



Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

One Winter Street Boston, MA 02108 • 617-292-5500

DEVAL L. PATRICK
Governor

RICHARD K. SULLIVAN JR.
Secretary

KENNETH L. KIMMELL
Commissioner

SUSTAINABLE WATER MANAGEMENT INITIATIVE GRANT Fiscal Reporting Cover Sheet

Project Number and Name: BRP 2013-06 – Sectional Flow Monitoring Program

Grantee: **Town of Holden**

Vendor Code: **VC6000191831**

Contract Number: **CT EQE 5014 TOWNOFHOLDENSWMI1414**

Invoice number:

For period beginning: ____ May 1, 2014 ____ through ____ June 30, 2014 ____

Contract amount: \$ 36,944.00

Billing to date (total):	\$ 0.00
Amount previous invoice	\$ 0.00
Amount this invoice	\$ 36,944.00
Salary/Fringe amount:	\$ \$763.59
Subcontractual amount:	\$ 34,980.41
Supplies and equipment:	\$ 1,200.00
Travel, printing and postage:	\$ 0.00
Less 10% retainage	\$ 3,694.40

Payment due \$ 33,249.60

Remaining balance \$ 3,694.40

Match: \$ 9,236.00

Amount spent: \$ 10,980.69

Amount left to spend: \$ 0.00

Notes:

Prepared by: Mark A. Elbag, Jr., P.E., W&S Superintendent date: June 27, 2014

Required attachments:

- Backup information consistent with Contract budget (Scope of Work Attachment B), e.g., salaries and rates, subcontractor services, equipment/supplies invoices, etc.

REPORT

Sectional Flow Metering and Leak Detection Program

Town of Holden, Massachusetts

June 2014





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Cambridge, Massachusetts 02139
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cdmsmith.com

June 27, 2014

Mr. Mark A. Elbag, Jr., P.E.
Water & Sewer Superintendent
Town of Holden
1196 Main Street
Holden, MA 01520

Subject: Final Report - Sectional Flow Metering and Leak Detection Program
Town of Holden, Massachusetts

Dear Mr. Elbag:

In accordance with our Agreement dated June 6, 2014, CDM Smith Inc. (CDM Smith) is pleased to submit the enclosed report to the Town of Holden (the Town) documenting the sectional flow metering and leak detection program performed by the Town with Prowler Water Conservation Systems, LLC (Prowler). The sectional flow metering and leak detection program was performed using grant funds offered by the Massachusetts Department of Environmental Protection (MassDEP) under the Sustainable Water Management Initiative (SWMI) Grant Program.

We appreciate the opportunity to have assisted the Town of Holden with this important program to reduce unaccounted-for water and remain available to offer further assistance should follow-up efforts be desired. As always, please feel free to call me at (617) 452-6532 or Paul Cabral of CDM Smith at (518) 782-4530 should you have any questions or require additional information.

Very truly yours,

A handwritten signature in black ink, appearing to read "Andrew B. Miller".

Andrew B. Miller, P.E.
Associate
CDM Smith Inc.

Enclosure

cc: Paul R. Cabral, P.E., CDM Smith
Project Files



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Section 1

Introduction

In accordance with our Agreement dated June 6, 2014, this report documents the section flow metering and leak detection program performed by the Town of Holden with Prowler Water Conservation Systems, LLC (Prowler). The section flow metering and leak detection program was performed under a Sustainable Water Management Initiative (SWMI) Program from the Massachusetts Department of Environmental Protection (MassDEP).

Based on a workshop with the Town of Holden, Prowler and CDM Smith, on April 22, 2014, the project team determined that the Town of Holden water distribution system could be subdivided into the following five flow metering districts (see Figure 1):

- Low Service Area
- Jefferson Area
- Town Center Area
- Salisbury Area
- Chaffin Area

Fluxus Model F601 ultrasonic portable strap-on flow meters by Flexim were installed on water mains to continuously record flow into and out of each of the flow metering districts. Continuous flow was recorded for a 24-hour period for each district in order to calculate the hourly consumption at each district meter. By comparing the ratio of the minimum nighttime hourly flow rate to the total 24-hour flow, an indication of potential leakage in each of the districts can be determined and further leak detection within districts with high potential leakage can be performed. A ratio of 1:3 or 30% or less was considered to indicate acceptable potential leakage in a district. If the ratio was greater than 30% (e.g. 1:2 or 50%) then the district was considered to have high potential leakage. The proposed program was similar to the section flow metering and leak detection program performed by Pitometer Associates for the Town of Holden in 1998.

The report is divided into the following sections:

- Section 2 – Presents a Summary of the Sectional Flow Metering for the Low Service Area
- Section 3 – Presents a Summary of the Sectional Flow Metering for the Jefferson Area
- Section 4 – Presents a Summary of the Sectional Flow Metering for the Town Center Area
- Section 5 – Presents a Summary of the Sectional Flow Metering for the Salisbury Area
- Section 6 – Presents a Summary of the Sectional Flow Metering for the Chaffin Area
- Section 7 – Presents the Conclusions and Recommendations

Table 2-1
Section Flow Metering Hourly Rate Summary
Low Service Area
May 8-9, 2014

Hour	Highland Street Reservoir Positive Flow = Into System (gpd)	System Flow (gpd)
18:00-19:00	101,488 gpd	101,488 gpd
19:00-20:00	133,553 gpd	133,553 gpd
20:00-21:00	108,194 gpd	108,194 gpd
21:00-22:00	99,764 gpd	99,764 gpd
22:00-23:00	59,655 gpd	59,655 gpd
23:00-24:00	35,368 gpd	35,368 gpd
0:00-1:00	24,889 gpd	24,889 gpd
1:00-2:00	16,473 gpd	16,473 gpd
2:00-3:00	14,294 gpd	14,294 gpd
3:00-4:00	13,875 gpd	13,875 gpd
4:00-5:00	37,852 gpd	37,852 gpd
5:00-6:00	98,473 gpd	98,473 gpd
6:00-7:00	179,551 gpd	179,551 gpd
7:00-8:00	166,658 gpd	166,658 gpd
8:00-9:00	101,046 gpd	101,046 gpd
9:00-10:00	94,009 gpd	94,009 gpd
10:00-11:00	81,378 gpd	81,378 gpd
11:00-12:00	54,882 gpd	54,882 gpd
12:00-13:00	58,394 gpd	58,394 gpd
13:00-14:00	58,181 gpd	58,181 gpd
14:00-15:00	58,617 gpd	58,617 gpd
15:00-16:00	70,654 gpd	70,654 gpd
16:00-17:00	72,348 gpd	72,348 gpd
17:00-18:00	97,357 gpd	97,357 gpd
24-hour Total Flow:		76,540 gpd
Maximum Hourly Rate:		179,551 gpd
Mi Nighttime Hourly Rate:		13,875 gpd
Min Nighttime Rate to Total Flow Ratio:		18.1 percent

