49.0	380.4
P	98.3%	98.0%	$0.36	$0.94	47.0	365.0
TOTAL	99.1%	97.7%	$0.84	$2.72	43.5	365.2

Figure 10-3: Average Annual Non-Revenue Water by Region



The average annual value of non-revenue water per connection is shown by region in Figure 10-4.[9] On a per-connection basis, utilities in Region E report the lowest average value of non-revenue water (approximately $14 per connection per year), and utilities in Regions D and K report the highest average value of non-revenue water (more than $50 per connection per year). Reported values include real loss, apparent loss, and unbilled authorized consumption. However, after accounting for the balancing adjustment, the average value of non-revenue water in Regions B, C, D, G, L, and N may be more than $80 per connection per year. The total balancing adjustment for Region A is negative, which causes the balancing adjustment assumption to reduce the average value of non-revenue water.

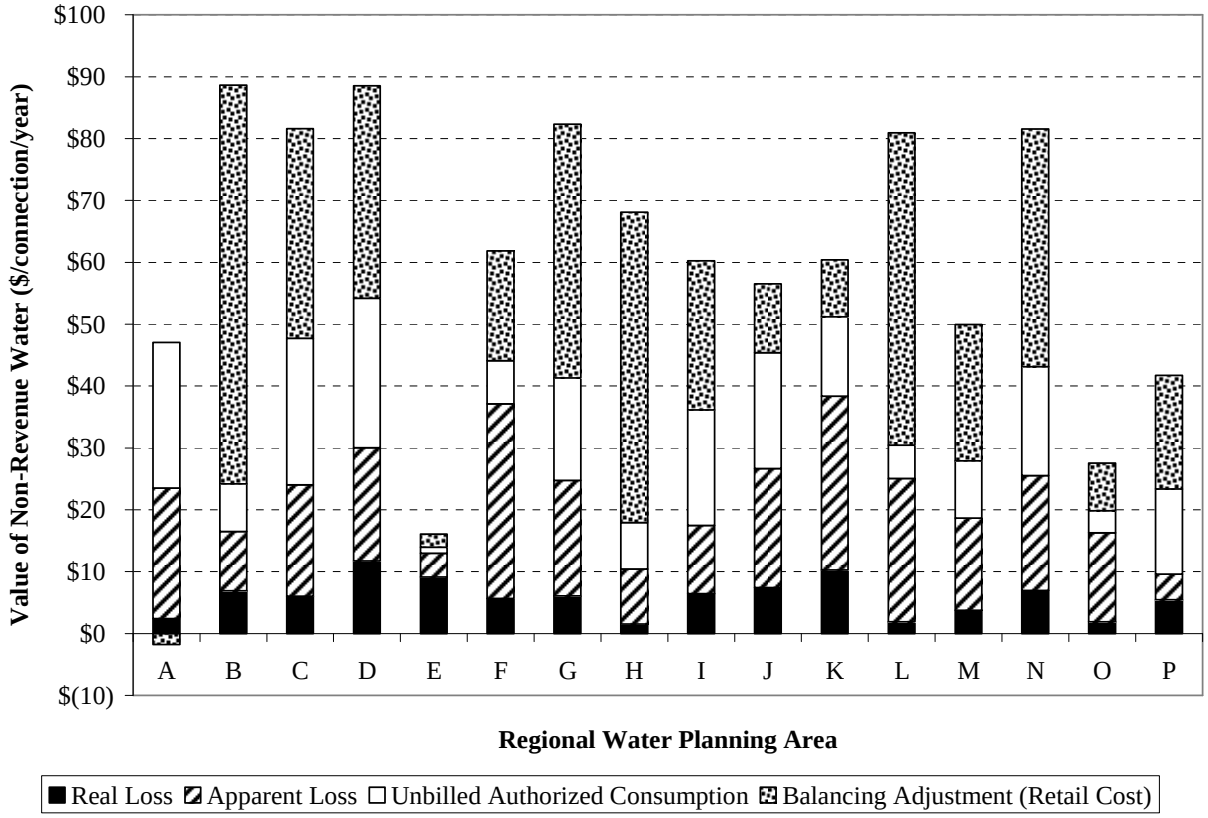
Graphs showing other average water loss performance indicators by region for all reporting water utilities (after quality control) are presented in Appendix D. These graphs present the performance indicators with and without the balancing adjustment assumption discussed in Chapter 6.A. The ranges of average real loss and average SLILI are on the low end of the ranges of real loss and ILI reported by North American utilities (Table 7-1), while the range of average apparent loss is similar to, or perhaps somewhat greater than, the range of apparent loss reported by North American utilities.

Regions B, H, and M each have an average balancing adjustment (absolute value) that is more than 10 percent of the corrected input volume (Figure D-1). With the balancing adjustment assumption, this results in a relatively wide range of upper and lower bounds for water loss performance indicators for these regions. This suggests that utilities in these regions should refine their water accounting procedures to more accurately quantify water use in each category.

Three regions (A, F, and O) have average SLILI values that range from 0.36 to 0.71 as calculated from the reported data and range from 0.71 to 1.77 with the balancing adjustment assumption (Figure D-4). As discussed in Chapter 5.C, the theoretical minimum SLILI is 1. These observations suggest that the larger utilities[25] in these regions may be underestimating real loss. It is interesting to note that these regions are contiguous and are located in West Texas and the Panhandle (Figure D-12). It is not known whether there is a common geographic or system factor that would result in low levels of real loss in these regions.

[25] Utilities having 5,000 connections or more and 32 or more connections per mile of main.

Figure 10-4: Average Annual Value of Non-Revenue Water per Connection by Region



The average SLILI values for Regions I and K suggest that the larger utilities[25] in these regions might benefit from real loss control measures.

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