



The Intelligence to Act

***PERFORMANCE ANALYSIS
ASTERRA SATELLITE LEAK DETECTION SERVICES***

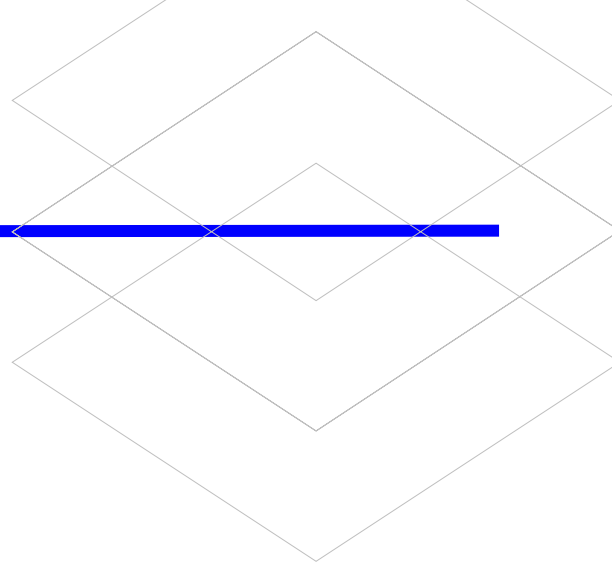
Pine-Strawberry
Water Improvement District, AZ
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Executive Summary Report

Prepared by: ASTERRA
4180 La Jolla Village Drive, Suite 530
San Diego, California 92037



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SUMMARY

This executive summary paper analyzes the ASTERRA satellite leak detection services performed in 2022 for the Pine Strawberry, AZ. Performance will be compared to benchmark results achieved in other ASTERRA projects around the world and North American traditional boots-on-the-ground (BOTG) leak detection projects.

- A total of 14 leaks were found pursuant to the satellite directed field inspection over a 10-day period; 10 leaks were on the utility side, and 4 leaks were on the customer side of the meter.
- The water loss value identified is \$115,831 per year of unrealized revenue.
- The total real water loss volume found by this program was .063 MGD or 23 MGY.
- Each crew field day identified 2.3 MGY of water loss volume. A total of 10 field crew days identified 23 MGY of potential recovered water supply.
- The total service cost, ASTERRA satellite surveys plus BOTG field leak inspection, mobilization and report preparation was \$54000.

DISCUSSION

The following analysis will focus on the real water loss value identified by the ASTERRA directed field leak inspection work.

Real water loss value found by this program are 63,216 gallons per day, or 23 million gallons per year, and the data is listed in table 1. This is calculated by multiplying the number of each type of leak (e.g., main, service, and other) found by the ASTERRA directed field inspections by its estimated leak flow rate as defined in the AWWA M36 Water Audits and Loss Control Programs Manual. This resulted in an average leak flow rate of 4.4 gpm. This factor was applied to the 10 utility side leaks found via the ASTERRA directed program.

Table 1
Water Loss Recovered

ASTERRA DIRECTED LEAKS - WATER LOSS				
	Number of Utility Leaks	Average Leak Flow Rate	Daily Water Loss Rate	Yearly Water Loss Reduction
Total	10	4.4 GPM	63216 GPD	23 MGY

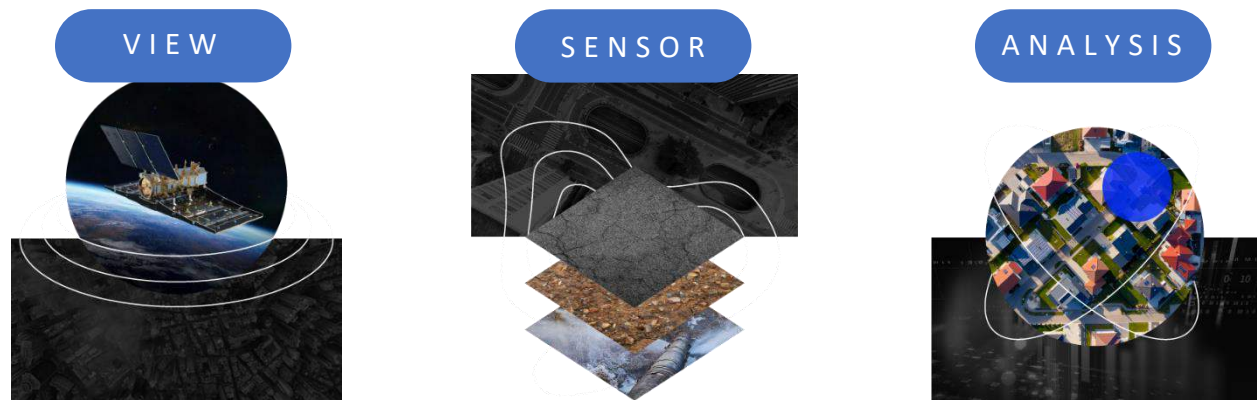
A total of 10 crew days were spent inspecting the points of interest (POIs) for leaks that contribute to the lost water. A total of 23 MGY of potential water loss was identified based on the leak estimates. Thus, each day a crew spent searching for leaks generated 2.3 MGY of potential water loss reduction, or effectively new supply. This lost water could be used to meet additional demand in the system without the need for additional aquifer withdrawals, or new capital improvements. These results show that crews spending days in the field searching for leaks, pursuant to the ASTERRA satellite program, generate valuable results. **Approximately 90% of the system is PVC/plastic piping, which is traditionally much harder to sound leaks on, more time consuming for traditional, blind survey leak detection methods and traditionally yields fewer leaks discovered. This variable speaks to the value of the ASTERRA guided leak**