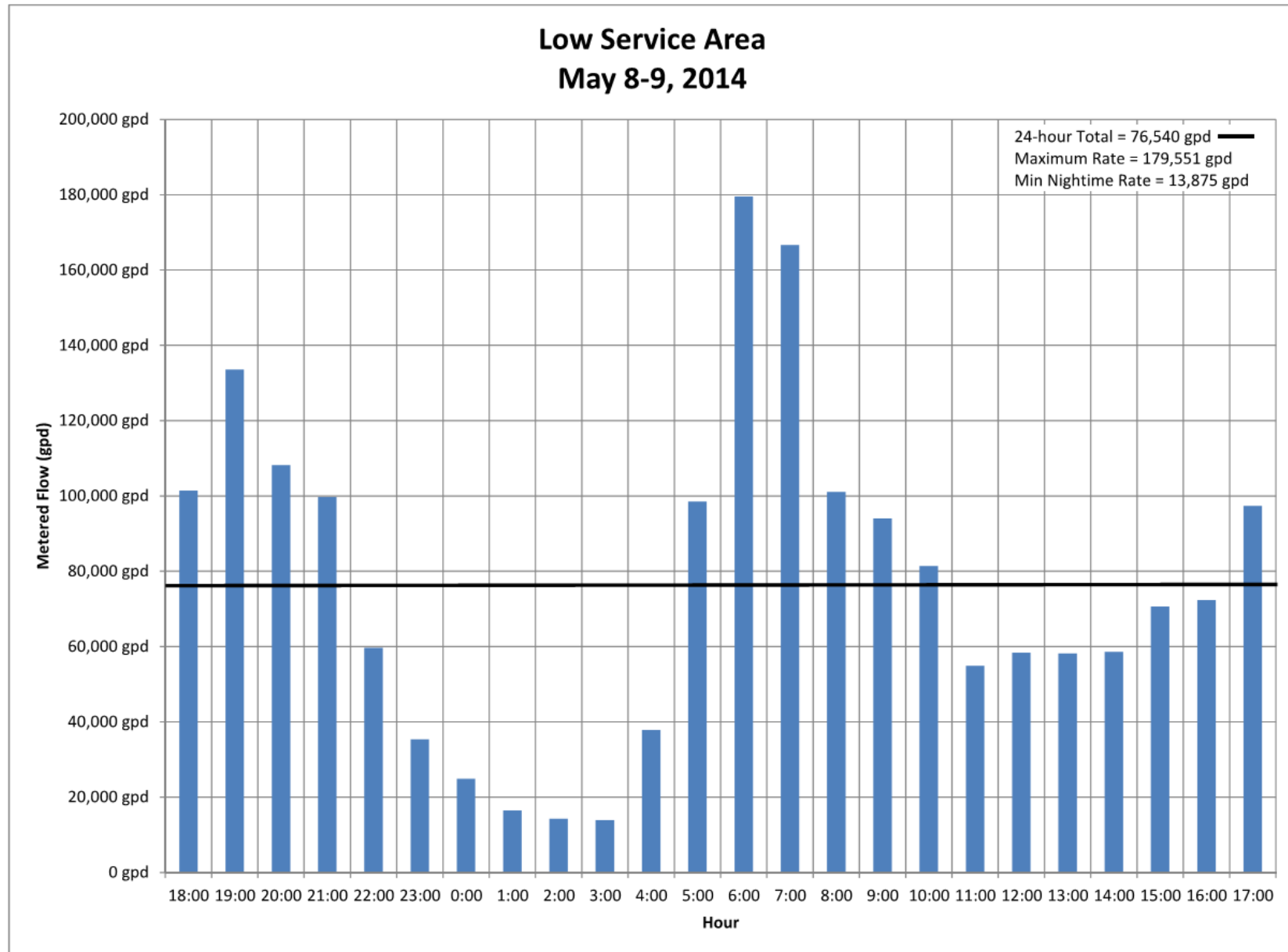


Figure 2-1

Section 3

Jefferson Area Section Flow Metering Summary

General Boundaries:	North and West – Rutland Town Limits East – Railroad Tracks/Asnebumskit Brook South – Main Street – Route 122A
Meter Locations and Size of Water Main:	Jefferson Tank – 16-inch Spring Street Well – 4-inch Sunnyside Ave and Pleasant St – 12-inch
Character of District:	Residential – Rural
Date of Flow Metering:	June 11-12, 2014
Weather during Flow Metering:	Cloudy/Showers, Temperature 54-68-degrees
Results of 24-hour Metering (see Table 3-1 and Figure 3-1):	
24-hour Total Flow:	172,211 gpd
Maximum Hourly Rate:	341,801 gpd
Min Nighttime Hourly Rate:	108,053 gpd
Min Nighttime Rate to Total Flow Ratio:	62.7 percent

Conditions of Test:

1. Gate Valve 34 on Quinapoxet Street at Summit Street Closed

Conclusion of Test:

A large minimum nighttime hourly flow rate as compared to the 24-hour total flow rate was observed, which signifies potentially a significant amount of leakage in the Jefferson Area. Further investigation is required to determine the location of the water loss.

For reference, in 1998, the Jefferson Area had a minimum nighttime flow rate as compared to the 24-hour total flow rate of 70 percent and a significant leak, estimated to be 180,000 gpd, was found on Main Street (Route 122A), west of Broad Street (Route 68).

Table 3-1
Section Flow Metering Hourly Rate Summary
Jefferson Area
June 11-12, 2014

Hour	Jefferson Tank Positive Flow = Into System (gpd)	Spring Street Well Positive Flow = Into System (gpd)	Sunnyside Meter Positive Flow = Into System (gpd)	System Flow (gpd)
17:00-18:00	34,239 gpd	114,790 gpd	-11,790 gpd	137,238 gpd
18:00-19:00	-167,628 gpd	115,112 gpd	242,610 gpd	190,095 gpd
19:00-20:00	-98,603 gpd	113,626 gpd	178,479 gpd	193,502 gpd
20:00-21:00	114,018 gpd	114,714 gpd	-92,842 gpd	135,890 gpd
21:00-22:00	-46,714 gpd	114,616 gpd	88,105 gpd	156,007 gpd
22:00-23:00	-165,194 gpd	101,472 gpd	213,659 gpd	149,937 gpd
23:00-24:00	-149,410 gpd	114,436 gpd	162,138 gpd	127,163 gpd
0:00-1:00	-196,693 gpd	114,717 gpd	212,443 gpd	130,467 gpd
1:00-2:00	-115,877 gpd	114,482 gpd	115,110 gpd	113,715 gpd
2:00-3:00	-11,791 gpd	115,057 gpd	110,995 gpd	214,261 gpd
3:00-4:00	-89,460 gpd	114,527 gpd	238,925 gpd	263,992 gpd
4:00-5:00	-30,284 gpd	114,714 gpd	194,088 gpd	278,517 gpd
5:00-6:00	333,578 gpd	114,450 gpd	-106,228 gpd	341,801 gpd
6:00-7:00	292,794 gpd	114,827 gpd	-158,563 gpd	249,058 gpd
7:00-8:00	138,392 gpd	115,127 gpd	-83,617 gpd	169,902 gpd
8:00-9:00	-134,828 gpd	114,342 gpd	203,942 gpd	183,456 gpd
9:00-10:00	-11,155 gpd	114,748 gpd	42,717 gpd	146,309 gpd
10:00-11:00	46,505 gpd	115,411 gpd	-8,029 gpd	153,887 gpd
11:00-12:00	18,125 gpd	114,181 gpd	8,292 gpd	140,597 gpd
12:00-13:00	13,234 gpd	114,564 gpd	16,200 gpd	143,997 gpd
13:00-14:00	-6,129 gpd	114,753 gpd	38,451 gpd	147,074 gpd
14:00-15:00	-71,324 gpd	114,674 gpd	94,900 gpd	138,250 gpd
15:00-16:00	-35,302 gpd	115,306 gpd	39,894 gpd	119,898 gpd
16:00-17:00	36,546 gpd	115,611 gpd	-44,104 gpd	108,053 gpd
24-hour Total Flow:				172,211 gpd
Maximum Hourly Rate:				341,801 gpd
Min Nighttime Hourly Rate:				108,053 gpd
Min Nighttime Rate to Total Flow Ratio:				62.7 percent

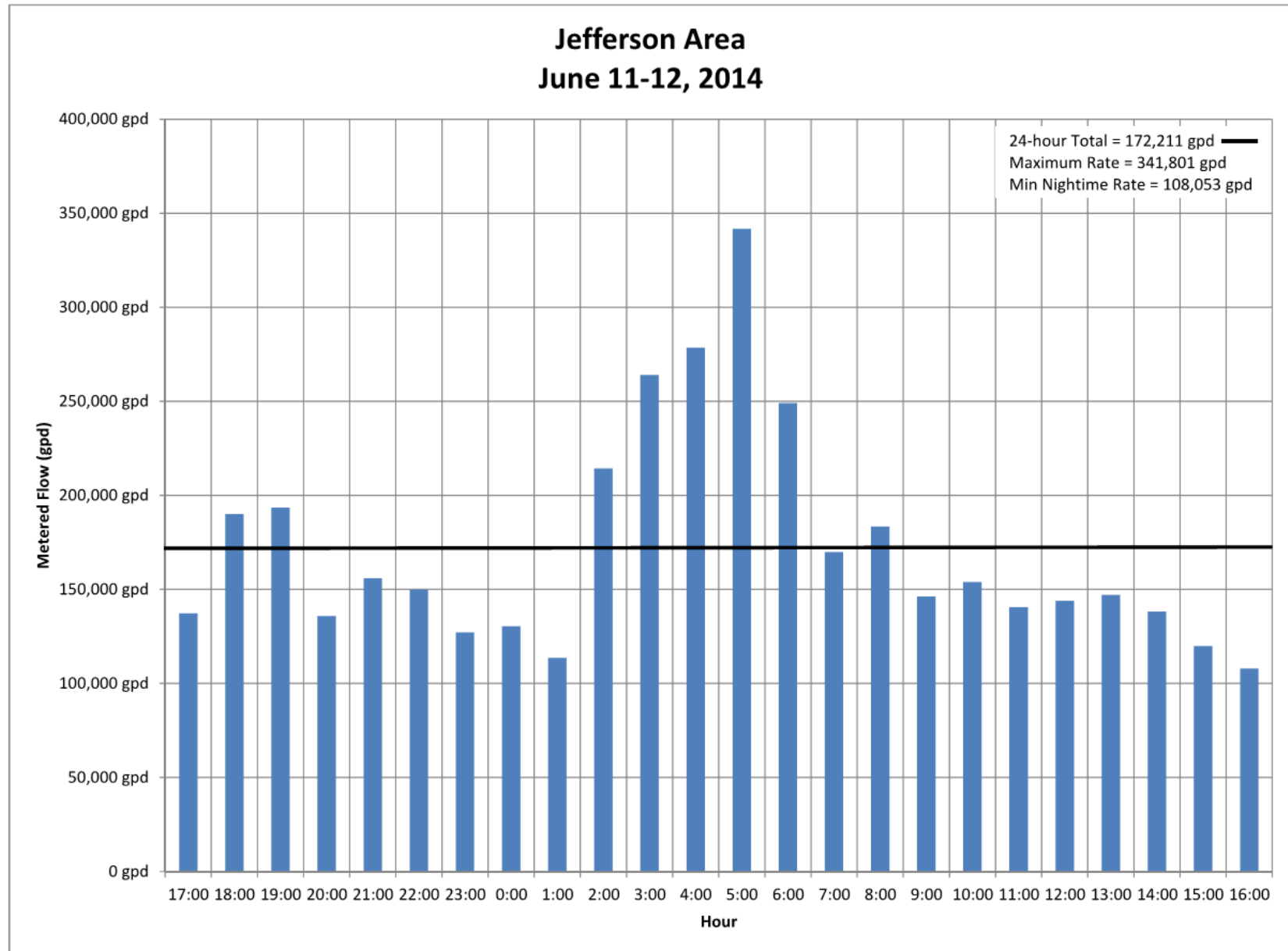


Figure 3-1

Section 4

Town Center Area Section Flow Metering Summary

General Boundaries:

North – Asnebumskit Brook

East – Asnebumskit Brook/Union Street/Wachusett Street

South – Reservoir Street/Main Street/Adams Road

West – Railroad Tracks/Paxton Town Limits

Meter Locations and Size of Water Main:

Avery Heights Tank – 12-inch

Sunnyside Ave and Pleasant St – 12-inch

Adams Road Old Booster Station – 10-inch

Character of District: Residential and Commercial

Date of Flow Metering: June 9-10, 2014

Weather during Flow Metering: Cloudy/Showers, Temperature 60-79-degrees

Results of 24-hour Metering (see Table 4-1 and Figure 4-1):

24-hour Total Flow:	365,225 gpd
Maximum Hourly Rate:	838,526 gpd
Min Nighttime Hourly Rate:	72,765 gpd
Min Nighttime Rate to Total Flow Ratio:	19.9 percent

Conditions of Test:

1. Highland Street Booster Pump Station Offline
2. Gate Valve 34 on Quinapoxet Street at Summit Street Closed
3. Gate Valve 525 – Bullard Street at Malden Street Closed
4. Gate Valve 171 – Baily Road at Main Street Closed
5. Gate Valve 349A – Salisbury Street at Main Street Closed
6. Gate Valve 621 – Industrial Drive Cross-Country Closed

Conclusion of Test:

The minimum nighttime hourly flow rate as compared to the 24-hour total flow rate at less than 30 percent was found to be acceptable and no further investigating is needed.

Table 4-1
Section Flow Metering Hourly Rate Summary
Town Center Area
June 9-10, 2014

Hour	Avery Heights Tank Positive Flow = Into System (gpd)	Sunnyside Meter Positive Flow = Into System (gpd)	Adams Road Meter Positive Flow = Into System (gpd)	System Flow (gpd)
11:00-12:00	164,939 gpd	119,102 gpd	154,589 gpd	438,630 gpd
12:00-13:00	26,358 gpd	99,345 gpd	264,303 gpd	390,007 gpd
13:00-14:00	30,319 gpd	52,783 gpd	277,172 gpd	360,274 gpd
14:00-15:00	46,605 gpd	-26,267 gpd	314,929 gpd	335,267 gpd
15:00-16:00	-23,142 gpd	59,128 gpd	292,530 gpd	328,516 gpd
16:00-17:00	71,636 gpd	67,851 gpd	249,791 gpd	389,279 gpd
17:00-18:00	104,808 gpd	81,401 gpd	271,507 gpd	457,716 gpd
18:00-19:00	-27,319 gpd	37,314 gpd	419,548 gpd	429,542 gpd
19:00-20:00	4,757 gpd	29,467 gpd	400,843 gpd	435,067 gpd
20:00-21:00	-39,530 gpd	-600 gpd	420,567 gpd	380,437 gpd
21:00-22:00	-69,488 gpd	-90,829 gpd	464,046 gpd	303,729 gpd
22:00-23:00	-128,448 gpd	-154,553 gpd	489,729 gpd	206,728 gpd
23:00-24:00	-162,134 gpd	-197,057 gpd	467,726 gpd	108,535 gpd
0:00-1:00	-143,019 gpd	-206,766 gpd	422,550 gpd	72,765 gpd
1:00-2:00	273,443 gpd	-16,279 gpd	-48,899 gpd	208,265 gpd
2:00-3:00	228,101 gpd	-13,884 gpd	-21,900 gpd	192,317 gpd
3:00-4:00	-144,706 gpd	-196,508 gpd	414,823 gpd	73,609 gpd
4:00-5:00	96,740 gpd	-155,484 gpd	298,286 gpd	239,542 gpd
5:00-6:00	584,001 gpd	66,582 gpd	66,376 gpd	716,959 gpd
6:00-7:00	435,562 gpd	160,081 gpd	242,883 gpd	838,526 gpd
7:00-8:00	112,445 gpd	193,872 gpd	311,794 gpd	618,111 gpd
8:00-9:00	-65,075 gpd	148,605 gpd	398,136 gpd	481,666 gpd
9:00-10:00	-141,719 gpd	62,486 gpd	487,143 gpd	407,911 gpd
10:00-11:00	-120,978 gpd	-4,778 gpd	477,754 gpd	351,997 gpd
24-hour Total Flow:				365,225 gpd
Maximum Hourly Rate:				838,526 gpd
Min Nighttime hourly Rate:				72,765 gpd
Min Nighttime Rate to Total Flow Ratio:				19.9 percent

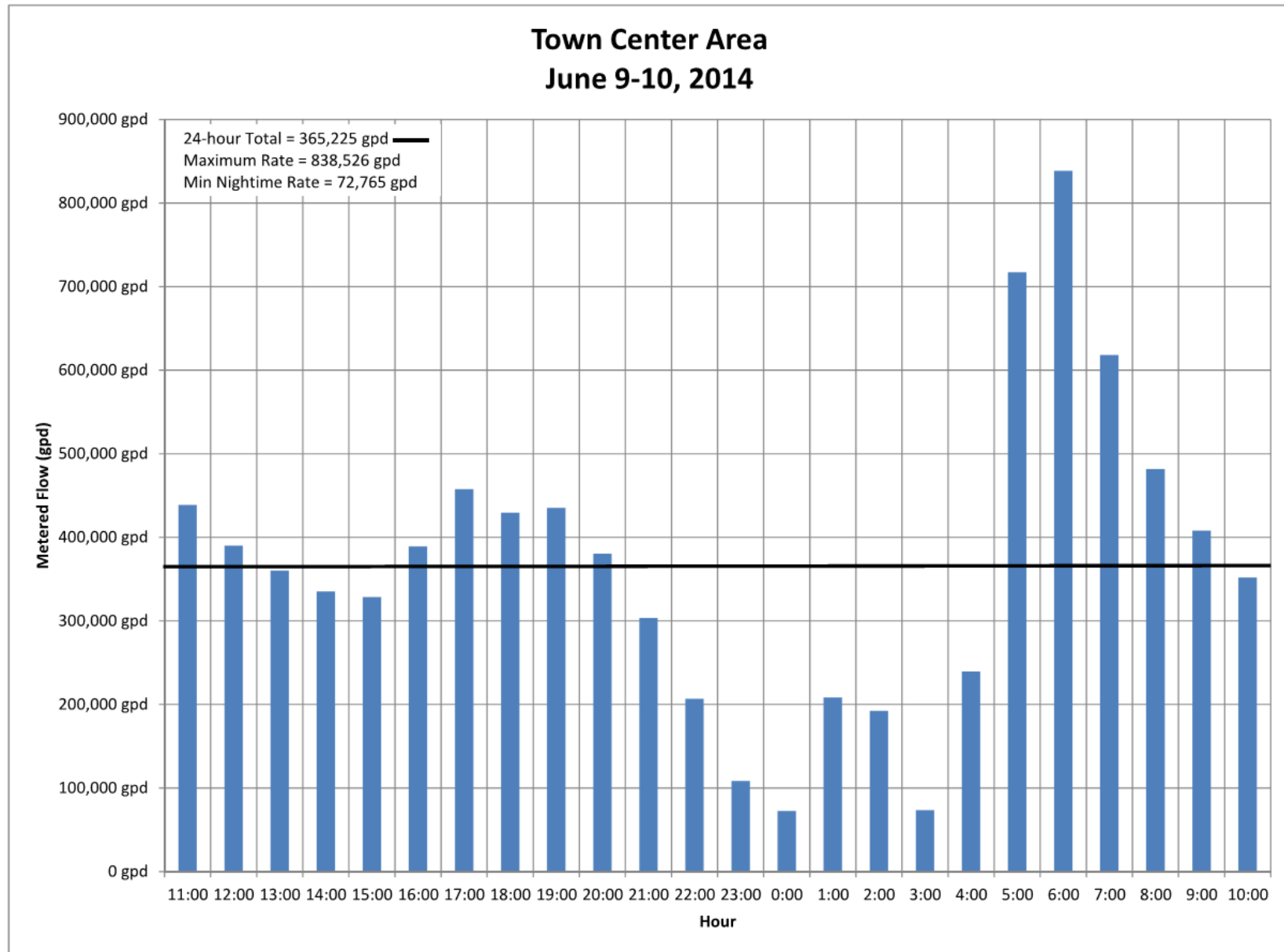


Figure 4-1

Section 5

Salisbury Area Section Flow Metering Summary

General Boundaries:	North – Main Street (Rt. 122A) East – South Main Street (Rt. 122A) South – Worcester City Limits West – Bailey Road
Meter Locations and Size of Water Main:	Cross-Country Water Main off Industrial Drive – 12-inch
Character of District:	Residential
Date of Flow Metering:	June 12-13, 2014
Weather during Flow Metering:	Cloudy/Showers, Temperature 54-64-degrees

