A FIELD EVALUATION OF THE SHOTSPOTTER GUNSHOT LOCATION SYSTEM: FINAL REPORT ON THE REDWOOD CITY FIELD TRIAL

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EXECUTIVE SUMMARY

- ShotSpotter is described as a technologically advanced acoustic sensing system capable of identifying, discriminating, and reporting gunshot information to the police in less than twenty seconds of a shot being fired. The technology was developed by Trilon Technology and field tested in Redwood City, California.

- The ShotSpotter gunshot location system is comprised of three primary components: acoustic sensor modules located in the target area, a base station (Sun Microsystems SparcStation 20 personal computer) located in the police dispatch center, and LabVIEW software that monitors all channels for gunshot sounds and then computes the relative time delays between the detections on different acoustic sensor modules.

- Trilon Technology suggests that approximately 8 acoustic sensor modules are required to cover a one square mile area. Trilon estimates that to purchase the ShotSpotter system will cost approximately $150,000 for the first square mile and an additional $100,000 to $120,000 for each additional square mile of coverage.

- Redwood City, California, and in particular Redwood Village, a neighborhood of approximately one square mile, was selected as the experimental test site due to its high incidence of celebratory and random gunfire: the rate for random gunfire in the test site (1,279 per 100,000 people) was substantially higher than the city wide rate (493 per 100,000 people). Redwood Village is mainly a middle class community which consists primarily of residential housing units mixed with light industrial/commercial enterprises.

- Field testing in Redwood Village comprised the installation of 8 acoustic sensor modules on various rooftops of residences and buildings in the experimental target area. These modules were disguised by their design as some resembled heating vents while others resembled bird houses.

- We conducted the ShotSpotter field trial on June 26 and 27, 1997. Using police calls for service data, the Cincinnati Evaluation Team randomly selected 32 locations from where blank rounds would be discharged. Of these 32 locations, blanks were discharged from 27 face block addresses and 5 intersection addresses.

- Three types of weapons and the number of rounds to be fired from each weapon were randomly assigned to each of the selected locations. The weapons used in the ShotSpotter Field Trial were a .38 Caliber Pistol, a 12 Gauge Shotgun, and an MP5 Assault Rifle. No more than four blank rounds were discharged at any location.

- Findings from the ShotSpotter Field Evaluation indicated that overall, the gunshot location technology was able to annunciate (detect) nearly 80 percent of the test shots. Specifically, the technology annunciated shotgun rounds at the highest rate (90 percent) followed by pistol rounds (77 percent) and then assault rifle rounds (63 percent).

- The gunshot location technology was able to triangulate (locate) 84 percent of the test shots (N = 26 of 31 shooting events) within a median margin of error of 25 feet. Shotgun events had the highest rate of triangulation at 100 percent (N = 10 of 10 events) with a median margin of error of 23.5 feet. Pistol events were triangulated 85 percent of the time (N = 11 of 13 events) within a 25 foot margin of error followed by the MP5 assault rifle which was triangulated 63 percent of the time (N = 5 of 8 events) within a 27 foot margin of error.

- Citizen perceptions of the random gunfire problem and ShotSpotter effectiveness were obtained through focus group interviews.

- Proponents of the gunshot location technology felt that the technology was advantageous because it can pinpoint gunfire incidents more quickly and accurately, people tend to feel safer since its implementation, and installation of the ShotSpotter system has assisted in police community relations.

- Opponents to the ShotSpotter gunshot location technology indicated that it has had no impact on the arrest rate of persons discharging weapons, the community is developing a false sense of security, and no deterrent effects are being realized as a result of the ShotSpotter system. In addition, system opponents suggested that it is too expensive to purchase and maintain this technology. They felt that money would be better spent by hiring law enforcement officers.

- Officer perceptions of the random gunfire problem and ShotSpotter effectiveness were obtained through written questionnaires. Officers did not have much confidence in the system's ability to identify or locate incidences of random gunfire. More specifically, officers indicated that they did not believe that the ShotSpotter technology improved their response times to random gunfire calls for service over and above citizen initiated events.

- Officers believed that ShotSpotter could help identify random gunfire hot spots and that this knowledge could help them to reduce random gunfire incidents. Over two thirds of the officers prefer using ShotSpotter over relying solely on citizen calls.

I. INTRODUCTION

The ShotSpotter gunshot location system is designed to detect and locate random gunfire. ShotSpotter was developed and manufactured by Trilon Technology and is described as:

> "A gunshot location system that uses acoustic sensors placed on roof tops or utility poles to detect gunshots in an urban setting. The sounds from the sensors are sent to a central computer placed at a police dispatch center. The relative arrival times of gunshot sounds from the sensors allow the computer to calculate the precise location of gunfire. This information is plotted on a computer map of the community" (Showen, 1996:130).[1]

The ShotSpotter gunshot location system was installed in Redwood Village in April 1996. Redwood Village is a small neighborhood in Redwood City, California that receives police services from both the Redwood City Police Department and the San Mateo County Sheriff's Office. We begin this final report with a description of the gunshot location system that was developed by Trilon Technology and installed in Redwood City, CA (Section II). Section III describes the Redwood City test area, the rationale for selection of Redwood Village as the experimental test site, and the complexities of installing ShotSpotter in Redwood Village. Section IV describes our methodology for firing test shots to evaluate the accuracy of the ShotSpotter under field trial conditions and in Section V, we report the results of the ShotSpotter Field Trial. We then report the results from a series of focus group interviews with community members in Section VI. And finally, in Section VII, we report our results from the officer surveys that document officer perceptions of the random gunfire problem in Redwood Village and their feelings about the effectiveness of using ShotSpotter to address this problem.

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[1] Showen, Robert (1996) "An Operational Gunshot Location System." SPIE Vol. 2935:130-140. Also available at www.ShotSpotter.com

II. SHOTSPOTTER: THE GUNSHOT LOCATION SYSTEM INSTALLED IN REDWOOD CITY[2]

The gunshot location system installed in Redwood City, CA (ShotSpotter) was designed and manufactured by Trilon Technology. ShotSpotter seeks to identify the location and time of gunfire in a specified target area through a series of acoustic sensor modules. The ShotSpotter system is comprised of acoustic sensors located in the Redwood City target area, a central computer located in the Redwood City Police Department's Dispatch Center, and gunshot detection and location identification software.

The acoustic sensors include microphones, acoustic sensing elements, and gunshot identification electronics. They resemble birdhouses and heating vents and are enclosed in weatherproof containers that are approximately one cubic foot in size. Eight sensors were installed on rooftops of various businesses and residences in the experimental target area. The sensors are designed to detect muzzle blasts from gunfire or other explosions and then transmit the sound of the gunfire via telephone line to a central computer located in the Redwood City Police Dispatch Center. The parameter settings of the ShotSpotter software determines the system's level of sensitivity: if the thresholds are set quite high, then background noise is less often identified as gunfire. Conversely, if the thresholds are set quite low, then more background noise has more potential to be incorrectly identified as gunfire[3]. Once the sensors detect a sound

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[2] The information used in this section to describe the Shotspotter Gunshot Location was derived from personal communication with Trilon Technology, the ShotSpotter website (www.shotspotter.com), SPIE Vol. 2935, and ShotSpotter Progress reports generated by Trilon Technology subsequent to each trial phase.

[3] Muzzle blasts from gunfire have distinctive waveforms as do the sounds from other similar sources. However, the setting parameters determine what level of extraneous noise will

and transmit the information to the central computer, the ShotSpotter software discriminates against most other community sounds (such as car backfires, jack hammers, thunder, and barking dogs) and locates the location of gunfire and explosions. Gunshot events are displayed on a computer map in the police dispatch center within approximately 15 seconds of the noise being made. The computer map distinguishes properties' boundaries including front or side yards, curbsides or street corners.

The information transmitted from the acoustic sensors in the target area is received by a Sun Microsystems SparcStation 20 computer located in the dispatch center of the Redwood City Police Department. The Sparc 20 system contains an SB-MIO multi-function card from National Instruments which runs the Trilon Software. The Sun Microsystems SparcStation 20 was selected as the operating system due to its ease of connectivity, information processing capabilities, and memory capabilities. Each potential gunfire event takes up approximately 2.3 megs of memory. The ShotSpotter system stores all waveforms for every detected gunfire event and six seconds of audio from each detecting acoustic sensor. As such, a significant amount of hard drive space and system memory is required when numerous gunfire events occur simultaneously or when many noises are relayed to the system in quick succession (i.e. New Year's Eve, or 4th of July).

Determination of the precise location of gunfire events is conducted through a series of iterations of triangulation algorithms. The system can generate an overview map which presents

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trip the system. Hence, the more rigorous the parameter settings, the less likely it is that jack hammers, thunder and car backfires will set the system off (increase the rate of true negatives). Alternatively, the less rigorous the parameter settings, the more likely it is that extraneous noise will trip the system (increase the rate of false positives).

locations of historical shootings to discern patterns in space or time. The ShotSpotter computer can be placed in a dispatch center with stand-alone or integrated outputs[4], or it can be at a remote site. The software routines developed and used by Trilon Technology to detect and identify the location of random gunfire is written in LabVIEW. The LabVIEW software monitors all channels for gunshot sounds and then computes the relative time delays between the detections on the different sensors. The triggering system is programmed to respond when any channel (each acoustic sensor has its own channel) exceeds the programmed threshold levels. The system then checks the event for characteristics of gunshot sounds such as short rise times, abrupt onset of impulses, and variable secondary echoes at each detecting sensor. The locating software does not analyze the other channels unless the trigger signal could be a gunshot. Once the system registers a potential gunshot on one channel, it searches other channels for confirmation of the sound. If four channels register the sound,[5] the software then triangulates the system data to identify the gunshot location and displays it on a neighborhood map using LabVIEW's Picture Control Toolkit. Once the ShotSpotter system detects a shot and reports this location on the computer screen, dispatchers can play back a six second snippet of sound from any sensor to assist them in determining what they believe to be the true source of the sound: firecracker

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[4] The system can stand alone within the dispatch center or it can be linked into the dispatch center's operating system.

[5] The ShotSpotter system in Redwood City used the four channel criteria as a basic system parameter. The system can be set such that only one channel is required for system initiation. Alternatively, the system can be set so that many channels are required to initiate the system (theoretically, as many channels as number of sensors can be required before the system will register a gunshot - 8 in the case of Redwood City). For purposes of the Redwood City field trial, the Police Dispatch Commander expressed a desire to lower the threshold from four to three channels to ensure that the system would register a shot.

string, multiple gunshots, shotgun blast, backfire.

Trilon Technology claims that one to several square miles of a gunfire-impacted area can be covered by a single system which comprises six to ten sensors. Areas with mixed residential land use characterized by one to three story buildings would require approximately eight sensors per square mile. In higher-rise areas Trilon contends that sensor density may need to be increased (Personal Communication, President of Trilon Technology, June 7, 1997).

The ShotSpotter system was installed in the Redwood Village target area for eighteen months. Trilon was contracted (installation and maintenance) by the Redwood City Police Department and the San Mateo County Sheriff's Office for $25,000 to field test the ShotSpotter system. The University of Cincinnati Evaluation Team conducted an independent field test of ShotSpotter during June 1997. In the fall of 1997 the Redwood City Police Department and the San Mateo County Sheriff's Office purchased the ShotSpotter gunshot location system for $85,000. The police department is currently responsible for the cost of maintenance to the system. Trilon Technology indicated that an annual maintenance contract costs about $16,000 (Personal Communication, President of Trilon Technology, June 7, 1997).

Trilon Technology suggested that if the system were to become a large scale sale item, the cost to purchase the entire system would be approximately $150,000 for the first square mile of coverage and $100,000 to $120,000 each additional square mile of coverage. Maintenance costs of the system would fluctuate above or below the $16,000 benchmark quoted for Redwood City depending on the size and nature of the installation for each city. In addition, leasing and lease-to-own agreements are available to police departments (Personal Communication, President of Trilon Technology June 7, 1997).

III. REDWOOD CITY AS A RESEARCH SITE

Located on the Bay Area peninsula halfway between San Francisco and San Jose, Redwood City is home to approximately 70,000 people and covers roughly 23 square miles. It is the oldest Bayside City in San Mateo County and has been the County Seat since 1856. The median population age is 33 years old with nearly 70 percent of the population ranging between 18 and 64 years of age. Redwood City's population is 66 percent white, 4 percent African American, and 24 percent Hispanic origin. The unemployment rate in Redwood City is 4.1 percent.

The Redwood City community is comprised of commercial, residential, and industrial land usage. Nearly fifty percent of housing in Redwood City is comprised of single family structures. The remaining residential structures are comprised of anywhere from two to 50 units. The average housing cost for a 3 bedroom, 2 bath house ranges from $350,00 to $390,000. Average monthly rent for a 2 bedroom apartment is $1,025.

Industry in Redwood City is dominated by services and trade. Being the home of the only deepwater port in the south San Francisco Bay area Redwood City is well suited for deep draft ship and ocean going tug/barge berths which routinely transport large amounts of liquid and dry bulk products. The combination of strategic location (between San Francisco and San Jose/Silicon Valley), available deepwater facilities, and efficient service, has enabled the Port of Redwood City to become the fastest growing "small" bulk port in California.[6]

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[6] Demographics for Redwood City, 4/13/98 [On-line]Available: http://www.ci.redwood-city.ca.us/city/demographics.html.