detection efforts – locating 14 leaks in 10 days, despite the majority of pipe having plastic material.

Approximately 93% of the leaks found by field inspections (13 of 14) resulting in real water loss are due to leaks that have not yet surfaced. These leaks potentially can last for many months or even years before they are discovered without the ASTERRA survey program. Locating these leaks earlier adds to the value proposition of the satellite program.

The overall yearly value of the ASTERRA satellite program to Pine Strawberry, AZ is \$115,831 of unrealized revenue (based on a retail cost of \$5.02 per 1,000 gallons) for the services provided. The total investment in this program including ASTERRA satellite surveys and field leak inspection crew costs was \$54000. 100% of the POIs were physically inspected by the BOTG (39 of 39).

ASTERRA TECHNOLOGY



ASTERRA utilizes specialized radar signals taken from a satellite to scan the area of interest and collect the resulting reflected signals. These signals are analyzed and processed to identify specific indicators of wet soil saturated with potable water, screening out the signal noise and other interferences. The result is a map showing points of interest. The ASTERRA analysis typically highlights 5-10% of the entire system length, and only these locations, where there is expected to be a leak, are inspected by BOTG leak detection teams. Thus, the time and resource cost of leak detection is much lower than traditional leak detection approaches (e.g., full-system, random, systematic, or block map).

PINE STRAWBERRY PROJECT AREA RESULTS

The satellite image for the Pine Strawberry, AZ service was collected in September 2022 and covered the entirety of its service area. Table 2 shows the results from the work performed. A grand total of 14 leaks were found during this effort. Of the 14 leaks found by ASTERRA direction, 10 were on the utility side of the meter, and thus are non-revenue water leaks, while 4 were on the customer side of the meter. The 14 leaks were found in 10 crew inspection days. A total of 7.1 miles of pipeline were physically inspected by the BOTG crews. This resulted in a performance metric of 1.4 leaks per day found and 2 leaks found per mile inspected. The field inspection work was conducted between October 26th and November 9th of 2022. The breakdown of the 10 utility side leaks found by subtype is listed below in Table 2.

Table 2

Leak Type Identified via ASTERRA Directed Field Investigation

ASTERRA – Pine Strawberry, AZ LEAK TYPE							
Pipe Main	Service Pipe	Service Connection	Valve	Meter	Hydrant	Backflow Preventer	Curb Stop
0	4	1	1	1	0	0	3

Further, Table 3, below, lists the AWWA M36 leak flow size by subtype. AWWA Manual M36 is silent on the size of meter, curb stop and backflow preventer leaks, so these were estimated based on a meta-analysis of over 1800 traditional boots-on-the-ground projects performed in North America between 2009 and 2018.

Table 3

AWWA M36 Leak Flow Rates (GPM)

AWWA MANUAL M36 LEAK SIZE BY TYPE - GPM							
Pipe Main	Service Pipe	Service Connection	Valve	Meter	Hydrant	Backflow Preventer	Curb Stop
10.4	6.9	6.9	6.9	0.4	3.5	1.0	0.7

Table 4, below, calculates the real water loss identified by the ASTERRA directed field work using the utility side leaks in Table 2 and the leak flow rates in Table 3.