Results of 24-hour Metering (refer to the table that follows for hour by hour data):

24-hour Total Flow:	172,276 gpd
Maximum Hourly Rate:	275,900 gpd
Min Nighttime Hourly Rate:	89,209 gpd
Min Nighttime Rate to Total Flow Ratio:	51.8 percent

Conditions of Test:

1. Chapin Tank offline at the Chapin Tank Booster Station
2. Salisbury Street Interconnection Pump Station offline
3. Gate Valve 190 – Industrial Drive at Cross-Country, which was closed for the Town Center Area Flow Metering is Opened
4. Gate Valve 171 – Baily Road at Main Street Closed
5. Gate Valve 349A – Salisbury Street at Main Street Closed
6. Gate Valve 757 – Newell Road at Winter Hill Road Closed

Conclusion of Test:

A large minimum nighttime hourly flow rate as compared to the 24-hour total flow rate was observed, which signifies potentially a significant amount of leakage in the Salisbury Area. Further investigation is required to determine the location of the water loss.

Table 5-1
Section Flow Metering Hourly Rate Summary
Salisbury Area
June 12-13, 2014

Hour	Industrial Drive Meter Positive Flow = Into System (gpd)	System Flow (gpd)
20:00-21:00	164,000 gpd	164,000 gpd
21:00-22:00	134,417 gpd	134,417 gpd
22:00-23:00	126,119 gpd	126,119 gpd
23:00-24:00	89,209 gpd	89,209 gpd
24:00-1:00	156,944 gpd	156,944 gpd
1:00-2:00	160,418 gpd	160,418 gpd
2:00-3:00	141,520 gpd	141,520 gpd
3:00-4:00	89,218 gpd	89,218 gpd
4:00-5:00	122,481 gpd	122,481 gpd
5:00-6:00	194,290 gpd	194,290 gpd
6:00-7:00	259,980 gpd	259,980 gpd
7:00-8:00	275,900 gpd	275,900 gpd
8:00-9:00	265,244 gpd	265,244 gpd
9:00-10:00	205,262 gpd	205,262 gpd
10:00-11:00	183,179 gpd	183,179 gpd
11:00-12:00	175,482 gpd	175,482 gpd
12:00-13:00	165,455 gpd	165,455 gpd
13:00-14:00	171,287 gpd	171,287 gpd
14:00-15:00	175,606 gpd	175,606 gpd
15:00-16:00	182,913 gpd	182,913 gpd
16:00-17:00	179,084 gpd	179,084 gpd
17:00-18:00	168,976 gpd	168,976 gpd
18:00-19:00	184,423 gpd	184,423 gpd
19:00-20:00	163,223 gpd	163,223 gpd
24-hour Total Flow:		172,276 gpd
Maximum Hourly Rate:		275,900 gpd
Min Nighttime Hourly Rate:		89,209 gpd
Min Nighttime Rate to Total Flow Ratio:		51.8 percent

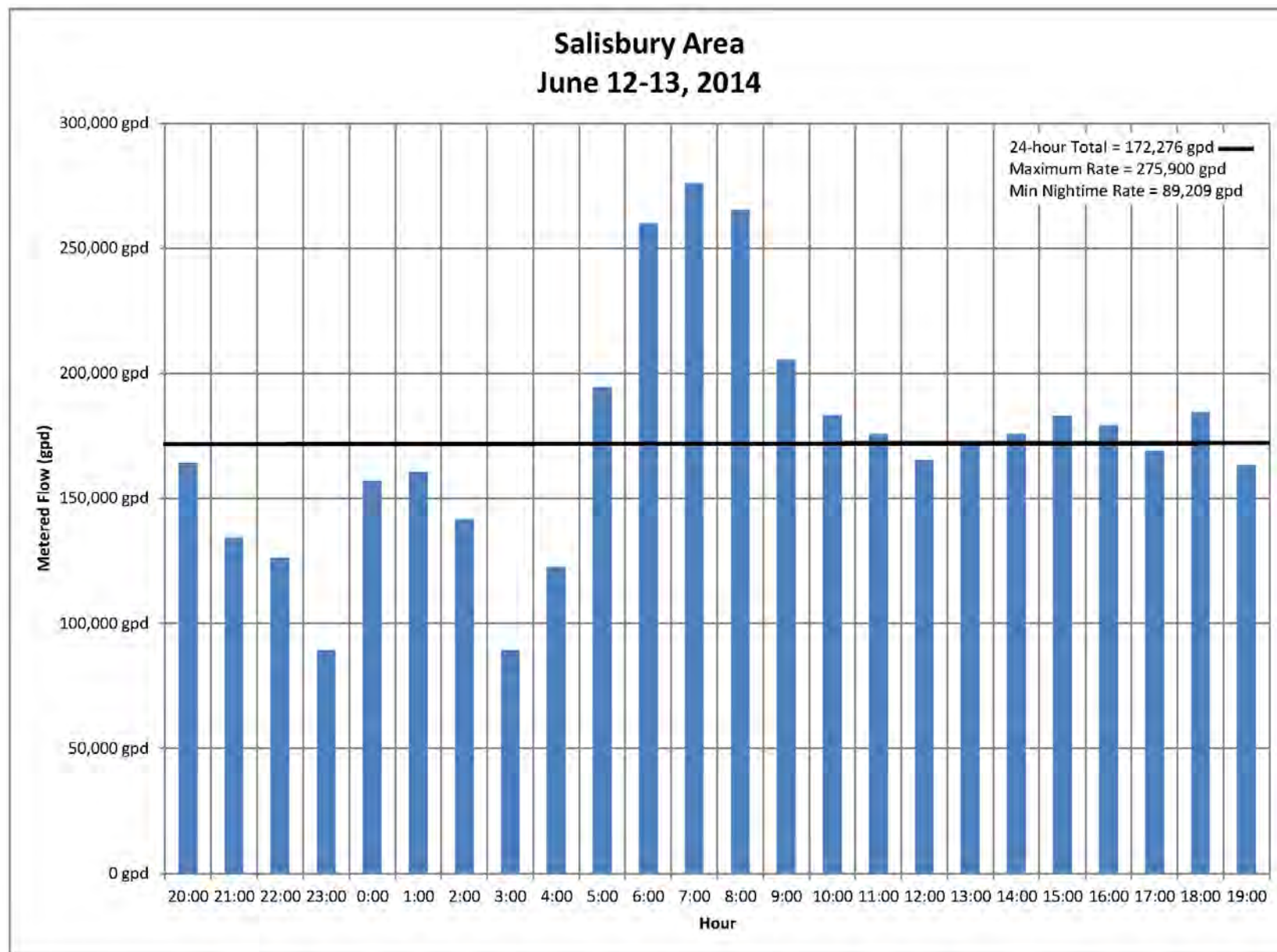


Figure 5-1

Section 6

Chaffin Area Section Flow Metering Summary

General Boundaries:

North – Malden Street

East – West Boylston Town Limits

South – Worcester City Limits

West – Wachusett Street/South Main Street (Rt. 122A)

Meter Locations and Size of Water Main:

Adams Road Old Booster Station – 10-inch

Brattle Street Interconnection – 10-inch

Character of District: Residential and Commercial

Date of Flow Metering: June 12-13, 2014

Weather during Flow Metering: Cloudy/Showers, Temperature 54-64-degrees

Results of 24-hour Metering (see Table 6-1 and Figure 6-1):

24-hour Total Flow:	460,520 gpd
Maximum Hourly Rate:	840,320 gpd
Min Nighttime Hourly Rate:	200,380 gpd
Min Nighttime Rate to Total Flow Ratio:	43.5 percent

Conditions of Test:

1. Gate Valve 525 – Bullard Street at Malden Street Closed
2. Gate Valve 757 – Newell Road at Winter Hill Road Closed

Conclusion of Test:

A large minimum nighttime hourly flow rate as compared to the 24-hour total flow rate was observed, which signifies potentially a significant amount of leakage in the Chaffin Area. Further investigation is required to determine the location of the water loss. The Town of Holden should first sound the normally closed boundary valves between the Low Service and High Service water mains to ensure the boundary valves are closed tight and not passing water from the Chaffin Area of the High Service System into the Low Service System as unmetered water leaving the high service area would increase the ratio.