Redwood City Police Department[7]

The Redwood City Police Department embraces a community policing philosophy and employs 87 sworn officers and 37 non-sworn civilians. They collectively field approximately 65,000 total calls per year (dispatching 33,000 calls) and in 1996, the department handled over 3,000 Part I crimes. The department is organized into three divisions where sworn officers are in either patrol, investigations, or administration. The Redwood City Police Department's Patrol Division is the largest of the three divisions. It is comprised of the Marine Unit, Community Service Officers (non-sworn personnel), and Patrol Officers. The Patrol Division consists of all uniformed officers who respond to emergency and non-emergency calls for service.

The Administrative Division is responsible for the Communications Division (dispatchers and 911 operators), the Records Unit, the Training Unit, the Crisis Resolution Team, and the Special Weapons and Tactics Team (SWAT). All Redwood City police officers receive a minimum of forty hours of training on an annual basis. In addition to specific training for specialty positions, all officers receive continuous training in the areas of domestic violence investigations, firearms, pursuit driving, first aid and hazardous materials.

The final division comprising the Redwood City Police Department is the Investigations Division. Investigations is responsible for long term case follow-up, narcotics investigations, sexual assault investigations, robbery investigations, burglary investigations, and street crime. In addition to handling adult level cases, the Investigations Division of the Redwood City Police

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[7] Background information of the Redwood City Police Department was obtained from the Redwood City Police Department's website, [On-line] Available:http://www.ci.redwood-city.ca.us/police/index.htm

Department has a detective assigned as the Juvenile Officer who works with a counselor to tackle problems at schools as well as to assist families in the Redwood City community.

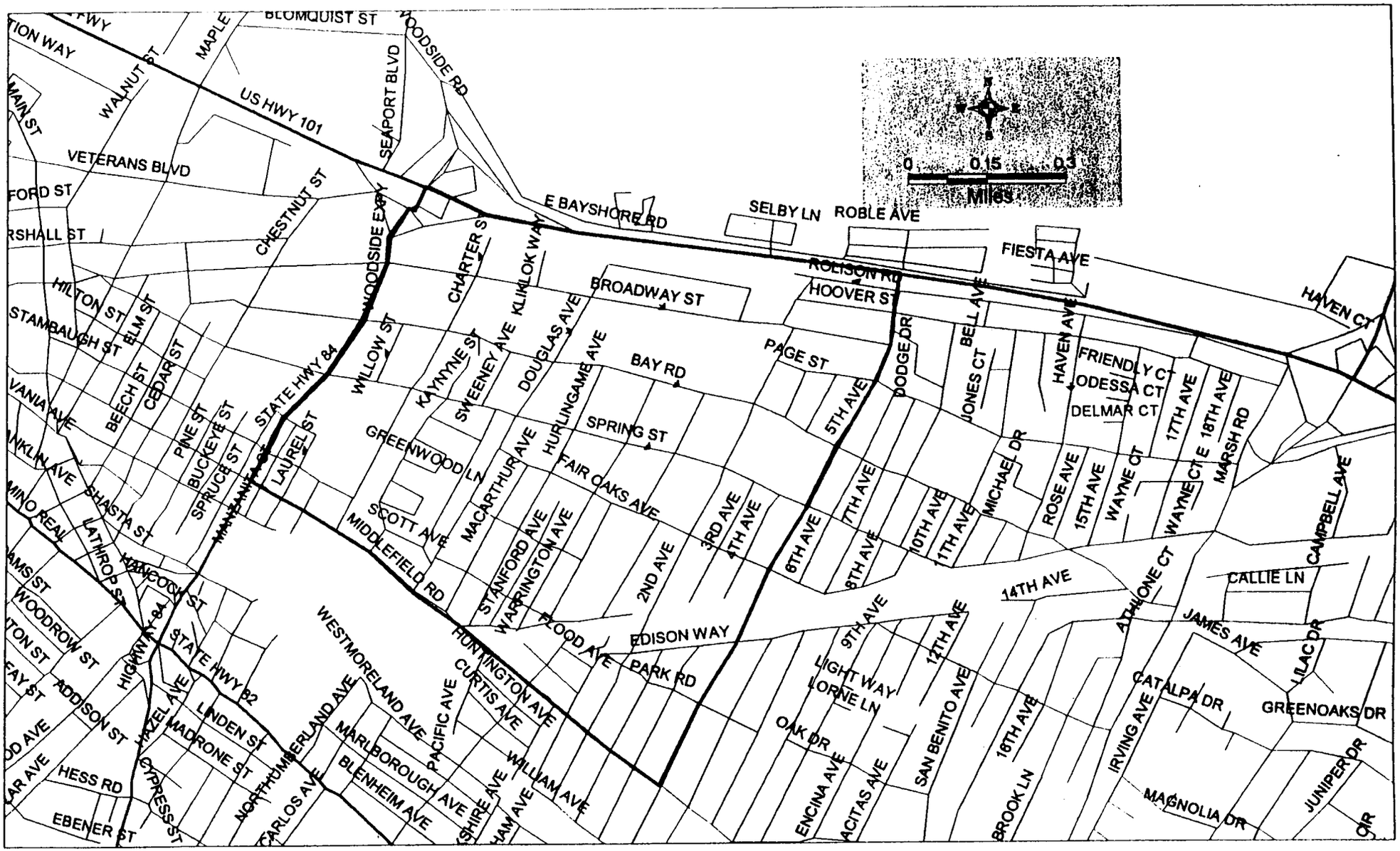
Experimental Site Selection

The Redwood City Police Department and the San Mateo County Sheriff's Office agreed to pilot test the ShotSpotter gunshot location system in the Redwood Village area of Redwood City. The experimental test area is policed by both the Redwood City Police Department and the San Mateo County Sheriff's Office. The Redwood Village community is comprised of a predominately Hispanic population. While the one square mile area that makes up Redwood Village has low income sections, it is primarily a middle class community. The experimental target area consists mainly of residential housing units mixed with light industrial/commercial enterprises. The terrain in the Redwood Village community is predominately flat and couched between three major thoroughfares: Bayside Freeway, Woodside Expressway, and Middlefield Road (see Figure 1 overpage - Map of Experimental Target Area). Official data from both the Redwood City Police Department and the San Mateo County Sheriff's Office indicate that the reporting areas comprising Redwood Village were over-represented in total calls for service for random shots fired (see Appendix I for a detailed description of the collection and analysis of calls for service data): random gunfire calls for service represented less than 1 percent of all calls citywide (N = 345 of 72,821 total calls). Of all random gunfire calls for service, 26 percent occurred in the Redwood Village experimental area (N = 90) in 1996. Random gunfire calls represented two percent of all calls in the experimental area (1,279 shots per 100,000 people) whereas random gunfire calls represented just .4 percent of all calls across the other areas of Redwood City (367 shots per 100,000 people).

Figure 1

SHOTSPOTTER FIELD TRIAL

Experimental Target Area



IV. FIELD TRIAL METHODOLOGY: TEST SHOTS IN REDWOOD CITY

A detection device like ShotSpotter is subject to four possible outcomes: Two of these potential outcomes are correct and two constitute errors. When functioning ideally the detection device emits a warning when confronted with the appropriate stimulus (**true positive**) and remains inactive in the absence of the stimulus (**true negative**). Errors occur when the device emits a warning in the absence of the appropriate stimulus (**false positive**) or fails to emit a warning when the stimulus is present (**false negative**).

An example of such a device is a smoke detector designed to warn potential victims. When no smoke is present the device should remain in its neutral state, emitting a warning only when its sensors detect smoke. Thus, when the device is neutral no warning is produced (**true negative**) and no evasive actions taken. When smoke is present the device activates an alarm (**true positive**) and corrective actions taken. Potential dangers occur when the device reacts without the presence of smoke (**false positive**) since evasive action is undertaken needlessly and when it fails to activate when smoke is present (**false negative**) since necessary evasive actions are not taken.

The usefulness of ShotSpotter is dependent upon its ability to accurately detect gun shots when present. Ideally when a shot is fired the system alerts dispatchers with a light, buzzer, and map indicating the location of the shot. Dispatchers then mobilize and deploy officers to investigate the incident. While ShotSpotter is neutral, the dispatcher assumes no shots are being fired. Resources are expended when shots are fired and detected (**true positive**) and conserved when shots are not fired nor detected (**true negative**). The operational usefulness of ShotSpotter is contingent upon its ability to accurately respond to the appropriate stimulus, since **true**

positive and **true negative** responses result in optimum police efficiency. **False positive** and **false negative** outcomes reduce police efficiency or waste resources. Our evaluation of the ShotSpotter system, therefore, attempted to assess the proportion of false positive and false negative outcomes.

To assess whether or not the ShotSpotter technology could accurately identify and locate random gunfire, we originally proposed a controlled field trial of ShotSpotter involving the shooting of blanks and the igniting of 1" firecrackers. Use of both firearms and firecrackers under field trial conditions would have enabled the Evaluation Team to determine whether or not the gunshot location technology could identify alleged gunfire and delineate between types of discharges. However, due to criminal ordinances against fireworks in Redwood City we were unable to release firecrackers in the experimental test area under field trial conditions. By disallowing firecrackers to be part of the ShotSpotter field trial, we were unable to directly ascertain the false positive rate of the system. Nonetheless, direct measures of true positives, false negatives, and to a lesser extent true negatives were sought from our field trial. This section describes our field trial design, discusses how the design was altered slightly during the days that we fired the test rounds, and describes the parameters of the field trial method.

The Field Trial Design

Firing test blanks[8] under controlled field trial conditions in order to test the performance

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[8] The original proposal was to discharge live rounds of ammunition. However, numerous discussions with the Chief, his advisors, and personnel from Trilon Technology led to an agreement of discharging blanks as opposed to live rounds. While the amplitude waves generated by blanks are not identical to the amplitude waves generated by live ammunition it was indicated that they were relatively close enough to serve as sufficient replacements for live ammunition. Additionally, the potential danger imposed on the community by discharging live

of ShotSpotter was approved by the Redwood City Police Department in June 1997. The University of Cincinnati Evaluation Team worked with the Redwood City Police Department personnel to select weapon types, the number of shots to be fired, and the times and locations from where test shots would be fired. Based on the most common weapons typically fired in the experimental area, the Redwood City Police Department suggested that three weapon types be used: an MP5 assault rifle, a 12 gauge shotgun, and a .38 caliber pistol. The Redwood City Police Department suggested that these three types of weapon would be a representative cross section of weapons fired by offenders in the Redwood City area. The decision to alternate between weapon types, number of shots, and time and location of shots in the field trial provided the Evaluation Team with the ability to conduct a rigorous assessment of ShotSpotter's ability to detect and locate random gunfire.[9]

Negotiating the Field Trial

The Redwood City Police Department allowed the Evaluation Team to conduct the field test during two time periods: 10:00 am to 3:00 pm and 7:00 pm to 10:00 pm. These times were set by the Police Department in conjunction with Trilon Technology because they avoided heavy traffic hours (rush hour in the morning and rush hour in the evening) and they would not interfere with the majority of residents' sleeping patterns. Avoiding heavy traffic hours decreased the possibility of false positive alerts during our field trial as reduced levels of background noises were somewhat artificially restricted (i.e. car backfires and car horns) through this process. We

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ammunition was an imminent factor in deciding to use blanks in the field trial.

[9] This was fortunate because the ability to delineate between types of discharges was lost when the igniting of firecrackers in the field trial was ruled out.

acknowledge that, in real life situations, such background noises cannot be ignored. However, given the fact that blanks were used as opposed to live rounds (blank rounds result in the ShotSpotter system registering of wave forms characterized by lower amplitudes) and that the evaluation team wanted to provide the best possible atmosphere for system validation, it was determined that these hours were the best for our field trial.

Two major factors were considered in our negotiations with the Redwood City Police Department about the number of gunshot events in the ShotSpotter field trial: (1) how many total gunshot events would be needed to provide a fair test of the ShotSpotter system? and (2) how many rounds could be discharged without creating an uproar in the Redwood Village community? The Evaluation Team originally proposed 120 test events. The Redwood City Police Department suggested 20 events. The Redwood City Police Department, the Evaluation Team, and Trilon Technology agreed that 32 test events[10] would be a fair compromise. Once the types of weapons to be used, the number of shots to be fired, and the time frames were agreed upon, the Evaluation Team had to determine the location of each shot, the type of weapon to be used at each location, as well as the number of rounds to be discharged at each location.

Sample

To determine the location of the test shots, the Evaluation Team employed a multistage random sampling design. We started with an extensive examination of the locations of random gunfire in the Redwood City calls for service data that corresponded to the address ranges in the experimental test area (see Appendix I for a detailed description of the calls for service data used

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[10] In establishing that 32 test events would be acceptable the Redwood City Police Department agreed that 80 test shots could be discharged across the range of 32 event locations.

in this report). The calls for service data revealed both "hot" spots and "cold" spots for random gunfire in the experimental area. "Hot" spots were defined as face blocks or intersections with one or more random gunfire incidents in the past year. Alternatively, "cold" spots were defined as face blocks or intersections with no incidences of random gunfire in the past year. The Evaluation Team identified 134 intersections and face blocks with at least one call for service for a random gunfire incident from January 1 to December 31, 1996 and 164 intersections and face blocks with no calls for service for a random gunfire incident from January 1 to December 31, 1996 in the Redwood City test site (see Appendix I). We proceeded to randomly select 22 "hot" spots and 10 "cold" spots to generate the 32 test face blocks and intersections for the field trial (N = 32).[11]

Once these 32 locations were identified, the Evaluation Team had to select specific addresses (either on a face block or an intersection) from these "hot" and "cold" spot locations in order to specify the precise location from where test rounds would be fired. Of the 22 "hot" spots we randomly identified 19 face block addresses and 3 intersections as the locations where shots would be fired. Similarly, from the 10 cold spots, 8 face block addresses and 2 intersections were selected as test shot locations.

