

# Drone Solutions & 3D Mapping for Inventory Control

Mulch & Soil Council Annual Meeting  
October 6, 2016

# Agenda

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- Key Personnel
- Firmatek Overview
- Understanding your Inventory
- Technologies used to Measure Inventories
- Applying the Technology to Inventories

# Speaker Bios

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## Contact Info

## Bio

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**Lauren Elmore**

*President*

*650.678.0219*

*lauren.elmore@firmatek.com*

Lauren is President and part owner of Firmatek. She has a background in finance and law. Lauren is part of the investment team from Indiana based private equity firm, Elmore Companies. She spent two summers at Dallas private equity firm glendonTodd Capital, LLC where she worked on deals in the technology and real estate industries. Prior to returning to Indiana University to pursue her J.D. and M.B.A., Lauren worked as a Consulting Associate at Cambridge Associates where she advised clients on asset allocation, manager selection, and spending.

Lauren received a B.A. in Economics from Stanford University in 2008, and received her J.D. and M.B.A. with honors from Indiana University in 2014.

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**Dustin Dudley**

*Director of Business Development*

*210.889.8641*

*dustin.dudley@firmatek.com*

Dustin joined Firmatek in 2015 as Director of Business Development. Prior to joining Firmatek, he was co-owner of Petram Measurements. During his time at Petram, he and Jeremy Wilson took Petram from a startup to a successful multinational stockpile measurement firm that measured over \$2.5 billion in aggregate products. Dustin has worked in the mining industry for 8 years.

Dustin lives in North Carolina with his wife Emily and their three children Cole, Caleb and Ellory.

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# Key Personnel

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## Contact Info

## Bio



**Roger Sterry**  
*President of Client Services*  
614.582.9003  
roger.sterry@firmatek.com

Roger is President of Client Service. Prior to his start with Firmatek, he was CEO/Principal of PLMS, Inc.. When these two companies merged in 2015, Roger was pleased to become part of the team. Roger has worked in the mining industry since 1986 (Dupont/ETI), and he was among the first to use the prismless laser system (the beginnings of the technology we employ today). After experience in both in blasting and inventory measurement, he decided to focus on quantifying and developing a methodology of bulk raw inventory in 1992 and never looked back. Today he is recognized as an industry leader in the measurement and management of bulk raw material.

He resides in the Midwest with his wife Kimberly and 4 children.



**Gant Elmore**  
*Vice President*  
812.322.3977  
gant.elmore@firmatek.com

Gant is Vice President and part owner of Firmatek. He has a background in finance and law. Gant is part of the investment team for Indiana-based private equity firm Elmore Companies. Gant also spent a summer at Dallas-based private equity firm glendonTodd Capital LLC where he worked on deals in the technology and real estate industries. Before returning to Indiana University to pursue his J.D. and M.B.A., Gant was drafted by the Milwaukee Brewers in the 2011 MLB draft and played second base in the Brewers minor league system.

Gant received a B.A. in Economics from Yale University in 2011.



**Caleb Cass, PE**  
*Director of Engineering*  
915.539.4198  
caleb.cass@firmatek.com

Caleb is a civil engineer who lives in San Antonio, Texas and works on projects throughout the country. He started his career as a field inspector for one of the ten largest construction contractors in the U.S. and then went on to spend five years performing engineering design for a national consulting firm. Caleb now works for Firmatek and has spent the last six years performing engineering, mapping and consulting work primarily for mining, solid waste and engineering clients.

Caleb graduated in 2007 from the University of Texas at El Paso with a Bachelor of Science Degree in Civil Engineering and became a licensed Professional Engineer in Texas in 2012.

## Firmatek Overview

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Founded in the late 80s, Firmatek pioneered the use of lasers to measure stockpiles. The company has continued to stay on the forefront of technology with the use mobile LiDAR and drones. Today, Firmatek uses a variety of lasers and drones to collect data for our clients. Our experience using multiple types of equipment for data collection allows us to choose which one is right for your operation.

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Firmatek provides a variety of data solutions and mapping services to clients in the mining, construction, solid waste, and other industries. These are the companies that build the world we live in. They rely on the data that we provide to make many important decisions. We provide our clients with the most accurate measurements available. In addition, we spend the time to work with clients to explain our data and the numbers. We want to give each of you supreme confidence in the data.