Table 6-1
Section Flow Metering Hourly Rate Summary
Chaffin Area
June 12-13, 2014

Hour	Adams Road Meter Positive Flow = Into System (gpd)	Brattle Street Meter Positive Flow = Into System (gpd)	Chaffin Area Flow (gpd)
20:00-21:00	145,958 GPD	439,217 GPD	585,175 GPD
21:00-22:00	526,468 GPD	0 GPD	526,468 GPD
22:00-23:00	402,722 GPD	0 GPD	402,722 GPD
23:00-24:00	310,170 GPD	0 GPD	310,170 GPD
0:00-1:00	210,656 GPD	0 GPD	210,656 GPD
1:00-2:00	200,380 GPD	0 GPD	200,380 GPD
2:00-3:00	213,378 GPD	0 GPD	213,378 GPD
3:00-4:00	270,968 GPD	0 GPD	270,968 GPD
4:00-5:00	457,186 GPD	0 GPD	457,186 GPD
5:00-6:00	771,370 GPD	0 GPD	771,370 GPD
6:00-7:00	450,124 GPD	390,196 GPD	840,320 GPD
7:00-8:00	-225,208 GPD	938,186 GPD	712,978 GPD
8:00-9:00	-310,139 GPD	881,426 GPD	571,288 GPD
9:00-10:00	-384,383 GPD	857,097 GPD	472,714 GPD
10:00-11:00	-429,904 GPD	868,205 GPD	438,301 GPD
11:00-12:00	-442,713 GPD	885,388 GPD	442,675 GPD
12:00-13:00	-452,325 GPD	890,772 GPD	438,447 GPD
13:00-14:00	-456,903 GPD	873,061 GPD	416,158 GPD
14:00-15:00	-457,654 GPD	852,830 GPD	395,176 GPD
15:00-16:00	-455,982 GPD	846,810 GPD	390,828 GPD
16:00-17:00	-415,278 GPD	874,206 GPD	458,928 GPD
17:00-18:00	-373,683 GPD	888,857 GPD	515,174 GPD
18:00-19:00	-365,196 GPD	871,195 GPD	505,999 GPD
19:00-20:00	167,099 GPD	337,917 GPD	505,016 GPD
24-hour Total Flow:			460,520 GPD
Maximum Hourly Rate:			840,320 GPD
Min Nighttime Hourly Rate:			200,380 GPD
Min Nighttime Rate to Total Flow Ratio:			43.5 percent

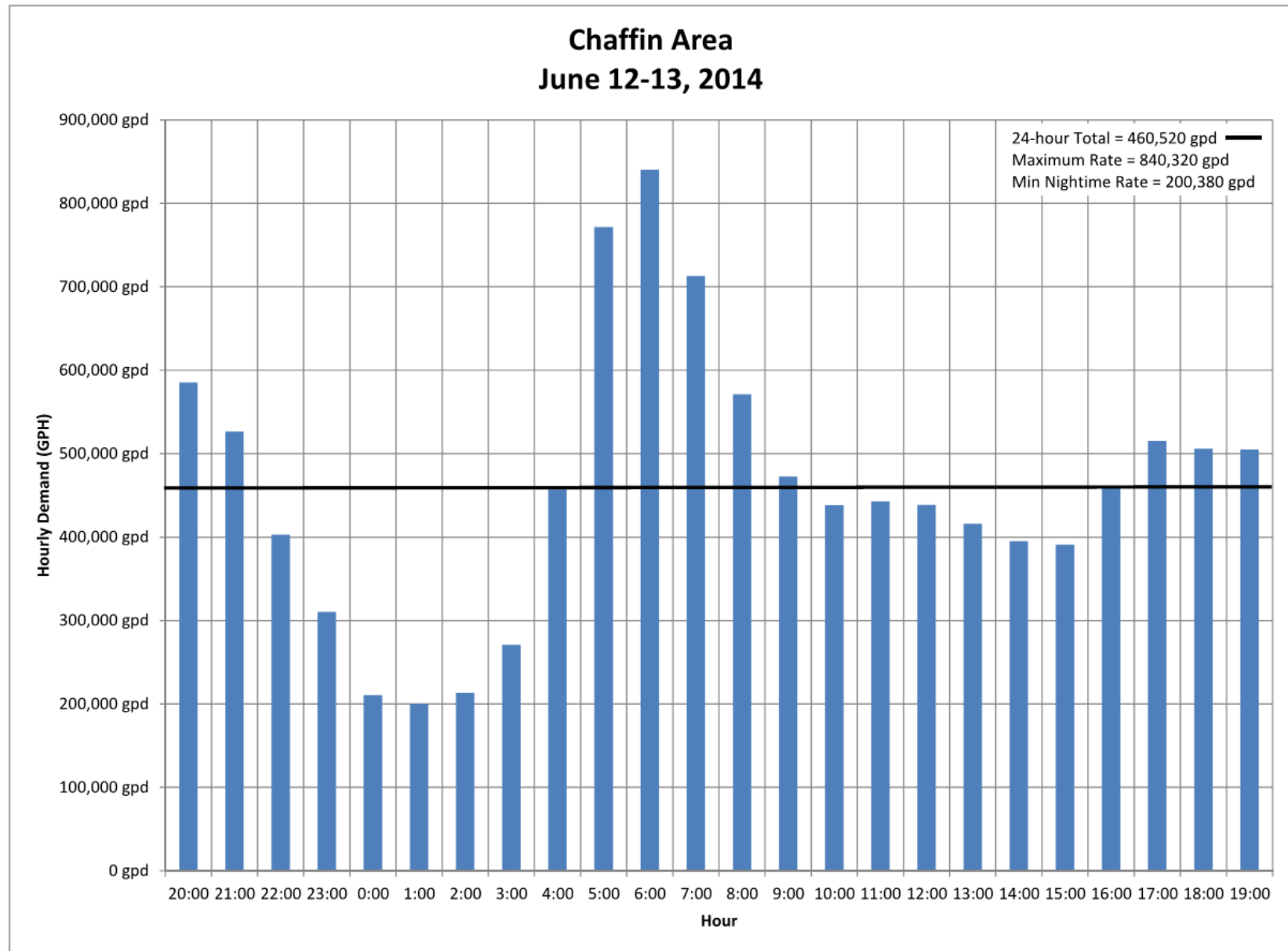


Figure 6-1

Section 7

Conclusions and Recommendations

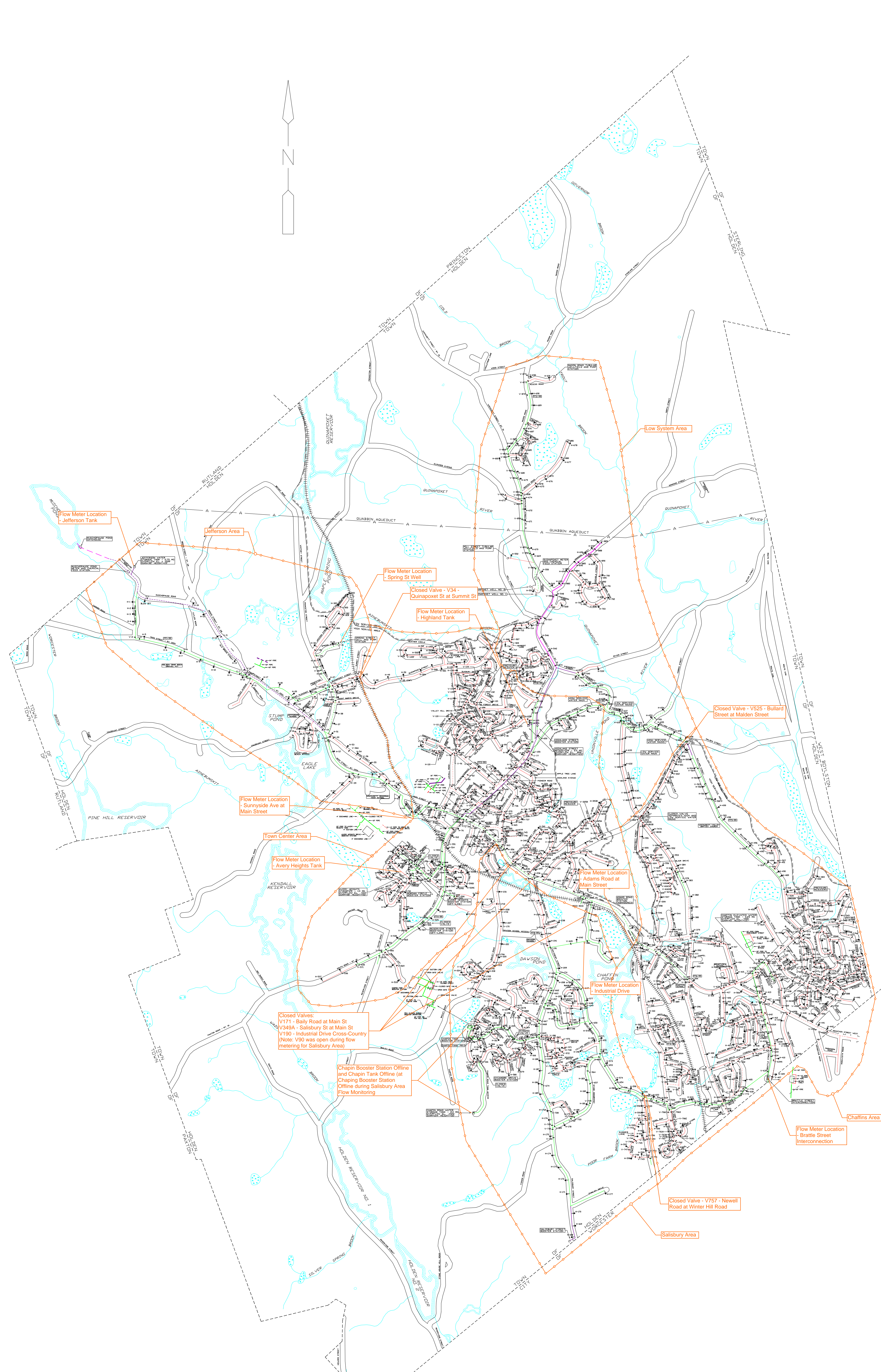
Overall, the section flow metering performed by the Town of Holden with Prowler Water Conservation Systems, LLC (Prowler) revealed large minimum nighttime flow rate as compared to the 24-hour total flow rate in the Jefferson Area (ratio of 62.7 percent), Salisbury Area (ratio of 51.8 percent) and Chaffin Area (ratio of 43.7 percent) while the Low Service Area (ratio of 18.1 percent) and Town Center (ratio of 19.9 percent) revealed low minimum nighttime flow rate as compared to the 24-hour total flow rate (see Table 7-1). A large minimum nighttime flow rate as compared to the 24-hour total flow rate signifies potentially a significant amount of leakage is occurring in the Jefferson Area, Salisbury Area and the Chaffin Area and further investigation is required to determine the location of the water loss. For reference, in 1998, the Jefferson Area had a minimum nighttime flow rate as compared to the 24-hour total flow rate of 70 percent and a significant leak, estimated to be 180,000 gpd, was found on Main Street (Route 122A), west of Broad Street (Route 68). Also, in 1998, the remaining high service areas had a minimum nighttime flow rate as compared to the 24-hour total flow rate of 30 percent. Using a minimum hour to 24-hour flow rate ratio of 30 percent as an acceptable ratio for the Jefferson Area, Salisbury Area and Chaffin Area, the estimated leakage in each area is 56,389 gpd, 37,527 gpd, and 62,224 gpd for a total of 156,140 gpd (see Table 7-1).