Similar to the random assignment of shot location, the evaluation team randomly assigned the type of weapon to be discharged as well as the number of test rounds for each unique test location. With 32 test locations established and 80 test rounds permitted to be fired,

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[11] 32 test locations were selected as sites to fire rounds. However, given the extensive media coverage of the first test location, the Evaluation Team chose to exclude the first shot location from this analysis. As such, this analysis reports from 31 test locations.

the Evaluation Team determined, through random assignment, which locations would receive one shot or bursts of two, three, or four shots. The MP5 assault rifle was randomly assigned to nine locations, the 12 gauge shotgun to ten locations, and the .38 caliber pistol to thirteen locations. As such, the evaluation team knew a priori where each weapon would be discharged as well as the type of weapon and number of rounds to be discharged at each randomly selected address .

Method

One member of the Evaluation Team was stationed in the police dispatch center with a Trilon Technician. Another member of the Evaluation Team was in the field with a sworn officer from the Redwood City Police Department. The person on site with the Trilon technician was in constant contact with the researcher in the field by means of cellular phone. The field researcher's responsibility was to verify the location, weapon type, and number of rounds to be fired prior to each shot event based on the sampling decisions. This enabled the Evaluation Team to compare data recorded in field notes from the actual shot locations against data generated by the ShotSpotter system. The primary responsibilities of the researcher in the field were to: (1) direct the officer to each randomly selected address; (2) instruct the officer as to the type of weapon to be discharged; and (3) direct the officer as to the number of rounds to be fired at each location. The researcher in the field kept in constant contact with the researcher in the dispatch center to ensure that locations and times were correct, weapon selections were correct, and number of rounds fired was correct. The police officer in the field, the dispatchers, and Trilon Technicians did not know where the shots would be fired from, when the shots would be fired, the types of weapon, or number of rounds prior to arrival at each test site.

Prior to entering the field, the Evaluation Team needed to establish rules for selecting the precise location of where the event (test shots) would occur. Since we had already selected the addresses to fire shots from, we only needed to establish rules as to exactly where, at the randomly selected address, we would fire the shots. Two rules were created to guide selection of the precise test shot location: First, every shot event that was selected to be fired at an address on a face block was alternated between the right and left sides of the property lines when facing the property. For instance, shots for event #2 were selected to be fired from 711 3rd Av. The location of the test shots was set for the right property line of this face block address. Event #3 (2424 Spring St.) was also selected as a location where shots would be discharged from a face block. However, since the previous event location was assigned to the right side of the property line this event (#3) was assigned to the left side of the property line.

A similar procedure was employed when test shots were to be fired at intersection addresses. The precise location for the test shots was determined by working in a clockwise sequence around the properties on the intersection. For example, event #6 (Warrington/Halsey) was assigned to the Southeast property parcel on the intersection. The next set of test shots (event #13) assigned to an intersection was to be discharged from the Southwest property parcel.

Field Problems

A number of problems occurred during the field trial that caused the Evaluation Team to alter test locations, times at which shots were fired, weapon types at various sites, as well as adjust the number of test shots at different locations. In total 16 of the 31 events had one or more forms of adjustment. Specifically, two gunshot events (events #11 and #16) had to be moved due to location discrepancies; three gunshot events (events #18, # 20, and #21) required

alteration in the times at which test shots were fired; five gunshot events (events #25, #26, #27, #29, #31) required alteration in the type of weapon fired at the test location; and finally, eleven gunshot events (events #18, #19, #21, #22, #23, #25, #26, #27, #30, #31, #32) required adjustment in number of test rounds fired at each location. We describe the adjustments to the field test below.

Alterations of Event Location

Two test locations were altered during the field trial. Event #11 (475 Broadway Av.), was originally linked to 401 Broadway Av. This location, however, required a slight adjustment in the designation of the shot location due to new construction on the entire face block that resulted in more street addresses than what we had estimated from computerized maps of the street address ranges. We decided that 475 Broadway Av. was a close approximation of the same spatial location as the Evaluation Team's original location selected at 401 Broadway Av. The second event that received a change in the location of the test shots was event #16. This event was originally located at 676 Douglas Av. However the location for this event, while remaining on the same street block, was moved directly across the street to 765 Douglas Av. due to police jurisdictional discrepancies. Both San Mateo County Sheriff's Office and the Redwood City Police Department have jurisdiction for policing the Redwood Village community. In order to ensure equal representation of test locations in both San Mateo County Sheriff's jurisdiction and Redwood City Police Department's jurisdiction we decided to relocate this test location.

Alterations in Times When Test Shots Were Fired

Three events required alterations in the times designated to fire the test shots. Event #18, #20, and #21 required firing test rounds at the same location twice. For event #18 four test

rounds were discharged; two at 1151 and two at 1159 in the morning of June 26, 1997. The second set of rounds were fired at this location some eight minutes later to confirm the earlier set of rounds that informed us that one of the system sensors was not functioning. Similar problems occurred for events #20 and #21. For these three events, the test rounds discharged in the morning failed to register an automatic annunciation given the malfunctioning sensor in the field (sensor # 1 (blue) located on Fifth Avenue near Middlefield). As such, we postponed firing test rounds until the evening to allow the malfunctioning sensor come back on line.[12] Later that afternoon, the sensor came back on line and the Evaluation Team resumed testing.

The fact that the sensor was malfunctioning during our field trial offers an important insight into the field reality of a gunshot detection device like ShotSpotter. Technically, our Evaluation Team could have counted all gunshot events that were scheduled to occur during the period of the "downtime" (N = 15 events) as false negatives if indeed the system failed to detect the gunfire events. However, it is most likely that the results would have remained the same since seven of the eight sensors continued to function as normal. Since our Evaluation Team was limited to very few field trial events (N = 32), we chose to postpone the scheduled trial shots until the sensor was back on line. Our caveat, therefore, in reporting these field trial results is that the amount of downtime of a system like ShotSpotter could significantly impact the rates of

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[12] Trilon personnel indicated that from time to time one or more sensors will go off line for a short period of time, but will come back on line. As a result, it was suggested that once the sensor was back on line, the testing could commence. The Evaluation Team, while on a tight time schedule was assured by Trilon that the sensor would return to operation relatively quickly and testing could begin immediately.

system failures to detect gunfire.[13]

Alterations in Weapon Type Fired at Test Locations

The type of weapon fired at five event locations was changed due to initial over sampling of the MP5 assault rifle. Originally, we had over-sampled the MP5 assault rifle because we were informed that this was the most common type of weapon fired in Redwood City. Nonetheless, since the MP5 assault rifle was the weapon least likely to be identified by ShotSpotter, and because we did not want to bias the test results through over-sampling, we altered the random distribution of weapon type to reflect a more uniform distribution across test locations. The .38 caliber pistol was randomly selected to replace the weapon type to be fired for events #25, #29, and #31. Similarly, the 12 gauge shotgun was randomly selected to replace the weapon type to be fired for events #26 and #27.

Once again, this alteration in the methodology greatly assisted the ability of ShotSpotter to achieve a higher true positive rate than what would have been the case if the original design was followed. Nonetheless, we believe that the change in method was warranted since we had so few shots (N = 32) to fire: by repeatedly failing to identify shots from the MP5 assault rifle would not have illuminated additional insights as to the operational accuracy of ShotSpotter. We point out, therefore, that reports of the Shotspotter's accuracy as to a system's accuracy needs to take into account the type of weapons that were fired.

Alterations in Number of Shot at Each Event Location

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[13] We have asked Trilon Technology for data on the system downtime. However, we were unable to obtain these data. Logging each sensor's operations is made but routines to download the downtime information is not written.

The final alteration in procedures for the ShotSpotter field trial entailed adjustments in the number of shots fired at event locations. Specifically, we altered the number of test rounds fired at eleven location (events #18, #19, #21, #22, #23, #25, #26, #27, #30, #31, #32) that had originally been selected to receive four test rounds each. We were informed by Trilon Technicians that two to three shots would be sufficient to identify multiple shots. As such, we decided that no event location would receive more than three test rounds.

V. SHOTSPOTTER EVALUATION: FIELD TRIAL RESULTS

The evaluation team assessed the performance of the ShotSpotter system based on four types of outcomes. First, did the ShotSpotter technology automatically annunciate and triangulate the "shot" location (True Positive)? Second, did the technology annunciate the "shot" yet fail to triangulate the true shot location? If triangulation failure occurred, could Trilon technicians take the information received from the system, adjust the software and then post-facto triangulate the "shot" location manually? Third, did ShotSpotter completely fail to annunciate or triangulate the "shot" location (False Negative)? Finally, in the instances where the system could triangulate and find the location of the "shot" fired, either prior to or after the software adjustment, what was the margin of error from the true shot location to the triangulated shot location (in feet)?

Table 1 provides a case by case description of each gunfire event in the ShotSpotter Field Trial by date, and time of shot, location and type of location, number of rounds fired, type of weapon used, the system parameter settings for each gunfire event, whether the shot was annunciated by the system, whether the system triangulated the event, and the margin of error in feet.

Table 1. Event by Event Description of Shot Spotter Field Trial

Event #	Date of Shot	Time of Shot (Military Time)	Shot Location	Type of Location	# of Shots Fired	Weapon Type	System Parameter	Annunciation		Triangulation			Average Margin of Error (in feet)
								Yes	No	Auto	Manual	Missed	
*Event 1	06/26/97	1854:57;1855:02,08	1061 Douglas St.	Face block	3	Rifle	21, 14, 8		No			Missed	-
Event 2	06/26/97	1925:35;38	711 3rd Av.	Face block	2	Shotgun	18, 14, 8	Yes			Manual		25
Event 3	06/26/97	1929:16	2424 Spring St.	Face block	1	Rifle	15, 12, 4		No			Missed	-
Event 5	06/26/97	1942:32	644 Stanford Av.	Face block	1	Shotgun	15, 12, 4	Yes			Manual		13
Event 4	06/26/97	1949:32;34	2820 Crocker Av.	Face block	2	Pistol	15, 12, 4	Yes		Auto			45
Event 6	06/26/97	2002:53:54	Warrington/Halsey	Intersection	2	Shotgun	15, 12, 4	Yes		Auto			13
Event 7	06/26/97	2010:10;11;13	888 2nd Av.	Face block	3	Pistol	15, 12, 4	Yes			Manual		154
Event 8	06/26/97	2015:14;15	861 Warrington Av.	Face block	2	Rifle	15, 12, 4	Yes			Manual		162
Event 9	06/26/97	2020:23;25	Charter at Cul de Sac	Intersection	2	Rifle	15, 12, 4		No			Missed	-
Event 10	06/26/97	2027:37;39	2524 Spring St.	Face block	2	Pistol	15, 12, 4	Yes			Manual		20
Event 11	06/26/97	2038:52;39:03	475 Broadway	Face block	2	Rifle	15, 12, 4		No			Missed	-
Event 12	06/26/97	2049:11;12;15	2742 Fair Oaks Av.	Face block	3	Shotgun	15, 12, 4	Yes		Auto			16
Event 13	06/26/97	2055:35;38;45	McArthur/Halsey	Intersection	3	Rifle	15, 12, 4	Yes			Manual		27
Event 14	06/26/97	2106:32;33	Pacific/Middlefield	Intersection	2	Pistol	15, 12, 4	Yes		Auto			27
Event 15	06/26/97	2114:29;30;32;34	473 4th Av.	Face block	4	Rifle	15, 12, 4	Yes			Manual		15
Event 16	06/26/97	2129:11:13	765 Douglas Av.	Face block	2	Shotgun	15, 12, 4	Yes		Auto			22
Event 17	06/27/97	1142:39;40	622 3rd Av.	Face block	2	Pistol	15, 12, 4	Yes			Manual		10
Event 18	06/27/97 06/27/97	1151:56;57 1159:55;56	2205 Middlefield Av. 2205 Middlefield Av.	Face block Face block	2 2	Shotgun Shotgun	15, 10, 4	- No		- Manual			- 200
Event 19	06/27/97	1211:04;05;05	3117 Hoover St.	Face block	3	Pistol	15, 10, 4		No			Missed	-