Some of the biggest names in the mining and solid waste industries trust Firmatek with their important operational calculations from inventory to remaining airspace.

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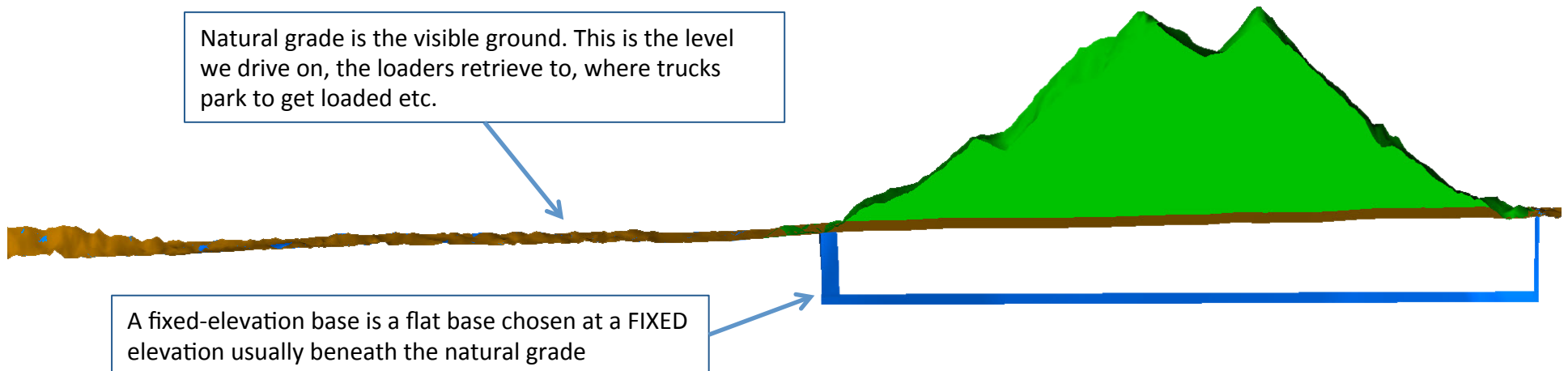
Since the 80s, Firmatek has grown from 2 people in a San Antonio warehouse to almost 30 people and 6 offices around the country. We can serve the needs of clients in any part of the United States and have worked in 3 other countries.

**Giving companies that build the world supreme confidence.**

# UNDERSTANDING YOUR INVENTORY

# Stockpile Base

- The base of the stockpile is one of the most important factors in measurement.
- Base Elevations:
  - Fixed elevation – Measured against a flat plane at a fixed elevation
  - Natural grade (toe of pile) – Measured against a base defined by the natural toe of the pile
- What is more accurate? What is more consistent?

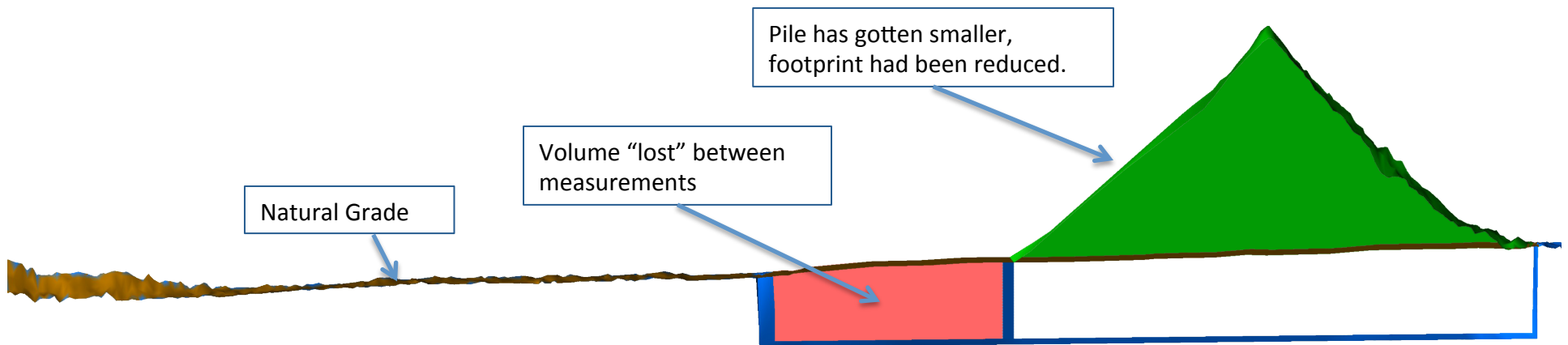


**What method do you think will achieve the most repeatable and accurate results when reconciling?**

- A. Natural Grade: Calculate the pile based on the visible base elevations (where the pile meets the ground)
- B. Fixed Elevation: Flat horizontal base using a fixed elevation at each measurement.