Table 4

Real Water Losses Identified

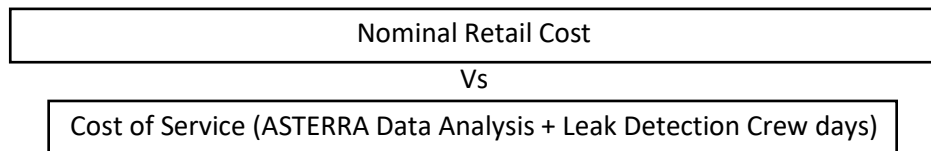
REAL WATER LOSS IDENTIFIED BY LEAK TYPE - GPM			
Leak Type	Number	Flow Rate (GPM)	Total Flow (GPM)
Main Pipe	0	10.4	0
Service Pipe	4	6.9	27.6
Service Connection	1	6.9	6.9
Valve	1	6.9	6.9
Hydrant	0	3.5	0
Meter	1	0.4	0.4
Backflow Preventer	0	1.0	0
Curb Stop	3	0.7	2
Total	10		43.9

WORK ORDERS

Work orders were NOT identified to cross reference any leak repairs made 1 week prior to the satellite pass, and POIs generated from the satellite imagery. If we can access work orders, we can further corroborate any repairs made which correlate with POIs marked as “quiet”. This process helps validate additional POIs which were marked as “quiet” during the leak investigation and further corroborates the satellite technology. Results from the work order analysis are provided as supplementary information and are not integrated into the “project area results” section above.

VALUE PROPOSITION

To calculate the value proposition of the ASTERRA satellite leak detection services, the cost of the work must be compared to the value of the water loss reduction. The value of the water is considered to be the nominal retail cost of water. Reducing NRW will directly impact the utility's bottom line because unnecessary production costs are avoided. The cost of service is comprised of the satellite imagery collection and analysis cost plus the leak crew cost. The value of water loss reduction is calculated by estimating the volume of water lost, the duration of the leak and the retail cost of water.



To calculate the amount of water lost per leak, a number of options are available. The estimates in AWWA Manual M36, Water Audits and Loss Control Programs are used in this analysis to be consistent with other project reports. Customer side leaks and work order leaks will not be used to calculate non-revenue water loss reduction. The daily leak loss rate will be normalized to a yearly value for the purposes of calculating the value benefit to Pine Strawberry, AZ.

To determine the value of the lost water, a retail cost must be calculated or assumed. When water is purchased wholesale from other entities, the unit cost is high. Groundwater is more costly than surface water as a source due to pumping costs. The retail price of water to customers is estimated to be \$5.02 per 1000 gallons.

These factors generate the dataset used to create the individual figures and thus calculate the financial savings to Pine Strawberry, AZ. Overall total cost of service was \$54000, and the total value of unrealized revenue was \$115,831.

RECOMMENDATION

It is recommended that Pine Strawberry, AZ continue to pursue the leak detection program with ASTERRA. Leaks continue to arise even as non-surfacing leaks are found and repaired. By continuing the ASTERRA program real water loss levels will stabilize and ultimately reduce. Furthermore, renewing the ASTERRA program on an annual basis generates a consistent and proactive leak assessment program. Having a proactive method of identifying high risk points in the system for leaks mitigates a reactive approach to leaks, thereby reducing the risk and incurred costs of deploying emergency repair crews to customer reported leaks, all the while facilitating a planned response to subsurface leaks otherwise not identified. By utilizing ancillary services for planning their response to leaks within the system, this also reduces crews working over the weekend and creates safer excavations.

Additionally, Pine Strawberry, AZ can take advantage of ASTERRA's new product, MasterPlan. ASTERRA's MasterPlan Pipe Deficiency Map provides a unique way to look at the potable water system that leverages the ability of the satellite imagery to identify clusters of leaks over the course of time, using two identical images. We call this a temporal analysis. This product is based on the proven ASTERRA algorithm that is used to detect leaks but is extended to monitor the system over time using a statistical analysis. The general process takes all POIs identified in two consecutive satellite passes (which are an exact repeat of coverage and angle) over the area of interest and analyzes the POI results. It then identifies the clustering of observed leaks within one image on a single date, repeat POIs on the same segment in two satellite passes on different dates, or both clustering and repeat issues. These results are processed through a learned statistical algorithm and used to assign pipes a score from 1 to 5, or low to high, signifying the level of deficiency observed.

This information can be used as an asset management tool for the planning, maintenance, and operations groups to add insight and value to their activities. The MasterPlan tool provides a look at the acute issues (currently existing) in the system. Together they can provide a new valuable tool to analyze system health and plan capital improvements, operating improvements, and maintenance program.



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