Table 1 cont'd. Event by Event Description of Shot Spotter Field Trial

	Date of Shot	Time of Shot	Shot Location	Type of Location	# of Shots Fired	Weapon Type	System Parameter	Annunciation Yes No	Triangulation Auto Manual Missed	Average Margin of Error (in feet)
Event 20	06/27/97 06/27/97	1239:32;33,33 2023:21,22;22	3051 Edison Way 3051 Edison Way	Face block Face block	3 3	Pistol Pistol	15, 10, 4	- Yes	- Auto	- 30
Event 21	06/27/97 06/27/97	1245:31,33 2034:45;46	2663 Fair Oaks Av. 2663 Fair Oaks Av.	Face block Face block	2 2	Rifle Rifle	15, 10, 4	- Yes	- Manual	- 30
Event 22	06/27/97	2039:51;52	560 Charter Av.	Face block	2	Pistol	15, 10, 4	Yes	Auto	15
Event 23	06/27/97	2043:35;36	615 2nd Av.	Face block	2	Shotgun	15, 10, 4	Yes	Auto	25
Event 24	06/27/97	2050:54;55	Woodside/Broadway	Intersection	2	Shotgun	15, 10, 4	Yes	Auto	45
Event 25	06/27/97	2051:38;39;39	2793 Spring St	Face block	3	Pistol	15, 10, 4	Yes	Auto	25
Event 26	06/27/97	2101:23;24	540 Stanford Av.	Face block	2	Shotgun	15, 10, 4	Yes	Auto	50
Event 27	06/27/97	2113:23;24	1109 Hilton St	Face block	2	Shotgun	15, 10, 4	Yes	Auto	15
Event 28	06/27/97	2121:33;34,35	2965 Fair Oaks Av.	Face block	3	Rifle	15, 10, 4	Yes	Manual	10
Event 29	06/27/97	2128:38;39;39	451 Dumbarton Av.	Face block	3	Pistol	15, 10, 4	Yes	Auto	25
Event 30	06/27/97	2134:47;48	871 KaynyneAv.	Face block	2	Pistol	15, 10, 4	Yes	Auto	15
Event 31	06/27/97	2137:24;24,24	2766 Bay Rd.	Face block	3	Pistol	15, 10, 4	No	Missed	-
Event 32	06/27/97	2144:38;38	708 Hurlingame Av.	Face block	2	Pistol	15, 10, 4	Yes	Manual	20
TOTALS	**2 Days**			**26 Face blocks 5 Intersections**	**78 Test Shots**	**10Shotgun 13 Pistol 8 Rifle**		**25 events Annunc. 6 events No Annunc.**	**14 events Auto 12 events Manual 5 events Missed**	**41 ft. (Avg margin error)**

[a] Event 1 is not included in the calculation totals because the time and location of the gunshot event was known a priori by Trilon Technology. This was done primarily to permit media coverage

[b] System Parameter refers to the settings programmed into the operating system which establish sensitivity levels of the ShotSpotter system. These parameter settings determine the ratio between the peak of the soundwave associated with an alleged gunshot and extraneous background noises

A total of 32 events were included in the field trial where shots were fired at random locations in Redwood Village. The Evaluation Team only reports 31 events as legitimate tests of the ShotSpotter system due to media interference at the first event location. All parties involved agreed from the outset that the media could be present at the initiation of the ShotSpotter evaluation. This agreement was made given the demands by the community to be involved in the field trial of the gunshot location technology. More importantly, for purposes of the field trial, Trilon Technology was aware of the time and location of the time and location of the first test event prior to its occurrence. For this reason we do not include event 1 in our evaluation of the ShotSpotter gunshot location system.

Table Two below presents the results of the field trial, examining the breakdown of results for each weapon type and each of the evaluation outcomes (identification, triangulation, error margin).

Table 2. Field Trial Results by Weapon Type

	Total Gunfire Events	Number of Shots Annunciated	Percent of Shots Annunciated	Number of Shots Triangulated			Percent of Shots Triangulated			Average Error Margin (In Feet)		
				Auto	Manual	Missed	Auto	Manual	Missed	Auto	Manual	Both
Rifle	8	5	63	0	5	3	0	63	38	-	48[a]	48
Pistol	13	10	77	7	4	2	54	31	15	26	51[b]	35
Shotgun	10	9	90	7	3	0	70	30	0	27	79[c]	41
Total	31	24	77	14	12	5	45	39	16	26.5	59[d]	41

[a] It should be noted that removal of event 8 (162 foot error in manual location) results in average error rate of 22 feet for manually located rifle events.

[b] It should be noted that removal of event 7 (154 foot error in manual location) results in average error rate of 17 feet for manually located pistol events.

[c] It should be noted that removal of event 18 (200 foot error in manual location) results in average error rate of 19 feet for manually located shotgun events.

[d] It should be noted that removal of events 7, 8, and 18 (154, 162 and 200 foot errors in manual locations) results in an average error rate of 19 feet for manually located events.

Table 2 shows that of the 31 test events, eight events consisted of MP5 assault rifle rounds, thirteen consisted of .38 caliber pistol rounds, and ten events consisted of 12 gauge shotgun rounds. Overall, the ShotSpotter technology annunciated nearly 80 percent of the test shots (N = 24). Specifically, the technology annunciated shotgun rounds at the highest rate (90 percent) followed by pistol rounds (77 percent) and the MP5 assault rifle (63 percent).

To determine the system's ability to triangulate gunfire events, we examined whether the system identified a gunshot event's location on its own (automatically), with assistance from a Trilon Technician (manually), or was unable to identify the location of the gunfire event (missed). Automatic triangulation refers to the system identifying the location of gunfire through a series of algorithmic iterations given the established parameters of the system. Alternatively, manual triangulation refers to the system identifying the location of gunfire only after a Trilon Technician adjusts the system parameters. The system was then allowed to reexamine those sensors for gunfire event locations through a similar series of algorithmic iterations given the newly established parameter settings. Finally, we documented those instances where the ShotSpotter system was unable to locate gunfire events.

Overall, the system was able to triangulate random gunfire events 84 percent of the time within an average margin of error of 41 feet (see Table 2). In terms of automatic identification, ShotSpotter was able to isolate the location of random gunfire 45 percent of the time with an average margin of error of 26½ feet. With assistance from a Trilon Technician, ShotSpotter was able to locate an additional 39 percent of the gunfire events within 59 feet. Shotgun events had the highest rate of triangulation at 100 percent (N = 10 events) with an average margin of error of

41 feet. Pistol events were triangulated 85 percent of the time within an average 35 foot margin of error followed by the MP5 assault rifle (63 percent of the time it was triangulated within an average of a 48 foot margin of error).[14]

We also examined the margins of error using the median distance to the location from where the shot was actually fired. The median margin of error overall was 25 feet: 27 feet for the MP5 rifle, 25 feet for the pistol, and 23.5 feet for the shotgun.

Table 3. Hot Spots /Cold Spots by Identification Type

	Automatically Identified	Software Adjusted and Identified	Missed and Not Identified	Total
Hot Spots	10 48%	9 43%	2 9%	21
Cold Spots	4 40%	2 20%	4 40%	10
Total	14 45%	11 36%	6 19%	31 100%

Table 3 presents the results from the analysis of hot and cold spots of random gunfire by identification type. This table shows that the ShotSpotter technology was more likely to identify "shots" in areas with high incidences of random gunfire as compared to areas with low incidences of random gunfire. We notice two findings from Table 3: First, the ShotSpotter technology was more likely to identify shots fired in hot areas than in cold areas. Specifically,

[14] While it appears that the system may more accurately locate pistol events than shotgun events (35 feet versus 41 feet) it must be observed that automatic triangulation of both events suggests nearly identical error rates (26 feet versus 27 feet). Further comparison of manually located events when excluding the two problematic cases (7 and 18) suggest nearly identical error rates (17 feet versus 19 feet).

only two of twenty-one shots were missed (whether the system identified the shot on its own or after adjustment) in citizen identified hot areas as compared to 4 shots (40 percent) in citizen identified cold areas. Second, when the system did not automatically identify the gunshot in cold areas, it was less likely that adjustment of the software would yield a location for the shot fired than when adjustments were made to triangulate the shot location for hot spots. That is, only two more shots could be identified in cold areas (20 percent increase) as a result of software adjustment as compared to a 43 percent increase in hot areas.

Table 4. Hot Spot/Cold Spots by Weapon Type

	MP5 (Assault Rifle)		Pistol (.38 Caliber)		Shotgun (12 Gauge)		Total
	Detect	Not Detect	Detect	Not Detect	Detect	Not Detect	
Hot Spots	5 24%	1 5%	6 28%	0 0%	8 38%	1 11%	21 100%
Cold Spots	0 0%	3 30%	5 50%	1 10%	1 10%	0 0%	10 100%
Total	5 18%	4 3%	11 39%	1 3%	9 36%	1 0%	31 100%

Table 4 examines whether type of weapon discharged in a hot or cold area increases or decreases the likelihood of detection. The table reveals that both pistol events (11 out of 12) and shotgun events (9 out of 10) were most likely to be detected. Alternatively, gunshot events where the assault rifle was discharged were least likely to be detected (5 out of 9) by the ShotSpotter system.

Concluding Comments

Overall, our field trial shows that the ShotSpotter system has a high degree of accuracy

(both in terms of detection and the margin or error) (a) when the system is not malfunctioning, (b) for weapons with clear muzzle blast waveforms (e.g. shot guns and pistols), (c) in locations where propagation paths are less likely to be blocked (e.g. places that repeatedly identify random gunfire ("hot spots") as opposed to those places that appear to be "cold spots"), (d) and when more sensors pick up the sound wave and enable more data to triangulate the precise location of the gunfire. We also note that the fact we fired blank rounds as opposed to live rounds could have impacted on the ability of the ShotSpotter system to perform to a higher level.

With these caveats in mind, we propose that the field trial of ShotSpotter offers some important insights to the accuracy of gunshot location systems. First, we know that, like any other technology, a system as complex as a gunshot detection system will have periods of sub-standard functioning. Second, the fact that ShotSpotter allows dispatchers to replay the sound of the noise identified by the gunshot location system as gunfire offers a "reality check" to the system that increases its usefulness. We propose that this reality check will decrease the unnecessary mobilization of police resources in response to false alerts of "shots" being fired. Third, police departments need to think very carefully about the way gunshot location systems will be used. In Redwood City, for example, the system is not used as a rapid response tool, but rather allows officers to go out to sites where gunfire has been identified and talk to people living at the target site about the dangers of illegally firing weapons in the air. We explore some of the perceptions of citizens and police about the usefulness of the ShotSpotter system in the following sections.

VI. CITIZEN PERCEPTIONS OF THE RANDOM GUNFIRE PROBLEM AND SHOTSPOTTER EFFECTIVENESS

One goal of our evaluation was to examine citizen perceptions regarding the public acceptance of the ShotSpotter gunshot location system in Redwood City. Through a series of focus group interviews, we were able to identify a number of issues pertinent to the ShotSpotter gunshot location system. Generally, the focus group interviews provided information about quality of life in Redwood City, the nature and extent of crime, and the biggest challenges facing the Redwood City community. More specifically, focus group participants were asked about the random gunfire problem in the area, past efforts employed by law enforcement personnel to address the random gunfire problem, and then a series of questions about police community relations, community involvement in obtaining the ShotSpotter gunshot location system, and public acceptance of this technology.

Focus Group Methodology

Participants for the focus group discussions were recruited through three informants who provided names of individuals to the field research coordinator. Captain Scott Warner of the Redwood City Police Department provided the names of officers and neighborhood representatives both for and against the system. Salvador Sandoval (community leader in Redwood Village), a proponent to the system, provided a list of contacts who would be in favor of the ShotSpotter gunshot location system. Judy Buchan (a former Redwood City Councilperson), an opponent to the system, provided a list of contacts who would be against the ShotSpotter gunshot location system. It was determined that three focus group sessions would be sufficient to assess public acceptance of the gunshot location system implemented in Redwood

City: a proponent group, an opponent group, and a group of individuals who offered mixed support for the ShotSpotter system.

The focus groups were conducted on Sunday June 8, 1997, at the Redwood City Police Department Headquarters. The discussions were led by Steve Depoe, Associate Professor and Director for the Communications Department at the University of Cincinnati (see Appendix II). Dr. Depoe specializes in political communication and is a recognized expert in conducting focus group interviews. The three 90 minute tape recorded sessions were structured as a series of questions posed by Dr. Depoe. Participants in the sessions first responded to a series of general questions about Redwood City, crime in Redwood City, and the extent and nature of the random gunfire problem, before offering specific feedback on the gunshot location system (see Appendix III).

Focus Group Demographics

Table 5 gives a break down of the demographic characteristics of the participants in the three focus groups. As can be seen from Table 5, fifteen individuals participated in the focus group sessions. A group of five individuals were assembled as those in favor of the ShotSpotter system while a group of three individuals opposed the system. In addition, a third group of Redwood City residents was assembled that offered mixed support for the ShotSpotter technology.

Table 5: Focus Group Demographic Characteristics

Focus Group Demographic Characteristics N = 15	Focus Group 1 Proponent Group N=5	Focus Group 2 Opponent Group N=3	Focus Group 3 Mixed Group N=7
Gender			
Women	2	1	6
Men	3	2	1
Age (range in yrs.)	32 - 42	47 - 58	16 - 67
Ethnicity			
Hispanic	4	0	7
Caucasian	2	3	0
Mean # yrs. in Redwood Village	22	32	23

The number of men and women in the proponent or opponent group was fairly evenly distributed (2 women and 3 men for the system, as compared to 1 woman and 2 men against the system). Alternatively, the mixed group was primarily all women. The greatest range of ages existed in the mixed group of interviewees (from 16 to 67), while individuals in the opponent group were markedly older than those in the proponent group. On average those in the opponent group have lived in Redwood Village longer than the interviewees in either the proponent or mixed groups. The majority of participants in the focus group sessions were of Hispanic origin.