## Stockpile Base - Continued

- If you answered A, you are correct!
  - Natural Grade, where the pile meets the ground will always be your most accurate, consistent and repeatable method.
  - Using a fixed point will always lead to unjustified losses or gains depending on the footprint and configuration of the stockpile. Unless you can guarantee the perimeter or footprint of the pile remains exactly the same without changing, you never want to use a fixed point.



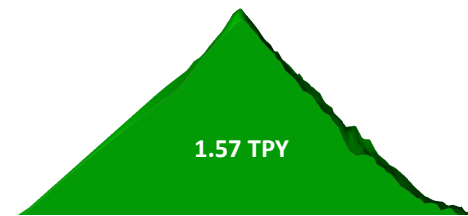
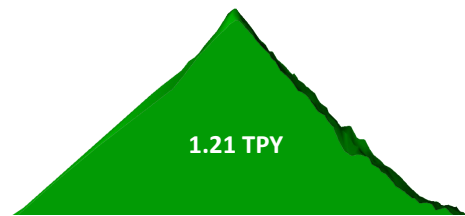
- **What is the immediate and obvious problem?**
  - We know that the loader never retrieved any product below the Natural Grade.
  - We know that the pile was loaded and that the floor was maintained at the Natural Grade.
  - The pile has now changed shape (smaller) and the footprint has been reduced.
  - The pile was calculated to the original fixed level using it's new footprint, but that material was never retrieved. Therefore, we are dealing with an *automatic deficit* before we even begin to measure the pile again.



## Becoming “Volume Minded”

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- Tonnage is important – we understand that. But you can never manage, reconcile or maintain your inventory based on tonnage.
  - Just because “everything we do is in tonnage” doesn’t mean it is the best way to do it
- Look at the illustration below: 2 piles of identical size. One has a conversion factor of 1.21 tons per cubic yard and the other heavier material has a conversion of 1.57 tons per cubic yard.
  - Additionally, these piles are what we would call “Benchmark” piles – we can compare most of the other piles in the plant to these two
- Different materials have different densities
  - It is important to know and check the density of the specific material
- Density changes based on environment and operational factors
  - Depending on the season and how wet it has been density will change
  - Other factors such as a pile being driven on will change density



**Variations in density make it difficult to think about and manage your inventory based on tonnage. A volume minded approach can help you keep track of your inventory.**

## Good House Keeping

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- There is a portion of every product that will never be retrieved from the moment it hits the ground.
  - That percentage is 2-3%
  - Did you know, when you have multiple piles of the same product, that percentage goes up?
- House keeping and pile consolidation go a long way in managing and maintaining your inventory.
- Let's look at your inventory differently: Instead of looking at a pile and calling it a particular product, let's begin to call it a pile of variable compounding loss.
  - Instead of 7 piles of a product, we refer to it as 7 piles of *variable compounding loss*
  - Do those products take on a whole new meaning for you now?
  - Does house keeping and consolidation have a new perspective for you?

**Consolidating piles and keeping the plant organized and clean reduces your loss**

# TECHNOLOGY



## Technology Options

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Technology	Accuracy	Reporting	Cost	Operator Involvement
GPS Surveying	Low	Medium	Low	Low
Aerial Photogrammetry	Low	Slow	High	Low
Terrestrial LiDAR	High	Fast	Moderate	Low
Drone Solutions	Moderate	Fast	Moderate	Moderate - High

# LiDAR

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- Mobile laser scanners (LiDAR) that capture 36,000 points per second
- Survey-grade GPS equipment
- Real time differential GPS correction
- Inertial measurement unit (IMU)
- Absolute data accuracy +/- 4 inches