CDM Smith recommends that the Town of Holden and Prowler perform additional acoustic leak detection within the Jefferson Area, Salisbury Area and Chaffin Areas and if required, the Town of Holden should consider performing subsection flow metering of these areas.

Table 7-1
Section Flow Metering Summary and Estimated Leakage

Area	24-hour Flow (gpd)	Maximum Hour Flow (gpd)	Minimum Hour Flow (gpd)	Min Hour to 24-hour Ratio (Observed)	Min Hour to 24-hour Ratio (Allowable)	Calculated Minimum Hour Flow (gpd)	Estimated Leakage (gpd)
Jefferson Area	172,211 GPD	341,801 GPD	108,053 GPD	62.7%	30.0%	51,663 GPD	56,389 GPD
Town Center	365,225 GPD	838,526 GPD	72,765 GPD	19.9%	19.9%	72,765 GPD	0 GPD
Salisbury Street	172,276 GPH	275,900 GPD	89,209 GPD	51.8%	30.0%	51,683 GPD	37,527 GPD
Chaffin Area	460,520 GPH	840,320 GPD	200,380 GPD	43.5%	30.0%	138,156 GPD	62,224 GPD
High Service Area	1,170,232 GPD	2,296,546 GPD	470,407 GPD	40.2%	26.9%	314,267 GPD	156,140 GPD
Low Service Area	76,540 GPD	179,551 GPD	13,875 GPD	18.1%	18.1%	13,875 GPD	0 GPD
Total	1,246,772 GPD	2,476,097 GPD	484,282 GPD	38.8%	26.3%	328,142 GPD	156,140 GPD

Note: In 1998, the Minimum Hour to 24-hour Ratio observed was 30 percent



Water Distribution System Map with
Sectional Flow Metering Areas
Figure 1-1

NOTE: LOCATIONS OF ROADS, SURFACE WATER AND WETLANDS ARE APPROXIMATE AND FOR GENERAL INFORMATION USE ONLY.





Prowler Water Conservation Systems, LLC

Supplying Leak Detection Solutions for Water & Sewer Distribution Systems

6 Marshall St. Leicester, MA 01524 Tel. 508-868 6300 Fax 508-752-5750

LEAK SURVEY REPORT- Holden Water Dept. –June 26, 2014

Date of Survey started June 9, 2014

Scope of Survey

Focus on sections of the water system identified as High Flow areas from flow tests completed June 20, 2014

Sections known as:

Jefferson- Avery Heights-Salisbury
(see maps of areas below)

DESCRIPTION OF EQUIPMENT USED:

The leak locators we use are sophisticated electronic instruments manufactured by Primayer of Hampshire England. These devices are digital, state of the art, self-contained instruments equipped with headphones, sensitivity and gain controls and a transducer ground pick-up. These devices are very sensitive to sound and are capable of detecting water leakage of approximately 1/2 gallon per minute. Water escaping from the orifice of a pipe has its own distinctive sound and can be heard by our instrument over other surrounding disturbances such as wind, automobiles and aircraft, and other underground utilities such as sewer flows, drainage flows, etc. The difference between this detector and others on the market is that it will respond to leak sounds beyond human hearing and give you a visible read out on the screen when this occurs. Our company has used this particular leak detector in all our previous leakage surveys and considers this device to be excellent in this field.

Instrumentation Used in this survey:

Primayer Eureka Model 2R Digital Computerized Leak Correlators

Primayer 'Enigma' Digital Correlating loggers

Primayer 'Phocus' Sound loggers

Z-Corr Digital logging correlators

Primayer Leak Correlators, are highly sophisticated leak finders that will pinpoint leaks that are difficult to locate above ground with our acoustic leak detection equipment. The equipment consists of a central unit, or processor, in which important data is entered, such as the type of pipe material, size of pipe, etc. A second link, or transmitter, is also used in the process of locating the leak. Both units have very highly sensitive sensors which are placed directly on the pipe on easily accessible spots, such as valves, hydrants or house connections. A water leak creates a noise which transmits on the pipes to both sides of the leak. The central unit compares the leak noises picked up by both sensors, and measures the time delay of the leak noise reaching both sensors. The computer processors measure the time lag between the sound coordinates and based on pipe size and diameter they will display the footage from each sensor to the location of the leak. The Correlator is

not affected by external noises such as passing traffic. Real time Correlators have a built in field calibration test that is used to verify that the instruments are in working order and are ready to process the sound that is heard between the placed microphones. This test typically gives a result of either "leak present" or "leak presence doubtful".

PRELIMINARY FINDINGS:

Electronic testing was done by computerized Correlators manufactured by Primayer LTD, Staffordshire, England. Beginning in the Salisbury section, water mains were closely scrutinized by placement of Correlators directly on to the water mains at intervals of no more than 500'. Where water mains were non-metallic, contact points were reduced by using available points of curb boxes and line gates. Each section was done on a low filtered basis for maximum accuracy. In addition to the computerized testing, each contact point was tested by digital acoustic measurement devices. In areas of extreme day time noise overnight loggers were deployed to sample noise at 3 a.m to 4 a.m.

LEAKS DISCOVERED DURING TESTING
During flow testing one leak was discovered and repaired at 24 Cook St. Size 33 gpm approximated.

Streets Tested		
Salisbury	Holt	Sunset
Newell	Laurelwood	Jennifer
Cranbrook	Reservoir St.	Kris Alan
Bailey	Avery Heights	Pleasant
Powers	Cook St.	Causeway
Donald	Parker Ave.	Main St.
Williams	Tanya	Muschopauge St.
Cutler	Millbrook	Broad St.
Main St. Rte 122A	Old Broad St.	Miles
Rondeau	Country Hill	Rondeau
Main St. near Holden trap rock company- logged overnight		
Salisbury near Town Pool- logged overnight		

As of the date of this report testing is ongoing and will be completed the week of July 7, 2014

Employees involved in this survey:

Alan Banks- 40 years leak detection experience

Matt Grouf- 2 years water system leak experience

Chris Seariac-14 years leak detection experience



Prepared by Alan Banks, President 6-26-14

FLOWVIEW™

UNDERGROUND INTELLIGENCE®
FOR ENHANCED DISTRIBUTION SYSTEM PERFORMANCE



ADS ENVIRONMENTAL
SERVICES®



Town of Holden Meter Testing Report

"

"Lxpg 2016



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6/26/14

Mr. Mark Elbag
Town of Holden
1196 Main St
Holden, MA 01520

Dear Mr. Elbag:

In accordance with our agreement, ADS Environmental Services has conducted Pitometer meter test for accuracy at various locations throughout the Town of Holden service area and herewith submits its report.

We wish to express our appreciation for the courtesy and cooperation extended to us by the personnel of the Holden Water during the course of the tests.