Focus Group Results

One fundamental question asked of all focus group participants was to summarize their

feelings and experiences as residents of Redwood City.[15] The common theme that emerged across all participant responses was that Redwood City was a very diverse place to live. One respondent remarked that Redwood City has a "a very diverse job base, from high tech computers to small businesses", while another respondent articulated that it has "tremendous cultural diversity, a nice climate, and a progressive infrastructure". When respondents were asked what is the biggest challenge facing their community, the responses ranged from police community relations, to quality of education, to lack of minority representation in government, to crime, public safety, and random gunfire.

Subsequent to general questions about quality of life issues in Redwood City, the focus group moderator concentrated on the extent and nature of the random gunfire problem in the Redwood City community, responses to this problem, and specifically resident perceptions of the ShotSpotter technology which has been employed to assist police with this problem. Focus group participants all suggested that the problem of random gunfire is generally celebratory in nature and often concentrated around certain holidays (New Years, Cinco De Mayo, and 4th of July). One respondent suggested that random gunfire has "a history in Redwood City and is part of Western settlement traditions." Other people stated: "it is not uncommon to find bullets lodged in front porches or gutters," and "our random gunfire problem is costly in terms of law enforcement, property damage, and declining property values."

Further, the general sentiments among focus group participants concerning the manner in

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[15] For purposes of writing up the focus group results we merged the responses of those from the mixed group that were in favor of the system with the proponents' responses and the responses of those from the mixed group that were not in favor of the system with the opponents' responses.

which the random gunfire problem in Redwood City has been handled could be broken into two distinct categories: police strategies and community strategies. Respondents from all three focus groups (proponents, opponents, and mixed respondents) perceived that the police, in the past, responded very slowly if at all to citizen complaints about random gunfire. Similarly, it was perceived that law enforcement "had no method for detecting incidences of random gunfire," "citizens could not accurately report the location from where shots were being fired," and that "law enforcement was hampered by multiple jurisdictions." From the standpoint of community strategies employed to address the problem of random gunfire in Redwood City, respondents indicated that a number of different tactics were employed. These strategies ranged from the development of neighborhood associations, to a community wide public awareness campaign ("Silent Night"), to the research of and call for gunshot location technology (ShotSpotter).

One purpose behind running focus group interviews was to develop an understanding of citizen satisfaction with using gunshot location technology to deal with the problem of random gunfire in Redwood City. When asked about the various perceived advantages and disadvantages associated with this form of technology, a range of responses were offered by both proponents and opponents of the system.

ShotSpotter Proponents

Proponents of the gunshot location system in Redwood City perceive that such a system can bring about a range of benefits to the community, the police department, and city council. Proponents suggest that the ShotSpotter gunshot location system can reduce police response times because it can "pinpoint the location of gunfire incidents quicker and more accurately than citizens calling in the event." They clearly believe this will have a positive impact on the random

gunfire problem in Redwood City.

Proponents of the system also stated that they believed "people feel safer in the community." They attribute the increased feelings of security to the fact that the ShotSpotter system has increased media attention and police publicity about the issue of random gunfire. Relatedly, advocates of the gunshot location technology suggested that increased media attention and police publicity as a result of the ShotSpotter system has had a deterrent effect on random gunfire by increasing the fear of apprehension. One respondent likened the effect of this technology on prospective shooters to the effect of increased surveillance on speeders. It causes people "to be more aware of their behavior because of the fear that someone is watching."

Another advantage to the system as perceived by proponents was how instrumental ShotSpotter has been in increasing cooperation between the city and the county while at the same time improving the relationship between the police and the community. The implementation of the ShotSpotter technology has afforded the Redwood City Police Department and the San Mateo County Sheriff's Office an opportunity to work together to address a common community concern: random gunfire. Advocates believed that the implementation of this technology "shows the community that law enforcement officials in Redwood City are indeed concerned about the random gunfire problem." Further, the collaborative effort taken by the community and law enforcement personnel in getting the ShotSpotter system field tested in Redwood City has provided the community with insight into the reality of police work and law enforcement with insight into the reality of living in a community with a high incidence of random gunfire.

Regarding the cost effectiveness of the ShotSpotter system, proponents clearly believe that the gunshot location system is more cost effective than hiring more officers, with the added

benefit of providing a database of shots fired locations. System advocates argue that the cost of the system will be realized in the hiring of only one police officer over a two year period. A real benefit of the system is that it is in operation 24 hours a day, 365 days a year. In addition to 24 hour surveillance by the system it provides an up to date database of all shots fired detections. Proponents suggest that this database could be used to track gunfire patterns and assist in the development of police interventions designed to reduce random gunfire in Redwood City.

Finally, those in favor of the ShotSpotter system, while aware that the solution to the random gunfire problem will require a multi-method approach, believe the system is a good start to solving the problem in Redwood City. They perceive that the system in conjunction with the public awareness campaign ("Silent Night") and the development of neighborhood partnerships has had a positive impact on random gunfire. Specifically, proponents stated that they "have seen a reduction in the number of shots fired on a regular basis and during holidays." One other advocate stated that "the measure of success for this community is 'do we hear less gunfire?'" and it was indicated that gunfire problem is diminishing.

Proponents also indicated concerns with the system. They commented that they are unsure of the system's ability to distinguish gunfire from other sounds in the environment. In fact they believed that it "sometimes confused car backfires or firecrackers for gunshots." They believed that it also had difficulty detecting gunfire because of how sound travels around buildings. Another common concern among system proponents was that ShotSpotter has had no impact on arrests. One final issue noted by ShotSpotter advocates was that there "is still a desire to employ more officers rather than purchase such technology."

ShotSpotter Opponents

In contrast to ShotSpotter proponents, system opponents offered one benefit of this system in conjunction with a number of disadvantages, some similar to the concerns expressed by system advocates. Those respondents not in favor of the ShotSpotter technology suggested that the system benefitted the community in that it "removed the necessity of individuals to report gunfire and by implication identify themselves to the police department." Opponents indicated that they wished to remain anonymous for fear of reprisal and did not think that the Redwood City Police Department should force those reporting incidences of random gunfire to have to identify themselves.

In addition, opponents came up with a number of disadvantages to using gunshot location systems. Echoing the concerns of those in favor of the ShotSpotter system, opponents stressed that system accuracy is questionable and there was no impact on arrests. Comments were made that "limitations in acoustics lead to false positive readings and on-site confirmation is still required." Opponents further remarked that "the community has a false sense that the gunshot location system is a deterrent, it has led to only one arrest, and there is no proof of decreased numbers of shots fired."

Opponents also commented that assessment of the gunshot location system has been tied to emotion and perception, rather than any kind of empirical data. Those respondents against the ShotSpotter system feel that the technology is at best effecting levels of fear in the community and not actual levels of crime. In addition, they believe that the "Silent Night" public awareness campaign is more responsible for any reduction in levels of gunfire than is the gunshot location system.

One final issue voiced by many system opponents revolved around the issue of cost and who would be responsible for maintenance of the technology. Opponents were concerned about the cost incurred by city and its ability to acquire and manage proprietary equipment. One respondent asked "Why should the city spend its money on the system, why not use military technology and capability paid for by the Federal Government?" Still others believed that hiring more officers was the more useful way to deal with the problem of random gunfire in Redwood City.

VII. OFFICER PERCEPTIONS OF THE RANDOM GUNFIRE PROBLEM AND SHOTSPOTTER EFFECTIVENESS

This section provides an overview of officer perceptions about a number of issues related to the random gunfire problem in Redwood City. First, it examines officer perceptions of the nature and extent of random gunfire in Redwood City and their routine for handling random gunfire calls for service. Next, we describe officers' beliefs about what types of strategies the police, the media, and the community could employ to impact the problem of random gunfire. Finally, we focus specifically on the impact of the ShotSpotter gunshot location system on officer work routine, officer confidence in the system to report incidences of gunfire, and their perceptions of the ability of ShotSpotter to improve police effectiveness in handling random shots fired occurrences.

Police Officer Survey Methodology

Written questionnaires were administered to officers in the Redwood City Police Department (see Appendix IV). The questionnaires were distributed by the Field Research Coordinator at the beginning of each watch or shift. The officers responded to the surveys after role call and returned the completed instruments to the watch commander prior to leaving role call. Each watch commander returned the completed instruments to the Captain who in turn routed the surveys to the field research coordinator one week later. The questionnaires contained questions concerning the extent and nature of random gunfire in each area. Further, the questionnaires requested information concerning the standard operating procedures of officers when responding to shots fired incidents.

All officers who could possibly be dispatched to shots fired incidents in the treatment area

Table 7 contains the demographic characteristics of officers that completed the written questionnaire. It is clear that the sample of Redwood City officers is comprised primarily of white males. Specifically, 92.3 percent of the sample consisted of male officers of which nearly 85 percent of those officers were white. Alternatively, in a community which is so heavily populated by Hispanic residents, only 7.7 percent of responding Redwood City officers were of Hispanic origin.

Table 7 also demonstrates that officers in the sample were primarily middle aged: over 80 percent of the surveyed officers were between the ages of 30 and 49. In addition, virtually all Redwood City responding police officers have college experience. More specifically, approximately 45 percent (42.3 percent) have associate's degrees while over one-quarter of the officers (26.8 percent) have bachelor's degrees.

In relation to officers' normal assignments, Table 7 indicates that the majority of surveyed officers were line level officers (92.0 percent). Further, slightly more than 50 percent (51.8 percent) of the officers in the sample had eleven or more years of policing experience. Table 7 also demonstrates that the majority of officers surveyed worked in the patrol division of the Redwood City Police Department.

were requested to complete a questionnaire (see Table 6). A total of 41 officers received questionnaires (N = 41 from the Redwood City Police Department) and 27 completed questionnaires were retrieved. Table 6 indicates that the overall response rate was 65.6 percent.

Table 6: Redwood City Police Department Response Rate

	Questionnaires Distributed	Questionnaires Received	Response Rate (percent)
Total	41	27	65.6
Gender			
Male	36	24	66.6
Female	5	2	40.0
Present Rank			
Police Officer	30	23	76.7
Sergeant	11	4	36.4
Shift			
Mids	12	7	58.3
Days	14	12	85.7
Swings	15	9	60.0

Table 6 displays the response rates by officers' gender, present rank, and by watch assignment. As Table 6 shows, forty percent of the female officers surveyed completed the questionnaire. Alternatively, of the male officers surveyed, slightly less than seventy percent responded (66.6 percent). In terms of response rates by officer rank, Table 6 indicates that while nearly forty percent (37.4 percent) of sergeants completed the questionnaire, over three quarters (76.7 percent) of the patrol officers completed the questionnaire. Further examination of Table 6 shows that the highest response rate by shift was from those officers working the day shift (85.7 percent).

Table 7: Demographic Characteristics of Officers in the Sample

	N	%
Gender		
Male	24	92.3
Female	2	7.7
Age		
23-29	2	8.3
30-39	12	50.0
40-49	9	37.5
50+	1	4.2
Ethnicity		
Caucasian	22	84.6
Hispanic	2	7.7
Other	2	7.7
Education		
High School/GED	0	0.0
Some College	8	30.8
Associate's Degree	11	42.3
Bachelor's Degree	7	26.9
Some Graduate	0	0.0
Rank		
Police Officer	23	92.0
Sergeant	2	8.0
Length of Employment		
1-5 years	3	11.1
6-10 years	10	37.0
11-15 years	7	25.9
16-20 years	3	11.1
20+ years	4	14.8
Normal Assignment		
Patrol	21	77.8
Traffic	1	3.7
Other	4	14.8

Several of the questionnaire items on the surveys administered to Redwood City officers tapped beliefs about the types of offenders that fired weapons, the days of the week when gunfire was most likely to occur, whether certain holidays were more likely to have incidences of gunfire, the types of weapons commonly used, and the locations of gunfire. The following analysis examines the nature and extent of gunfire in the Redwood City area.

Officer Survey Results

To assess the impact of ShotSpotter on Redwood City police officers in the treatment area, we asked a series of questions pertaining to officer perceptions of the impact of ShotSpotter on their work routine, officer perceptions of the value of ShotSpotter in investigating and solving shots fired incidents, officer confidence in the technology to accurately report both the occurrence of gunshots and their locations, and officer preference of citizen reporting versus ShotSpotter notification of an incident.

From Table 8 it is clear that Redwood City officers believe that male offenders are those persons responsible for discharging weapons. Every officer in the sample indicated that male shooters were responsible for the incidences of random gunfire in the experimental area. In terms of the age of offenders believed to be involved in random shots fired incidents, a majority of officers believed shooters were between the ages of 18 and 25 (58.8 percent). Further, approximately 16 percent (15.7) suggested that random shooters were between the ages of 14 and 17.

In order to examine when shots were most likely to occur, questions asked officers to stipulate the day of the week, whether certain holidays were more likely to have gunfire, and the hour of the day when they thought gunshots were likely to be fired. As expected, Friday (39.3

percent) and Saturday (41.2 percent) were the days identified as those most likely to have gunfire occurrences. Sunday (16.1 percent) was the third most likely day to be identified by the officers with the remaining days of the week being mentioned by only a limited number of officers (Table 8). Cinco de Mayo (25.7 percent), July 4th (30.0 percent), and New Years Day (20.0 percent) were viewed by officers as the holidays most likely to generate shots fired calls. New Years Eve (17.1 percent) was the fourth most mentioned holiday. Officers also agreed that the hours of the day between 6:00 pm and midnight were when shots were most likely to be fired, with the six hour period after midnight being the next most likely time for guns to be fired. Officers in Redwood City noted that the weapons used in most instances are pistols and handguns. Finally, officers overwhelmingly noted that in less than ten percent of the gunfire incidences are there injuries to people.