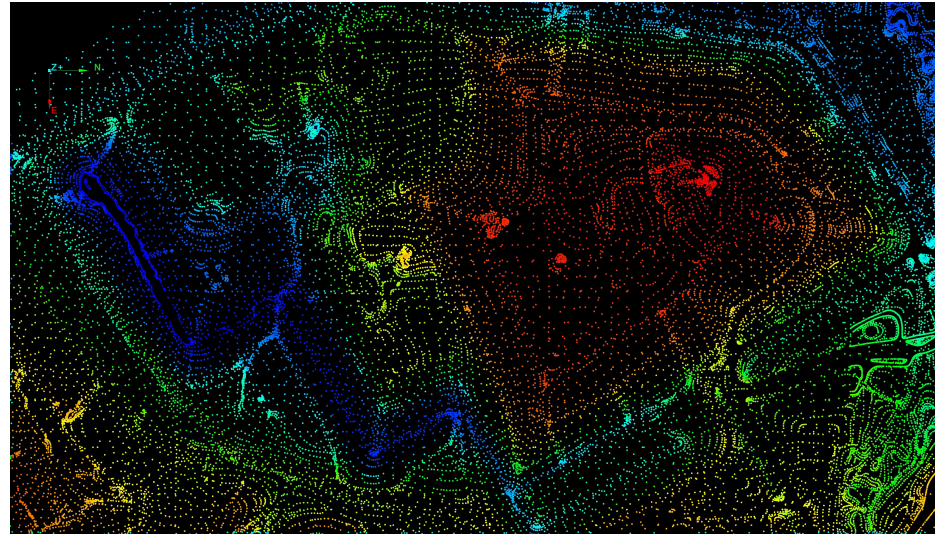
- Data is corrected while it is collected
- Tied to local control
  - Local benchmarks
  - Aerial panels
  - Set control points
- No targets needed

# Point Density

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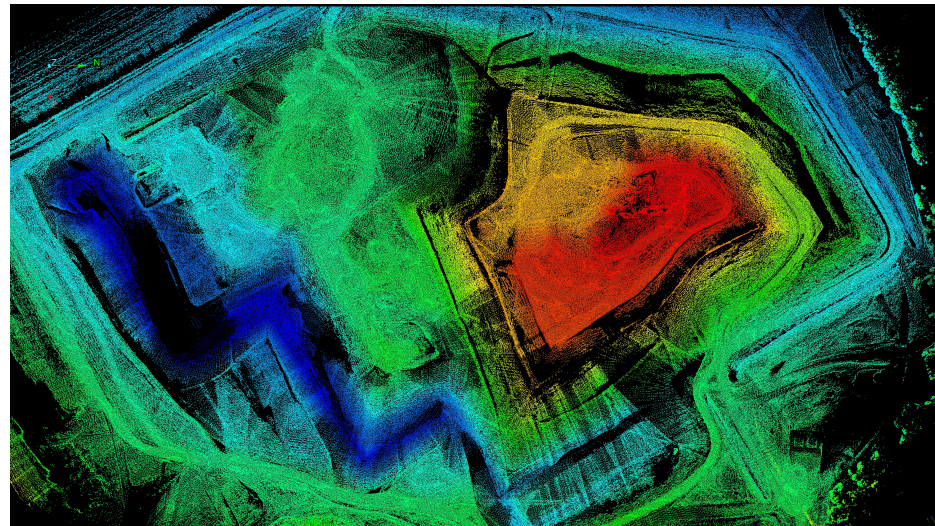
## Aerial Photogrammetry

- Good coverage
- Low point accuracy (+/- 12in)
- Low point density
- 28,250 Points
- 164 pts/acre



## Laser Scanning

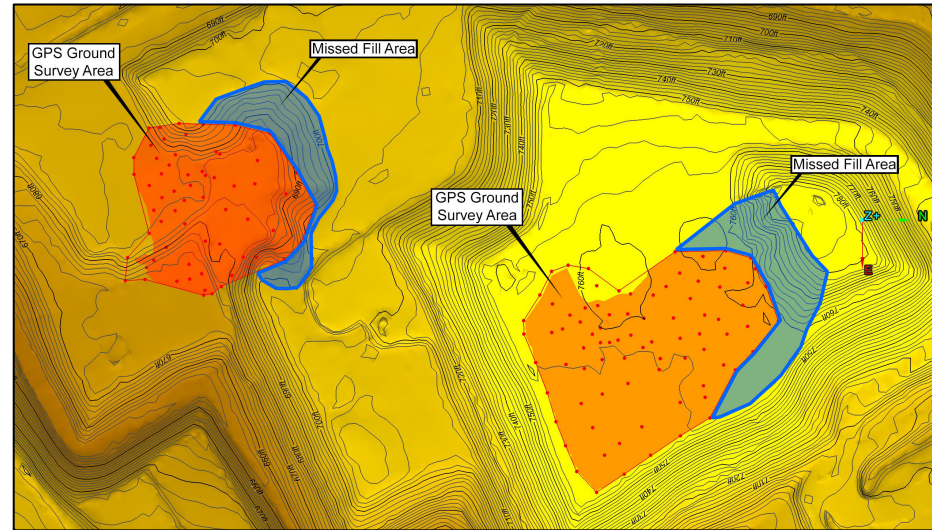
- Good coverage
- High point accuracy (+/- 4in)
- High point density
- 12,700,000 Points
- 73,620 pts/acre



