Disclaimer

This project was conducted with financial assistance from a grant from the Metropolitan Water District of Southern California through Metropolitan’s Innovation Conservation Program (ICP). ICP grants are provided to selected projects to test water savings potential and functional reliability of new water use efficiency devices. The findings of this project, summarized in this report, are solely from the project proponent. Metropolitan does not endorse any particular product, service, or company, including those discussed within this report. The information provided within this report is not certified by Metropolitan and any party referencing this report should verify information as needed for its own purpose.
SUMMARY FINAL REPORT

Abstract

The original design for LeakBusters® uses pressure sensors to detect water leaks. However, due to the fact that this pressure sensor approach involves major sprinkler system pipe rework, a non-intrusive method must be devised.

The modified design uses acoustic sensors to detect water leaks. This non-intrusive approach is more installation friendly than its predecessor.

The design of acoustic LeakBuster® was completed and two prototypes were built successfully. Tests were conducted to evaluate its functionality and water savings.

An in-depth marketing research was performed by a team of senior marketing students at California State University under professor Vigneron’s instructions. The market value for this product is about $117 million.

During the course of this project, DC Instruments won a SBIR award from EPA in 2009. The research direction for EPA is closely related to this project with some additional features, and they are (1) wireless communication, (2) leak location pinpointing, and (3) leak detection management software. DC Instruments will continue the research in these three areas until 2012.
# Table of Contents

1.0 Original Design......................................................... 3  
2.0 Modified Design....................................................... 4  
3.0 Tests........................................................................... 5  
4.0 How Much Water Can Be Saved?..................................... 7  
5.0 Marketing Efforts......................................................... 8  
6.0 What’s Next?............................................................... 9  
   6.1 Wireless Communication.......................................... 9  
   6.2 Leak Location Detection........................................... 10  
   6.3 Leak Management Software...................................... 11  

# Figures

Figure 1. Original proposed system...................................... 3  
Figure 2. A Modified System............................................ 4  
Figure 3. Test setup......................................................... 5  
Figure 4. PC software shown on a PC.................................. 6  
Figure 5. Water savings calculation.................................... 7  
Figure 6. Wireless communication..................................... 9  
Figure 7. Leak Pinpointing GUI......................................... 10  
Figure 8. Regression Technique......................................... 11  
Figure 9. Leak Management Software................................. 11
1.0 Original Design

An intrusive pressure transducer was proposed in the original RFP to detect water leaks. This approach requires major rework of PVC sprinkler pipes, which is not appealing to end-users.
2.0 Modified Design

A user-friendly non-intrusive acoustic sensor was designed. This acoustic sensor (LeakBuster®) has the following features:

1. Detecting leaks in a sprinkler system if the collected acoustic data is beyond the preprogrammed acceptable threshold
2. The preprogrammed acceptable threshold is programmable
3. The preprogrammed acceptable threshold can be self learned
4. The solenoid valve will be turned off if a leak is determined
5. A bypass switch can be activated to bypass the LeakBuster®
6. Installation only requires disconnection and connection of two wires from an automatic sprinkler timer
3.0 Tests

Use a LeakBuster prototype to listen to a sprinkler station.

1. Place and tape the microphone (from the LeakBuster prototype) to the PVC pipe of sprinkler station #5\textsuperscript{note}. The scotch tape provides sound insulation to reduce background audible noise.

   Note: this experiment was conducted on a household with 6 automatic sprinkler stations (#1 to #6).

2. Connect a RS232 cable to the LeakBuster, and launch the PC software to read sound frequency detected by the LeakBuster prototype.

The following software was written in Visual Basic 6.0 to read sound frequency from a LeakBuster. The communication interface is RS232 serial bus.
Figure 4. PC software shown on a PC
4.0 How Much Water Can Be Saved?

A leak can be created by removing one of the sprinkler heads. To quantitize the leaked water, connect one end of a water hose to the sprinkler’s leaked opening, and the other end to a water bucket.

In conclusion, with a LeakBuster, about 12.2 cubic feet of water can be saved for one sprinkler station for a typical 10-minute water cycle.

Figure 5. Water savings calculation
5.0 Marketing Efforts

Under Professor Vigneron’s direction, senior students – Zahrah Kassim, Kane Parkinson and Brian Pascual – developed a marketing study for LeakBusters during the Fall semester 2007. This study was further presented in the Student Fast Pitch Competition at Grand Salon, Student Union, CSUN in May 2008.

In summary, this report addresses the following subjects:

- SWOT Analysis
- Product entry strategy
- Sales channels
- Estimated business income
- Estimated market size

Estimated total market for general households: $117 million

Estimated Market Size in 1 year

10% of the market captured in 1 year: $117 million \times 10\% = $11.7 million

Estimated Market Size in 5 years

90% of the market captured in 5 years: $117 million \times 90\% = $105 million
6.0 What's Next?

DC Instruments received an award from EPA in 2009 for water leak detections, which is the furtherance of this ICP project. There are three key areas will be explored up to 2012, and they are described in the following sections.

6.1 Wireless Communication

![Diagram of wireless communication](image)

The leak information detected by LeakBusters® will be transmitted to the Internet through ZIGBEE and gateway wirelessly.
6.2 Leak Location Detection

Figure 7. Leak Pinpointing GUI

LeakBusters® are able to detect water leaks successfully. The next effort is to detect the leak location by using cross-correlation\textsuperscript{note1} and regression\textsuperscript{note2} techniques.

Note 1: sound wave arrives at two acoustic sensors at different time. From the time difference, leak location can be calculated.
Note 2: regression is a technique based on leak history. A leak location can be predicted if enough leak historical data is available.
6.3 Leak Management Software

The transmitted leak data will be analyzed by using Leak Management Software (LMS). LMS calculates and displays leak locations on a Google map, and then alerts end users for potential leaks.

In conclusion, LeakBusters® have been designed, prototyped and tested successfully for MWD ICP project. Our next effort is to add cutting edge technologies for large water infrastructure to detect leaks real-time, which leads to water savings.