Officers were also questioned about their beliefs as to the location from which most guns are fired. On the street in front of a house was mentioned most often (22.7 percent) as the location from which guns are most commonly fired. On a street corner, in an alley and from apartment complexes were the locations that were the next most likely to be mentioned by officers (Table 8).

Table 8: Nature of Gunfire Problem in Redwood City

	N	%
Gender of Shooting Offenders		
Male	26	100.0
Female	0	0.0
Age of Offenders		
14-17	8	15.7
18-21	15	29.4
22-25	15	29.4
26-30	5	9.8
31-39	2	3.9
40+	6	2.0
Day of Week		
Monday	1	1.2
Tuesday	0	0.0
Wednesday	0	0.0
Thursday	1	1.2
Friday	22	39.3
Saturday	23	41.2
Sunday	9	16.1
Holidays		
Christmas	3	4.3
New Years Eve	12	17.1
New Years Day	14	20.0
July 4th	21	30.0
Cinco De Mayo	18	25.7
Other	2	2.9

Table 8: (Continued)

	N	%
Shot Locations		
Street Corner	9	13.6
On Street in Front House	15	22.7
On Street in Front of	2	3.0
Business	17	2.6
Outside House	1	1.5
Inside Apt./Home	3	4.5
In Parking Lot	8	12.1
In Alley	3	4.5
In Park	8	12.1
Apartment Complex		
Shooting Hours	25	54.3
6 pm - Midnight	21	45.6
Midnight - 6 am		
Weapon Type	5	13.5
9 mm	1	2.7
Shot Gun	2	5.4
Rifle	15	40.5
Pistol/Handgun	5	13.5
Automatic Weapon	5	13.5
Semi-Automatic Weapon	1	2.7
22 Caliber	3	8.1
380s		
How Common an Injury	25	92.6
Less than 10%	2	7.4
11 - 25%		

In order to assess officer confidence in the ability of ShotSpotter to identify incidences of random gunfire, officers were asked about their confidence in the ability of ShotSpotter to identify actual gunfire.

Table 9: Officer Confidence in Ability of ShotSpotter to Identify and Locate Gunshots

	No Confidence		Some Confidence		Great Deal of Confidence	
	N	%	N	%	N	%
How much confidence do you have in the ability of ShotSpotter to *identify* actual gun shots?	11	40.7	16	59.3	0	0.0
How much confidence do you have in the ability of ShotSpotter to *locate* actual gun shots?	10	37.0	16	59.3	1	3.7

As Table 9 shows, no officers indicated that they had a great deal of confidence in ShotSpotter's ability to identify actual gunfire. Similarly, only one officer indicated a great deal of confidence in the system's ability to locate actual gun shots. A majority of officers however indicated that they had some confidence in ShotSpotter's ability to both identify (59.3 percent) and locate (59.3 percent) actual gunfire.

One impact on officer handling of ShotSpotter identified incidents may be that officers do not have as much information as they would have if an incident of gunfire had been reported by a citizen. In order to address this issue, officers were asked whether they had less, more, or about the same amount of information when they respond to a ShotSpotter identified random gunfire call versus a citizen identified random gunfire call. As can be seen in Table 10, approximately one quarter of the officers (25.9 percent) responding to the survey indicated that they had more information to work with when responding to a ShotSpotter initiated call. Alternatively, however, over 40 percent of the surveyed officers believed that they had less information when responding to a ShotSpotter initiated call for service while approximately 30 percent of the

respondents believed that they had about the same amount of information.

Table 10: Officer Perceptions of the Level of Information Associated with ShotSpotter Identified Gunfire Calls

	Less Information		About the Same		More Information	
	N	%	N	%	N	%
Amount of random gunfire information provided by ShotSpotter versus the amount of random gunfire information provided by citizens	11	42.3	8	29.6	7	25.9

Similar responses were observed when officers were asked about the amount of time they expended investigating ShotSpotter identified random gunfire calls versus a citizen identified random gunfire calls. Most of the officers said that they spent about the same amount of time on both types of calls. In fact, at least two-thirds (68.0 percent) of the officers believed that they spent no more time on ShotSpotter calls for service than they did citizen calls for service. Of the remaining officers, 16 percent believed that they spent less time investigating ShotSpotter cases while the other 16 percent believed that the spent more time.

Table 11: Officer Perception of the Time Spent Investigating ShotSpotter Identified Gunfire Calls versus Citizen Identified Calls

	Less Time		About the Same		More Time	
	N	%	N	%	N	%
Amount of time spent investigating a ShotSpotter identified gunfire call versus citizen identified gunfire call	4	16.0	17	68.0	4	16.0

Finally, dispatched calls that are ShotSpotter identified, do not appear to influence the quickness of the response. Only in 3.7 percent of the situations did officers note that their response to the ShotSpotter call was quicker than normal. Alternatively, 96 percent of the officers believed that they respond no more quickly to ShotSpotter identified calls for service than they do citizen identified calls for service.

Table 12: Officer Perceptions of Response Time

	True		False	
	N	%	N	%
Respond quicker to ShotSpotter identified gunfire calls than citizen identified gunfire calls	1	3.7	26	96.3

The last battery of questions from the patrol officer survey assessed officer perceptions of the impact of ShotSpotter on officer work routine and police outcomes. Questionnaire items addressed whether officers believed they were more likely to talk to citizens when responding to a ShotSpotter versus a citizen initiated call, whether officers thought that ShotSpotter would

increase the likelihood of arrest and whether officers perceived ShotSpotter to increase the survival rate of shooting victims. These issues were premised on the belief that the ShotSpotter technology was to improve the effectiveness of police officers in handling random gunfire incidents.

Regarding the amount of interaction with citizens when responding to ShotSpotter initiated versus citizen initiated calls for service, over 90 percent of the officers surveyed believed that they had more contact with citizens when responding to a ShotSpotter identified call for service.

Table 13: Likelihood of Interaction with Citizens

	True		False	
	N	%	N	%
I am more likely to talk to citizens when I respond to a ShotSpotter identified gunfire call than a citizen identified gunfire call	25	92.6	2	7.4

Officers completing the written questionnaire were requested to state whether they agreed with statements concerning the ability of ShotSpotter to improve the handling of shots fired calls. Table 14 displays the distribution of officer responses to these statements. Several patterns are evident in the distribution of responses reported in Table 14. Examination of all questions indicated that while officers did not generally believe that ShotSpotter will make them more effective in their handling of shots fired calls they did feel it could help to detect shooting patterns, make citizens feel safer, and they did prefer using the ShotSpotter over citizen calls for service alone.

Table 14 clearly indicates that officers did not feel that the system made them more

effective when handling shots fired incidents. Nearly 90 percent expressed such a belief. The majority of officers (92.6 percent) also did not believe that the use of ShotSpotter increased the likelihood of someone being arrested. Similarly, respondents (63.0 percent) did not believe that the system would help them in focusing on shots fired hot spots.

The statement that garnered the least agreement, and by implication the least support for ShotSpotter, pertained to the ability of the urban gunshot location system to "increase the likelihood the victim of a shooting will survive." Virtually every officer believed that the ShotSpotter system would not increase the likelihood that the victim of a shooting would survive.

Alternatively, however, nearly 90 percent of the officers believed that ShotSpotter would help them detect shooting patterns. In addition, the majority of respondents (59.3 percent) suggested that the system has decreased the number of random gunfire incidents and made citizens feel safer (56.0 percent) in their community. Finally, over two thirds of the officers (81.5 percent) stated that they preferred using the ShotSpotter system to identify and locate random gunfire over just citizen calls for service

Table 14: Officer Perceptions of the Effectiveness of ShotSpotter

	True		False	
	N	%	N	%
The ShotSpotter system will increase the likelihood someone will be arrested	2	7.4	25	92.6
The ShotSpotter system will help detect shooting patterns	19	86.4	3	13.6
The ShotSpotter system will help the police focus on shots fired hot spots	10	37.0	17	63.0
The ShotSpotter system will increase the likelihood that the victim of a shooting will survive	0	0.0	26	100.0
The ShotSpotter system has decreased the number of random gunfire incidents	16	59.3	11	40.7
The ShotSpotter system makes citizens feel safer	14	56.0	11	44.0
The ShotSpotter system has made me more effective when handling shots fired incidents	2	7.4	24	88.9
I prefer using the ShotSpotter system over just using citizen calls	22	81.5	5	18.5

Summary

In summary, an examination of the officer questionnaire data suggests a number of issues concerning officer perceptions of the ShotSpotter technology. The questionnaire data suggest that officers have confidence in the ability of the ShotSpotter technology to identify a gunshot and the location of the gunshot incident. More specifically, about 60 percent (see Table 9) of Redwood City police officers expressed at least some confidence in the ability of the ShotSpotter

system to accurately identify and locate incidences of random gunfire.

Officers indicated that they spent about the same amount of time investigating system identified calls for service in comparison to citizen identified calls (Table 11). Further, over 50 percent of the officers surveyed indicated that ShotSpotter provided them with about the same or more information regarding random gunfire calls than citizen calls for service (Table 10). Alternatively, while officers did believe that the urban gunshot system provided them with at least as much information as citizens calling the police, they did not believe that they responded more quickly to ShotSpotter initiated calls than citizen calls (Table 12).

The officer responses did, however, generally indicate a lack of confidence in the ability of ShotSpotter to improve officer effectiveness in handling gunshot calls (Table 14). Officers believed that the ShotSpotter system decreased the number of random gunfire incidents since its implementation, made citizens feel safer in their community, and helped to detect offender shooting patterns. They similarly felt that the system will not increase the likelihood of arrest and it will not help police focus on shots fired hot spots. In addition, they believed that the system will not increase the likelihood that shooting victims will survive and they did not believe that ShotSpotter has made them more effective when handling shots fired incidents.

VIII. CONCLUDING COMMENTS

The ShotSpotter Gunshot Location System was installed in Redwood City, California by Trilon Technology in 1996 and field tested by an Evaluation Team from the University of Cincinnati in June of 1997. Redwood City, and in particular Redwood Village, was selected as the site for which this technology would be tested due to its high annual incidence of random gunfire: the rate of random gunfire in the test site (1,279 per 100,000 people) was substantially higher than for the remainder of Redwood City (367 per 100,000 people). Field testing in Redwood Village comprised the installation of 8 acoustic sensor modules on various rooftops of residences and buildings in the experimental target area and a base station computer installed in the Redwood City Police Department's Dispatch Center.

Our assessment of this technology draws from three sources of data: (1) the firing of blank test rounds to assess system identification and location capabilities, (2) focus group interviews to assess citizen perceptions of the random gunfire problem in Redwood City and ShotSpotter effectiveness, and (3) officer surveys designed to assess officer perceptions of the random gunfire problem and ShotSpotter effectiveness.

The ShotSpotter field trial occurred on June 26 and 27, 1997. Using police calls for service data, the Cincinnati Evaluation Team randomly selected 32 locations from where blank rounds would be discharged. Of these 32 locations, blanks were discharged from 26 face block addresses and 6 intersection addresses. The Redwood City Police Department under the supervision of the Cincinnati Evaluation Team discharged blank rounds into the air at the selected face block and intersection addresses. In addition to the random selection of shooting locations, three types of weapons and the number of rounds to be fired from each weapon were randomly

assigned to each of the selected locations. The weapons used in the ShotSpotter Field Trial were a .38 caliber pistol, a 12 gauge shotgun, and an MP5 assault rifle. No more than four blank rounds were discharged at any location.

Results from the firing of test rounds indicated that overall, the gunshot location technology was able to annunciate (detect) 81 percent of the test shots (N = 25 of 31 shooting events). Specifically, the technology annunciated shotgun rounds at the highest rate (90 percent) followed by pistol rounds (85 percent) and the assault rifle rounds. Moreover, the firing of test rounds revealed that ShotSpotter was able to triangulate (locate) 84 percent of the test shots (N = 26 of 31 shooting events) within an average margin of error of 41 feet. Shotgun events had the highest rate of triangulation at 100 percent (N = 10 of 10 events) with an overall margin of error of 41 feet. Pistol events were triangulated 85 percent of the time (N = 11 of 13 events) within a 35 foot margin of error followed by the MP5 assault rifle which was triangulated 63 percent of the time (N = 5 of 8 events) within a 48 foot margin of error.

Further, examination of ShotSpotter's ability to triangulate "shot" locations when broken down by type of location ("hot" versus "cold" spot) indicated two striking findings. First, the ShotSpotter technology was much more likely to identify shots fired in hot areas than in cold areas. Specifically, only two of twenty-one shots were missed in citizen identified hot areas as compared to 4 shots (40 percent) in citizen identified cold areas. Second, when the system did not automatically identify the gunshot in cold areas, it was less likely that adjustment of the software would yield a location for the shot fired than when adjustments were made to triangulate the shot location for hot spots. That is, only two more shots could be identified in cold areas (20 percent increase) as a result of software adjustment as compared to a 43 percent increase in hot areas.