Respectfully submitted,

ADS Environmental Services

Michael Armes
Senior Project Manager

Cc: David Gunderson – ADS Field Engineer



Introduction

ADS conducted Pitometer production meter tests in the City of Holden Water Department and a flow measurement at the Salisbury pump station, Mill Street pump station, and Brattle Street, Spring Street and Quinipoxet pump station.

The tests were conducted by inserting a Pitometer in the main in series with the meters for a short duration and comparing the rate of flow recorded by the Pitometer with the rate of flow registered by the meter.

The flow data and test results follow.



Meter Test Procedures

The master meter tests were conducted by comparing the registration on the meter to the Pitometer flow measurements taken at gauging points near the primary meter location. Pitometer measurements were conducted using a Pitometer that was inserted into a pipe carrying the same flow as the meter. The Pitometer had two orifices, one facing upstream and the other facing downstream. The velocity of the flowing water produced a differential pressure between the orifices that was measured using a Rosemount transmitter and recorded by a Pitometer Computer Recorder (PCR). The water velocity was calculated from the following equation:

$$V = c \times (2 \times g \times d/12)^{0.5}$$

Where:

- V = Velocity in feet per second (fps)
- c = A coefficient established by laboratory calibration
- g = 32.174 feet per second per second
- d = Differential pressure in inches of water

A velocity profile was measured by conducting a traverse in which local velocities were measured at the center and ten other locations on each diameter. Average velocity was determined using the tangential rule integration technique in which average velocity is the arithmetic average of the local velocities at ten points located on either side of the center as follows:

$$R(0.1)^{0.5}, R(0.3)^{0.5}, R(0.5)^{0.5}, R(0.7)^{0.5}, R(0.9)^{0.5}$$

Where:

- R = Radius of the pipe

Average velocity and the velocity at the center of the pipe were used to calculate a velocity factor for the traverse, defined as the ratio of average velocity to center velocity. Flow was calculated from center velocity measurements using the following equation:

$$Q = 0.6463 \times VC \times VF \times A$$

Where:

- Q = Quantity of flow in million gallons per day (MGD)
- VC = Velocity at the center of the pipe in fps
- VF = Velocity factor
- A = Area of the pipe in square feet

An inside diameter measurement was also conducted at the gauging point using a Pitometer caliper rod to determine the exact diameter for the calculation of the Pitometer flow rate.



Flow Data & Test Results

Salisbury Pump Station

Meter Data	Manufacturer	
	Size of Meter	
	Number	
Test Data	Date of Test	June 24, 2014
	Length of Test	60 minutes
	Condition of Test	Normal flow
	Size of Pipe	10-inch
Results of Test	Pitometer Rate of Flow	1,339,000 gpd
	Metered Rate of Flow	1,332,000 gpd
	Difference	7,000 gpd
	Percentage Difference	0.5%; meter registers within allowable limits of accuracy

Mill Street Pump Station

Meter Data	Manufacturer	
	Size of Meter	
	Number	Not available
Test Data	Date of Test	June 23, 2014
	Length of Test	52 minutes
	Condition of Test	Normal flow
	Size of Pipe	8-inch
Results of Test	Pitometer Rate of Flow	275,000 gpd.
	Metered Rate of Flow	271,000 gpd.
	Difference	4,000 gpd
	Percentage Difference	1.6%; meter registers within allowable limits of accuracy



Quinipoxet Wells

Meter Data	Manufacturer	N/A
	Size of Meter	8-inch
	Number	N/A
Test Data	Date of Test	June 23, 2014
	Length of Test	30 minutes
	Condition of Test	Normal flow
	Size of Pipe	8-inch
Results of Test	Pitometer Rate of Flow	534,000 gpd
	Metered Rate of Flow	527,000 gpd
	Difference	7,000 gpd
	Percentage Difference	1.3% meter registers within allowable limits



Spring Street

Meter Data	Manufacturer	N/A
	Size of Meter	4-inch
	Number	N/A
Test Data	Date of Test	June 23, 2014
	Length of Test	30 minutes
	Condition of Test	Normal flow
	Size of Pipe	4-inch
Results of Test	Pitometer Rate of Flow	167,000 gpd
	Metered Rate of Flow	151,000 gpd
	Difference	16,000 gpd
	Percentage Difference	-9.5%; under-registration
Retest Results	Pitometer Rate of Flow	176,000 gpd
	Metered Rate of Flow	172,000 gpd
	Difference	4,000 gpd.
	Percentage Difference	2.3% meter registers within allowable limits of accuracy

Brattle Street

Meter Data	Manufacturer	N/A
	Size of Meter	10-inch
	Number	N/A
Test Data	Date of Test	June 24, 2014
	Length of Test	30 minutes
	Condition of Test	Normal flow
	Size of Pipe	12-inch
Results of Test	Pitometer Rate of Flow	1,108,000 gpd
	Metered Rate of Flow	1,080,000 gpd
	Difference	28,000 gpd
	Percentage Difference	-2.5% meter registers within allowable limits of accuracy



Gauging Point Locations

The following gauging point locations were used for the tests.

Main Size (inch)	Velocity Factor	Location	Details
10	0.874	Salisbury Street Pump Station	N/A
8	0.918	Mill Street Pump Station	Quinipoxet tap with Quinipoxet Wells off
8	0.783	Quinipoxet Wells	N/A
10	0.843	Brattle Street	N/A
4	0.904	Spring Street	N/A
8	0.933	Quinipoxet Finished	Quinipoxet and Mill St. wells combined



Conclusions

Meter accuracy tests were conducted on five (5) meters in the City of Holden Water Department. The tests showed that the Salisbury Pump Station, Mill Street Pump Station, Brattle Street and Quinipoxet Wells meters were all within the allowable limits of accuracy.

The Spring Street meters, was found to be under-registering by 9.5%. After meter repairs, a retest showed the meter operating within the allowable limits of accuracy.

Quinipoxet Wells Meter – The Pitometer rate of flow was 371 gpm, which was compared to the 366 gpm indicated by the meter. The meter is within the allowable limits of accuracy.

Spring Street – the average flow rate of the meter, 105 gpm, was compared to the Pitometer flow rate of 1116 gpm. The meter was found to be under-registering by 9.5%. After repairs, the meter average flow rate of 119.5 gpm was compared to the Pitometer flow of 122 gpm. Within allowable limits.

Mill Street Meter- the meter totalizer average of 188 gpm was compared to the Pitometer flow rate of 191 gpm. The meter is within the allowable limits of accuracy. The pump primer meter and the line going to waste were monitored and found to be minor.

Brattle Street Interconnect Meter – the meter rate of flow, 1.08 mgd or 748 gpm, was compared to the Pitometer rate of flow, 1.108 mgd or 769 gpm and found to be within the allowable limits of accuracy. The totalizer for the Brattle meter does not use a multiplier.

Salisbury Street Interconnect Meter – the middle pump from the Pitometer gauging point, Pump No. 2, was used to ensure laminar flow during the test. The totalizer average flow of 925 gpm was compared to the Pitometer flow of 930 gpm. The meter was found to be within the allowable limits of accuracy.

RECOMMENDATIONS

In general, Venturi and orifice plate meters require the sensing lines to be rodded and flushed to clear debris. This can be accomplished during a routine scheduled maintenance program.

The zero reading on the differential pressure (DP) cell needs to be checked for drift. Small bits of rust or air resting on a sensor can cause a zero drift. A zero can be readily checked by opening the bypass and closing one sensing line at the meter. This applies an equal pressure across the sensors. Using a communicator (with the right protocol) the DP cell zero can be corrected.

The 4 to 20ma loop between the DP cell and totalizer may need to be adjusted to ensure agreement between the two devices. Corrosion on wires can cause resistance in the milliamp signal. This can be corrected by performing a loop trim between the DP cell and totalizer.