Citizen perceptions of the random gunfire problem and Shotspotter effectiveness were obtained through focus group interviews. Focus groups (proponents and opponents) were developed with the help of the Redwood City Police Department and Redwood City community leaders. Findings from the focus group interviews revealed that the problem of random gunfire in Redwood City, and Redwood Village in particular, is believed to be celebratory in nature. It was suggested by proponents of the gunshot location technology that it can pinpoint gunfire incidents more quickly and accurately, people tend to feel safer since its implementation, and installation of the ShotSpotter system has assisted in police community relations.

Opponents to the ShotSpotter gunshot location technology indicated that it has had no impact on the arrest rate of persons discharging weapons, the community is developing a false sense of security, and no deterrent effects are being realized as a result of the ShotSpotter system. In addition, system proponents suggested that it is too expensive to purchase and maintain this technology. Money would be better spent by hiring law enforcement officers.

Officer perceptions of the random gunfire problem and Shotspotter effectiveness were obtained through written questionnaires. Generally, officers did have confidence in the system's ability to identify and locate incidences of random gunfire. However, officers indicated that they did not believe that the ShotSpotter technology would enhance their perfomance on random gunfire calls for service. Specifically, they did not believe that the system increased their response times to random gunfire calls for service over and above citizen initiated events. Moreover, they did not feel that the gunshot location system would increase apprehension rates or survival rates.

On the positive side, officers believed that ShotSpotter could help identify random gunfire

hot spots and that this knowledge could help them to reduce random gunfire incidents. Over two thirds of the officers prefer using ShotSpotter over relying solely on citizen calls.

With the aforementioned points in mind, we propose that the field trial of ShotSpotter offers some important insights to the accuracy of gunshot location systems. First, we know that, like any other technology, a system as complex as a gunshot detection system will have periods at which it is not functioning at its highest level of efficiency. Second, the fact that ShotSpotter allows dispatchers to replay the sound of the noise identified by the gunshot location system as gunfire offers a "reality check" to the system that increases its usefulness. We propose that this reality check will decrease the unnecessary mobilization of police resources in response to false alerts of "shots" being fired. Third, police departments must consider very carefully the way in which they will use gunshot location technology. In Redwood City, for example, the system is not used as a rapid response tool, but rather allows officers to go out to sites where gunfire has been identified and talk to people living at the target site about the dangers of illegally firing weapons in the air.

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APPENDIX I: CALLS FOR SERVICE DATA PREPARATION

Calls for service data were obtained in automated format from the Redwood City Police Department (RCPD) and the San Mateo County Sheriff's Office (SMCS). These data included calls received from January 1, 1996 through December 31, 1996. The ShotSpotter Field Trial was undertaken in an experimental area ("Redwood Village") that was selected because of its ongoing problem with random gunfire. The Redwood Village area is approximately one square mile and reflected an area with significantly more random gunfire -- slightly over two percent -- than the city or county as a whole. Since both the city and the county held jurisdiction in parts of Redwood Village we used data provided by both jurisdictions.

We examine the distribution of random gunfire calls for the 1996 calendar year only because these data were not contaminated by the implementation of the gunshot detection technology: we found that the Redwood City Police Department calls for service data were incomplete once the ShotSpotter system was implemented. Indeed, from conversations with call takers, dispatchers and the information systems administrator from the Redwood City Police Department, we discovered that (1) many citizens opted not the call the police once they knew the technology was installed and (2) call takers often times did not enter the call into the system. Since our use of the calls data in this final report is merely to understand the extent of the random gunfire problem in Redwood City prior to the implementation of the gunshot detection system, we propose that the 1996 data are adequate.

The RCPD file contained 72,821 calls for service in 1996. Of these, 345 were calls for random gunfire or (10-57) event codes. Thus, slightly less than one half of one percent of calls, city wide were for random gunfire. The SMCS file for just the Redwood City portion of their

jurisdiction during the same period contained 20,683 calls for service. Of these, 177 were random gunfire or (10-57). Thus, slightly less than one percent of the county calls to Redwood City were for random gunfire.

The calls for service data were useful both in documenting the problem of random gunfire in the experimental area and in planning our experimental test of the gunshot locator system. Prior to using these data, however, it was necessary to clean the data and reorganize the address or location field to ensure that we could identify calls occurring inside and outside of the area. The method of entering and recording these data in Redwood City was less than optimal and required significant allocations of time to prepare a common address field which could be utilized in computer programs to identify the location of gunfire both within and outside the area.

Using Calls for Service Data to Identify Experimental Area Addresses

We encountered significant problems with data entry in the location field which provided a variant of generally unstandardized methods of entering information into the location field. For example, we selected unique addresses from the call data from Redwood City for the calendar year 1996 and reduced the number of unique addresses by 43 percent — from 72,821 to 40,245 -- many of which were the same addresses entered in slightly different form. In order to identify addresses in the experimental area, therefore, it was necessary to standardize the address field. To accomplish this we identified all the streets and intersections in the experimental area and standardized address types for intersections and addresses. Following this procedure we were able to identify 4,295 calls in the experimental area of which 88 were random gunfire calls. We were then able to ascertain that the original data produced 2,205 unique addresses or roughly a 49 percent reduction in the number of locations. However, using our standardized location field we

were able to reduce the number of unique addresses from 4,295 to 707 or a 83 percent reduction. Thus significant savings could be obtained in location queries through standardization.

Much of this savings could be gained simply by standardization of the street and suffix names and including a directional component. An example may highlight the street/suffix problem. In some instances, for example, the suffix was either omitted or entered with some variation Ave, Avenue, Av, etc. There was also considerable variation in entry and spelling of street names. In an effort to identify addresses in the experimental area it was necessary to first select the various streets included within the parameters of the area. Thus one would first identify Middlefield as a street name and select those records with this identification. The address range for the experimental area could then be specified and addresses falling within the area identified. In order to identify the street name, it was necessary to identify it in the database. In the case of Middlefield Street the various entries include "Middlefield", "Middle", "MF", "M.F.", "M/F", "M*F", "M-F", and additional variants of these such as "M. F." or "atMF*Douglas". Encompassing the abbreviation "MF" as in the last example while including an automotive license number such as [2MFG301] results in the identification of such records regardless of the actual streets involved. The following lines of code and output provides an example of selecting the Broadway address range:

```
select eventnum,rxdate,evcode,evdescrip,location2,newadd,yr96,              ;
  num1,num2,str1,str1suf,str2,str2suf,addtype,addok,pexp,isexp              ;
  where yr96 and ("BW"$LOCATION2 OR "B/W"$LOCATION2 OR "B.W"$LOCATION2 OR   ;
  "BRDWAY"$LOCATION2 OR "BWAY"$LOCATION2 OR "B-WAY"$LOCATION2 OR            ;
  "BDWAY"$LOCATION2 OR "BDWY"$LOCATION2 OR "BRDWY"$LOCATION2 OR             ;
  "BWY"$LOCATION2 OR "B-WY"$LOCATION2 OR "BDWY"$LOCATION2 OR                ;
  "BROAD"$LOCATION2 OR "BRAOD"$LOCATION2 OR "BROADWAY"$LOCATION2 OR         ;
  "B W"$LOCATION2 or "B  -W"$LOCATION2)                                     ;
  from d:\redwood\RCPDX into dbf BROADX
```

The output below is an example of the range of records produced by the above code. The code actually produced 3,845 individual records, of which, 2,627 were unique. Each of these records were then standardized and a new location field (newadd) created to provide standardization.

LOCATION2	CNT
(10-19) OCCD POWER HOUSE GYM 2075 BWAY	1
(10-19) RE GARDEN MOTEL 1690 BROADWAY	1
(10-19) RE WS*BWAY	1
(10-19) WS*BROADWAY	1
10 BIRCH / E/B WHIP > ECR	1
100 BLK BROADWAY 3PLK581	1
2227 B-WAY	1
2227 BDWAY	1
2227 BROADWAY	20
2227 BROADWAY COURTHHOUSE COFFEE SHOP	0
2227 BROADWAY * COURT HOUSE	1
2227 BROADWAY/COURTHOUSE COFFEE	1
2227 BW	52
2227 BWAY	8
MAPLE // BRDWAY 2FGL583	1
MDFLD & BRDWY ON BIKE	1
MIDDLEFIELD*B W	1
MILLS*BROADWAY	3
MILLS-BROADWAY	1
MILLS/BROADWAY	1
N/B ARGUELLO N/OF BDWAY	1
S/B BW @ MAPLE	1
S/B BWY / DOUGLAS 2RXV952	1
S/B ECR * BDWAY 3JPA271	1
S/B ECR / BROADWAY	3
S/B ECR /BROADWAY	1
S/B ECR AT BROADWAY	1
SAFEWAY PKNG LOT 850 WS EB WS ON FOOT	1
SB BRDWAY	1
SB ECR*MADISON 1BBW741	1
WOODSIDE /BROADWAY	1
WOODSIDE RD AND BROADWAY	1
WOODSIDE ROAD*BROADWAY, RC	1
WOODSIDE/BW 3KVR619	1
WS / BWAY 307VLI	1
WS W BROADWAY	1
WS*BROADWAY	3
WS*BWAY "TRILBYZ"	1
WS/BW	3

This process was then repeated for the twenty north/south and twenty-four east/west streets in the experimental area. After the records had been standardized they were combined and a unique set of streets was available to compare with a program which identified the experimental streets and address ranges.

The above problems were not encountered in the SMCS database which appears to have been designed with mapping coordinates allowing the distribution of call locations. Although these data present some problems of their own, their standardization allows uniformly applicable code to assign data to a new location field.

Experimental Test Shot Location Identification

Calls for service data were also essential in our identification of test shot locations within the experimental area. The experimental design called for the identification of "hot spot" and "cold spot" random gunfire locations. "Hot spots" were identified as face block locations with 1 or more random gunshot events during 1996 and "cold spots" were identified as locations with no reported incident during the same year.

We began by independently identifying the face blocks or address range hundred blocks and intersections in the experimental area. In all there were 175 hundred blocks and 123 intersections in the experimental test area (see Figure 1, page 9). We provided standardized addresses to each of the hundred blocks and intersections. We next standardized the address ranges for the 522 random gunfire call events reported in Redwood City (N=345) and San Mateo (N=177) in 1996. These resulted in 139 unique addresses in the experimental test area that had at least one random gunfire call: 70 unique addresses (51 hundred blocks and 19 intersections) in San Mateo County and 69 unique addresses (50 hundred blocks and 19 intersections) in Redwood

City. There were, however, duplications in the address field between the two jurisdictions.[16] These duplications reduced the total number of unique addresses (intersections and hundred blocks) from 139 to 134, with 101 hundred blocks and 33 intersections having previous random gunfire calls during 1996. Thus 101 of the 175 identified hundred blocks (57 percent) and 33 of the 123 intersections (26 percent) had a previous random gunfire call during 1996.

The experimental design called for 32 shots to be fired with two thirds of the shots being fired in "hot spot" and one third in "cold spot" locations. Therefore 22 randomly selected "hot spot"locations (hundred blocks or intersections) from the 101 hundred blocks and 33 intersections and 10 randomly selected "cold spot" locations (hundred blocks and intersections) from the 74 hundred blocks and 90 intersections that had no previous random gunfire calls were selected. Specific addresses for the hundred blocks were then randomly selected from the address ranges for each hundred block.

Some variations of these experimental shot locations were dictated by the conditions encountered during the experiment. For example, where addresses previously identified from maps no longer existed due to construction or efforts to avoid replication for the lack of shot identification in an identified "dead zone" in the north/east corner of Redwood Village. These deviations are more fully explained in the experimental shots section of this report.

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[16]Whether these resulted in joint policing of these addresses or double entries for addresses having been first reported either to the county or city is not known.

APPENDIX II

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EDUCATION

1986	Ph.D., Communication Studies Northwestern University, Chicago, Illinois
1984	M.A., Communication Studies Northwestern University, Chicago, Illinois
1981	B. F. A., Speech & Theater Arts; A., English Emporia State University, Emporia, Kansas

PROFESSIONAL EXPERIENCE

1997-present	Head, Department of Communication, University of Cincinnati
1994 - present	Director, Center for Environmental Communication Studies, University of Cincinnati
1992 - present	Associate Professor, Department Head, Department of Communication, University of Cincinnati, Ohio
1987 - 1992	Area Chair and Director of Undergraduate Studies, Department of Communication, University of Cincinnati, Ohio
1986 - 1992	Assistant Professor, Department of Communication, University of Cincinnati, Ohio

HONORS

1994	University of Cincinnati Faculty Achievement Award (granted by Division of Research and Advanced Studies, University of Cincinnati)

SELECTED PUBLICATIONS AND PRESENTATIONS

Depoe, S.P. (1998). Public involvement and civic discovery, and the formation of environmental policy: A comparative analysis of the Fernald Citizens Task Force and the Fernald Health Effects Subcommittee. In S. Senecah, (Ed.). Proceedings of Conference on Communication and Our Environment. Syracuse: Syracuse University Press.

Depoe, S. P. (1997). Environmental communication (review). Critical Studies in Mass Communication, 14, 367-379

Depoe, S. P. (1996). Environmental justice for all: the persuasive campaign of Benjamin Chavis. In K. Salamone & D. Sachsman (Eds.). Proceedings of Conference on Communication and Our Environment. Chattanooga, TN: University of Tennessee, Chattanooga Press.

Duffield, J. J. and Depoe, S. P. (1997, Feb). Lessons From Fernald: Reversing NIMBYism Through Democratic Decision-Making. Inside EPA's Risk Policy Report, 3, 31-34.