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Londonderry, NH 03053
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**60 N. Harrison Ave, Suite 31
Congers, NY 10920
845.268.1201 - Fax 845/268-1203**

www.adsenv.com



50 Hampshire Street
Cambridge, Massachusetts 02139
tel: +1 617 452-6000
fax: +1 617 452-8000

Please Remit To:
CDM Smith Inc.
P. O. Box 4021
Boston, Massachusetts 02211

INVOICE

June 28, 2013

Mr. Mark Elbag
Water & Sewer Superintendent
Department of Public Works
1196 Main Street
Holden, MA 01520

Project No. 104433
Invoice No: 80494821

Amount Due

This Invoice: **\$ 11,384.03**

PROFESSIONAL SERVICES RELATED TO THE WATER DISTRIBUTION SYSTEM SECTIONAL FLOW MONITORING ANALYSIS AND REPORTING, IN ACCORDANCE WITH AGREEMENT DATED JUNE 6, 2014

Services through June 28, 2014

Labor Costs

Employees

	<u>Hours</u>	<u>Rate</u>	<u>Total Costs</u>
PESCATORE, J	3.5	\$ 121.65	\$ 425.76
MILLER, A	2.0	\$ 104.16	\$ 208.32
CABRAL, P	54.0	\$ 76.30	\$ 4,120.20
JANAKAS, M	2.0	\$ 44.99	\$ 89.99
Subtotal	61.5		\$ 4,844.27
Overhead @ 135.0%			\$ 6,539.76
Total Labor Costs			\$ 11,384.03

Total: \$ 11,384.03

To ensure proper credit, please reference invoice number on your payment

If you have any questions concerning this invoice, please call Leslie Fortier @ (617)452-6687





Invoice # : 32379-0614

ADS Project No.: 32379

ADS Project Name: Holden, MA Water Test 13

Customer Number: 10276

Date of Invoice: June 24, 2014

Invoice Period: 6/23/14 to 6/27/14

Attention: Mr. Mark Elbag
Town of Holden
1196 Main St
Holden, MA 01520

Billing No: 1

Purchase Order: 383

REMIT TO: ADS, LLC
PO BOX 673809
DETROIT MI 48267-3809

PAY ITEM	DESCRIPTION	Number of Units	Unit Cost	Total	Product Line	CURRENT MONTH BILLINGS		PREVIOUS TOTAL BILLINGS		TOTAL TO DATE BILLINGS		BALANCE Remaining
						Number of Units	Amount	Number of Units	Amount	Number of Units	Amount	
1	Pitometer short duration water meter test at 6 locations. (lump sum)	1	\$4,647.00	\$4,647.00	.31	0.83	\$3,857.01	0	\$0.00	0.83	\$ 3,857.01	\$789.99
				CONTRACT AMOUNT			\$3,857.01		\$0.00		\$ 3,857.01	\$789.99
				Retainage			\$0.00		\$0.00		\$0.00	
				Net Amount Due This Billing			\$3,857.01		\$0.00		\$3,857.01	

Signed and Certified By:

Michael Ames
Senior Project Manager

Amount Due This Invoice:

\$3,857.01

Payment due within 30 days

Please direct all questions concerning this invoice to (603) 625-1212

Prowler Water Conservation Systems, LLC

6 Marshall St.
Leicester, MA 01524
Tel 508-868-6300

**Invoice**

Date	Invoice #
6/26/2014	502

Bill To**Ship To**

Holden DPW-Water Division
1196 Main St.
Holden, MA 01520
Att: Mark Elbag

P.O. Number		Terms	Tech	Date Done	Via	Location	Project No.	
				6/26/2014				
Qty.	Code		Description				Unit	Amount
6.5	Day		Leak Detection/Correlation/Electronic Survey in Holden water system. Start 6-19 to 6-26-14 including overnight loggin sections.				600.00	3,900.00

Prowler Water Conservation Systems, LLC

6 Marshall St.
Leicester, MA 01524
Tel 508-868-6300

**Invoice**

Date	Invoice #
6/18/2014	498

Bill To

Holden DPW-Water Division
1196 Main St.
Holden, MA 01520
Att: Mark Elbag

Ship To

P.O. Number		Terms	Tech	Date Done	Via	Location	Project No.	
				6/18/2014				
Qty.	Code	Description					Unit	Amount
103 2	Hours Site Flow Weekly Flow Rental	Deployment and Retrieval of Flexim Fluxus Model F601 Ultrasonic flow measurement devices for 24 hour measurements at 13 flow points in the Holden Water System from April 28 to May 9. On Site set up and retrieval Set of three : Fluxus Flexim Model F601 Ultrasonic flow units including 3 remote battery packs and Pipe Thickness gauge. Includes Fluxus data 32 software collated charts in Excel format.					95.00 2,370.00	9,785.00 4,740.00
							Total	\$14,525.00

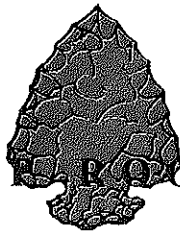
CRUSHED STONE

BITUMINOUS CONCRETE

REMIT TO:

Holden Trap Rock Company
P.O. Box 276
Berlin, MA 01503

HOLDEN TRAP ROCK COMPANY



HOLDEN, MASSACHUSETTS

01520-0031/508-829-4795

Division of Massachusetts Broken Stone Company

ACCOUNT NO. 208324

SOLD TO
SOLD TO
Town of Holden Water Dept.
Water Department
1204 Main Street
Holden, MA 01520

INVOICE	26463
PAGE	1
DATE	05/23/2014
TERMS	Net 30 Days

FOB 2013

Ticket	Date	P.O.	Order	Location	Product	Qty	Rate	Amount	Fee Amount	Tax Amount	Total
14809	05/21/2014		01	1	Type I Top	7.89	65.00	512.85	0.00	0.00	512.85
14834	05/21/2014		01	1	Type I Top	1.91	65.00	124.15	0.00	0.00	124.15
Subtotal						9.80 Ton		\$637.00	\$0.00	\$0.00	\$637.00
Invoice Total						9.80 Ton		\$637.00	\$0.00	\$0.00	\$637.00
Total Invoice ----- >										\$637.00	

Please Remit: Holden Trap Rock
P.O. BOX 276, BERLIN, MA 01503

ONE

BITUMINOUS CONCRETE

REMIT TO:
Holden Trap Rock Company
P.O. Box 276
Berlin, MA 01503

HOLDEN TRAP ROCK COMPANY



HOLDEN, MASSACHUSETTS

01520-0031/508-829-4795

Division of Massachusetts Broken Stone Company

ACCOUNT NO. 208324

SOLD TO
SOLD TO
Town of Holden Water Dept.
Water Department
1204 Main Street
Holden, MA 01520

INVOICE	26500
PAGE	1
DATE	05/31/2014
TERMS	Net 30 Days

FOB 2013

cket	Date	P.O.	Order	Location	Product	Qty	Rate	Amount	Fee Amount	Tax Amount	Total
5009	05/29/2014		01	1	Dense Top	4.76	67.00	318.92	0.00	0.00	318.92
5020	05/29/2014		01	1	Dense Top	2.16	67.00	144.72	0.00	0.00	144.72
5036	05/29/2014		01	1	Dense Top	3.19	67.00	213.73	0.00	0.00	213.73
Subtotal						10.11 Ton		\$677.37	\$0.00	\$0.00	\$677.37
Invoice Total						10.11 Ton		\$677.37	\$0.00	\$0.00	\$677.37

Total Invoice ---- > \$677.37

Please Remit: Holden Trap Rock
P.O. BOX 276, BERLIN, MA 01503

SUSTAINABLE WATER MANAGEMENT INITIATIVE GRANT

Town Match Fiscal Reporting Sheet

Project Number and Name: BRP 2013-06 – Sectional Flow Monitoring Program

Grantee: Town of Holden

Vendor Code: VC6000191831

Contract Number: CT EQE 5014 TOWNOFHOLDENSWMI1414

Town Resources, through April 30, 2014

	# Employees	Hours	Hourly Rate	Total
Mark Elbag, Water & Sewer Superintendent				
Coordinate hiring of consultants	1	12	\$56.66	\$679.92
Coordination Mtgs	1	8	\$56.66	\$453.28
Flow monitoring planning	1	8	\$56.66	\$453.28
Flow monitoring setup	1	12	\$56.66	\$679.92
Meter testing coordination	1	16	\$56.66	\$906.56
Sub-total				\$3,172.96
Crew Time				
4/25 Valve cleaning and operating	2	4	\$37.50	\$300.00
4/28 Meter installation	3	10	\$37.50	\$1,125.00
4/28 Valved cleaning and operating	2	4	\$37.50	\$300.00
4/30 Meter installation	2	4	\$37.50	\$300.00
Sub-total				\$2,025.00
Equipment Time				
Backhoe	1	14	\$40.00	\$560.00
Sub-total				\$560.00
Total Town Resources, through April 30, 2014				\$5,757.96

SUSTAINABLE WATER MANAGEMENT INITIATIVE GRANT

Town Match Fiscal Reporting Sheet

Project Number and Name: BRP 2013-06 – Sectional Flow Monitoring Program

Grantee: Town of Holden

Vendor Code: VC6000191831

Contract Number: CT EQE 5014 TOWNOFHOLDENSWMI1414

Town Resources, May 1 through June 27, 2014

	# Employees	Hours	Hourly Rate	Total
Mark Elbag, Water & Sewer Superintendent				
Coordinate hiring of consultants	1	4	\$56.66	\$226.64
Coordination Mtgs	1	8	\$56.66	\$453.28
Leak Detection Coordination	1	8	\$56.66	\$453.28
Flow monitoring setup	1	16	\$56.66	\$906.56
Mater meter testing coordination	1	4	\$56.66	\$226.64
Report Review & Coordination	1	8	\$56.66	\$453.28
Reporting	1	4	\$56.66	\$226.64
Sub-total				\$2,946.32
Crew Time				
6/23-6/24 Master Meter Testing	1	16	\$37.50	\$600.00
6/9-6/13 Meter installation	3	24	\$37.50	\$2,700.00
6/23-6/26 Leak Detection Direction	1	8	\$37.50	\$300.00
Sub-total				\$3,600.00
Equipment Time				
Backhoe	1	16	\$40.00	\$640.00
Sub-total				\$640.00
<u>Town Resources, May 1 through June 27, 2014</u>				\$7,186.32