O'Connor, S., Barnhill, D., and Depoe, S. P. (1995). Inventory of public concerns at the U. S. Department of Energy's nuclear weapons complex: CERE interim public concerns report. New Orleans LA: Xavier University.

SPONSORED RESEARCH

Dec. 1997-Aug. 1998	Principal Investigator, "Pilot Field Workshops for the National Dialogue." Grant awarded by the League of Women Voters U.S. Education Fund under a cooperative agreement with the U.S. Department of Energy. ($5,000). 5% FTE academic, 15% FTE vacation.
Nov. 1996 - August 1997	Principal Investigator, "Environmental action partnerships: Environmental communications in Hamilton County." Grant awarded by Ohio Urban University program. ($26,000). 5% FTE.
Sept. 1996 - June 2000	Faculty investigator, "Lower Price Hill environmental leadership coalition." Awarded by National Institute of Environmental Health Sciences. ($597,388) 10% FTE.
March 1996 - Sept. 1997	Principal Investigator, "Technical support for public affairs activities." Contract awarded to University of Cincinnati by Fluor Daniel Fernald. ($88,759). 10% FTE.
Oct. 1995 - Sept. 1997	Co-Investigator, "Pollution prevention: Promoting environmental justice in Lower Price Hill." Funded by the U.S. Environmental Protection Agency. Principal investigator: Terence Cody, University of Cincinnati. ($177,895). 3% FTE.
May 1994 - May 1995	U.C. Principal Investigator, "Inventory of public concerns and identification of barriers to risk communication." Consortium for Environmental Risk Evaluation (CERE) project funded by the Department of Energy. CERE co-principal investigators: James L. Regens, Tulane University; Sally O'Connor, Xavier University. ($100,000).

APPENDIX III

NATIONAL INSTITUTE OF JUSTICE
REDWOOD CITY FOCUS GROUP SESSION
JUNE 3, 1997
NUMBER OF PARTICIPANTS:
SESSION NOTES

2. If you could summarize your feelings and experiences as a resident of this community in one sentence, w what would you say? Redwood City is . . .

3. What is the best thing about living in Redwood City?

4. What is the biggest challenge facing your community?

5. When I say the words "random gunfire," what do you think of?

6-7. Prior to the implementation of the Gunshot Location System, was random gunfire causing a problem in Redwood City? If so, when did you start noticing the problem? What were the major elements of the problem? What types of people were causing the problem? Do you know why they were firing their weapons?

8. When was the problem most acute? At what times of the day, week, month, or year was the problem at its peak?

9. Historically, what has been the response of the Redwood City Police Department to the random gunfire? What was their response to the latest controversy involving random gunfire?

10. When the problem first arose, what did the local community do about it?

11. Was there a single triggering event which led the city to explore alternative ways of dealing with the problem? If so, what was the event? Or did the problem simply become more chronic? When the local community decided to act on the problem, what alternative strategies were explored?

13. What have been the advantages and benefits of a Gunshot Location System?

14. What have been the disadvantages and problems associated with the Gunshot Location System?

15. On balance, do you believe that the Gunshot Location System has reduced the random gunfire problem in Redwood City? Why?

17. Does anyone have any closing comments concerning the system? Any suggestions for improvements?

APPENDIX IV

POLICE OFFICER SURVEY PROTOCOL
RANDOM SHOTS FIRED EVALUATION
REDWOOD CITY POLICE DEPARTMENT

Date _____

Please indicate the shift you work: ____First ____Second ____Third ____Fourth
Please indicate your badge number _____

1. On what day, or days, of the week do you think most shots fired calls occur? (mark all that apply)
___Monday___Tuesday___Wednesday___Thursday___Friday___Saturday___Sunday

2. Are there any holidays that generate shots fired calls? (PLEASE LIST ALL THAT APPLY)
_____

3. In the course of a 24 hour time period between which hours do you think most shots are fired?
_____

4. From which of the following locations do you think most shots are fired?
___ (1) Street corners
___ (2) On the street in front of a house
___ (3) On the street in front of a business
___ (4) Outside a house
___ (5) Outside a business
___ (6) Inside a home or apartment
___ (7) Inside a business
___ (8) In a parking lot
___ (9) In an alley
___ (10) In a park
___ (11) In an apartment complex

5. What do you think is the age of most shots fired offenders?
___ (1) 14 through 17 years old
___ (2) 18 through 21 years old
___ (3) 22 through 25 years old
___ (4) 26 through 30 years old
___ (5) 31 through 39 years old
___ (6) 40 years old and above

6. What type of weapon, or weapons, are most commonly used in shots fired incidents?
_____

7. Most shots fired incidents involve: ___ (1) Males ___ (2) Females ___ (3) Both

8. What type of suspects do you believe are involved in most shots fired incidents?
____ (1) African American
____ (2) Caucasian
____ (3) Hispanic
____ (4) Latin American
____ (5) Mexican American
____ (6) Asian American

9. How often do you think that a shots fired incident results in an injury to a person?
   ____(1) Less than 10 percent of the time
   ____(2) Between 11 and 25 percent of the time
   ____(3) Between 26 and 50 percent of the time
   ____(4) Between 51 and 75 percent of the time
   ____(5) More than 75 percent of the time

10. We are interested in better understanding officer activities in response to shots fired calls (citizen identified and Shot Spotter identified). Please indicate which of the following actions you have taken in response to a shots fired call.(MARK ALL THAT APPLY)
   ___ (1) arrest suspect
   ___ (2) issue warning
   ___ (3) drive by identified location
   ___ (4) talk to a complainant
   ___ (5) talk to community residents
   ___ (6) conduct additional surveillance of the area
   ___ (7) other (please explain_____)

11. Considering all of the shots fired calls that you have responded to in the last six months, how often have you performed each of the following tasks?
   ___ % of all calls where you arrest suspect
   ___ % of all calls where you issue warning
   ___ % of all calls where you drive by identified location
   ___ % of all calls where you talk to a complainant
   ___ % of all calls where you talk to community residents
   ___ % of all calls where you conduct additional surveillance of the area
   ___ % of all calls where you perform other tasks

12. Considering a typical shots fired call, how much time do you spend performing each of the following tasks?
   ___ time spent in minutes arresting suspect
   ___ time spent in minutes issuing warning
   ___ time spent in minutes driving by identified location
   ___ time spent in minutes talking to a complainant
   ___ time spent in minutes talking to community residents
   ___ time spent in minutes conducting additional surveillance of the area
   ___ time spent in minutes doing other tasks

13. Please indicate (1) the average amount of time it takes you to arrive at the scene once you receive a shots fired call, and (2) the average amount of time it takes from arrival at the scene to writing a report or referencing the call to another call for service.
   (1)_____average time in minutes to arrive at the scene
   (2)_____average time in minutes from arrival to report writing or referencing call

14. Are there specific locations within your patrol area where shots are often fired?
   (1) ____YES (2)____NO

   If YES, please identify the specific locations.

   _____

15. On the map below, please mark any locations that you would consider a shots fired hot spot location.

16. Have specific strategies been developed that focus on these shots fired hot spot locations?

(1) ____YES (2)____NO

16.a If YES, please indicate which strategies have been/are being developed for problem locations.

_____ (1) determination of hot spot locations by crime analysts
_____ (2) increased patrol in hot spot identified areas
_____ (3) public awareness programs
_____ (4) public education programs
_____ (5) meet with community groups/leaders in trouble areas
_____ (6) a task force that deals specifically with the problem of random gunfire
_____ (7) all of the above
_____ (8) nothing other than standard operating procedure has been developed
_____ (9) Other _____

17. What could the Redwood City Police Department do to improve the overall effectiveness of officer responses to random shots fired incidents?

_____ (1) hire more officers
_____ (2) spend more time on the scene searching for physical evidence
_____ (3) spend more time on the call searching for witnesses
_____ (4) meet with community leaders to inform them of where hot spot locations exist
_____ (5) install in cruisers gunshot locator systems(a system that transmits gunshot location directly to the cruiser
_____ (6) nothing more than what is already being done
_____ (7) Other _____

18. What could the community do to improve the overall effectiveness of officer responses to random shots fired incidents?

_____ (1) report random gunfire incidents more consistently
_____ (2) report random gunfire incidents more quickly
_____ (3) inform one another as to seriousness of this problem
_____ (4) put together a community task force to deal with the problem of random gunfire
_____ (5) nothing more than what they are doing currently
_____ (6) Other _____

19. What could the media do to improve the overall effectiveness of officer responses to random shots fired incidents?

_____ (1) educate the public via public service announcements about the seriousness of the problem of random gunfire
_____ (2) educate the public as to the potential consequences of celebratory gunfire(injuries, deaths)
_____ (3) air public service announcements about gun safety
_____ (4) inform public to report any and all suspected incidents of gunfire immediately
_____ (5) inform public to report any and all suspected incidents of gunfire consistently
_____ (6) inform public that the police have a new tool that can identify where shots are being fired from
_____ (7) nothing more than what they are doing currently
_____ (8) Other _____

We would now like to ask you a few questions about your experience with the Shot Spotter Gunshot Detection System . This system was installed in August 1996 and was intended to help in the identification and locating of shots fired incidents. We are interested in your beliefs about the effect this system may have on your job.

20. In the last six months, approximately how many shots fired calls (citizen identified and Shot Spotter identified) have you responded to?

_____ number of shots fired calls

20a Approximately, how many of these calls were citizen identified gunfire calls? _____
20b Approximately, how many of these calls were Shot Spotter identified calls? _____
20c Approximately, how many of these Shot Spotter identified calls also had complainants? _____
20d Approximately, how many of these Shot Spotter identified calls were false alarms? _____

21. When you respond to a Shot Spotter identified call do you typically have more, less, or about the same amount of information about the shots fired incident as you have when you respond to a citizen identified call for random gunfire?

___ (1) more information when I respond to Shot Spotter calls than citizen calls
___ (2) about the same amount of information when I respond to Shot Spotter calls than citizen calls
___ (3) less information when I respond to Shot Spotter calls than citizen calls

22. Is the amount of time that you spend investigating a Shot Spotter incident greater, less, or about the same as the amount of time you spend on a citizen identified call for random gunfire?

___ (1) a greater amount of time on a Shot Spotter call than a citizen call
___ (2) about the same amount of time on a Shot Spotter call than a citizen call
___ (3) less time on a Shot Spotter call than a citizen call

23. How likely is the Shot Spotter System to improve your ability to solve shots fired calls?

___ (1) very likely for Shot Spotter to improve my ability to solve shots fired calls
___ (2) somewhat likely for Shot Spotter to improve my ability to solve shots fired calls
___ (3) not likely at all for Shot Spotter to improve my ability to solve shots fired calls

24. How much confidence do you have in the ability of Shot Spotter to identify actual gun shots?

___ (1) a great deal of confidence in the ability of Shot Spotter to identify actual gun shots
___ (2) some confidence in the ability of Shot Spotter to identify actual gun shots
___ (3) no confidence at all in the ability of Shot Spotter to identify actual gun shots

25. How much confidence do you have in the ability of Shot Spotter to identify the specific location of a gun shot?

___ (1) a great deal of confidence in the ability of Shot Spotter to identify the specific location of a gun shot?
___ some confidence in the ability of Shot Spotter to identify the specific location of a gun shot?
___ no confidence at all in the ability of Shot Spotter to identify the specific location of a gun shot?

The next section contains a number of statements about the Shot Spotter System. Please mark whether you believe the statement is true or false. We are concerned with your own personal beliefs. There is no right or wrong response to these statements.

26. I respond quicker to Shot Spotter identified shots fired incidents than I do citizen identified calls for random gun fire. TRUE FALSE

27. The Shot Spotter System will increase the likelihood someone will be arrested in a shots fired incident. TRUE FALSE

28. The Shot Spotter System will help the police focus on shots fired hot spots. TRUE FALSE

29. The Shot Spotter system will increase the likelihood that the victim of a shooting will survive. TRUE FALSE

30. I think citizens are accurate in identifying random gunfire. TRUE FALSE

31. I think citizens are accurate in their reporting of shots fired locations. TRUE FALSE

32. The Shot Spotter System has made me more effective when handling shots fired incidents. TRUE FALSE

33. The Shot Spotter System will help the police detect shooting patterns. TRUE FALSE

34. Gun fire incidents have decreased since the Shot Spotter System was installed. TRUE FALSE

35. I am more likely to talk to citizens when I respond to a Shot Spotter identified call than a citizen identified call. TRUE FALSE

36. I prefer using the Shot Spotter System over just using citizen calls. TRUE FALSE

Please answer the following biographical questions.

35. What is your present rank? _____

36. How long have you been employed by Redwood City Police Department?
_____ Years _____ Months

37. How long have you been assigned to your present district?
_____ Years _____ Months

38. What is your normal assignment? _____

39. How old are you? _____years

40. Are you a (1) _____ Male or (2) _____Female

41. What is the highest year of school you have completed?
(1) _____ 11 years or less
(2) _____ High school graduate or GED
(3) _____ Some College
(4) _____ Associate's Degree (AA or AS)
(5) _____ Bachelor's Degree (BA or BS)
(6) _____ Some Graduate course work
(7) _____ Advanced Degree (Specify) _____

42. What is your ethnic origin?
(1) _____ African American
(2) _____ Caucasian
(3) _____ Hispanic
(4) _____ Latin American
(5) _____ Asian American
(6) _____ Other(Specify) _____