# Data Coverage

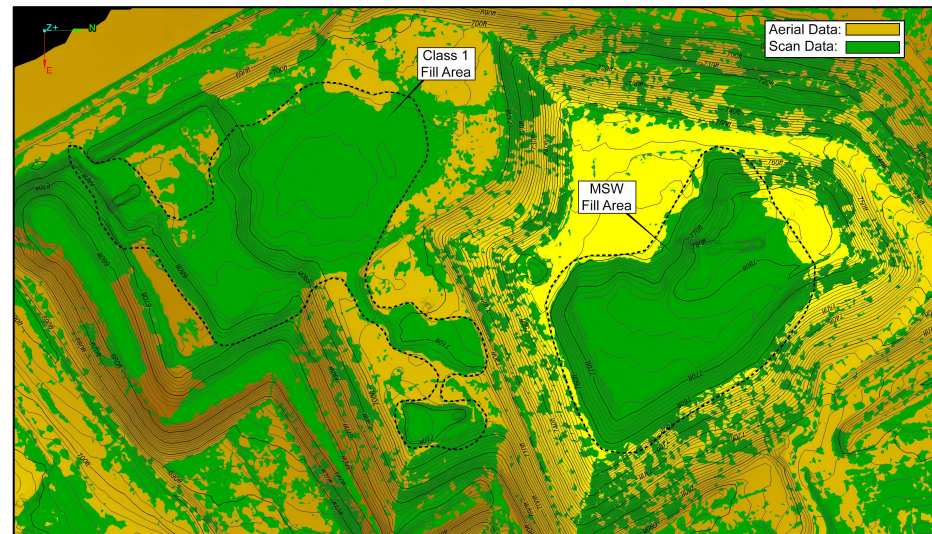
## GPS Ground Survey

- Poor coverage
- Missed areas of fill
- High point accuracy
- Low point density



## Laser Scanning

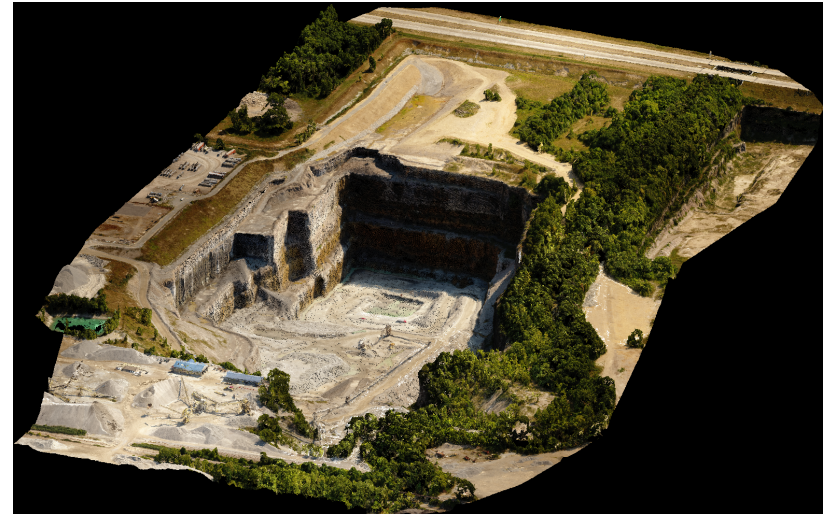
- Good coverage
- High point accuracy
- High point density
- Data captured beyond fill area



# Drones

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- Drone accuracy
  - Absolute vs. Relative Accuracy
  - Control points
- Important things to think about with drones
  - Type of drone (copter vs. fixed)
  - Price points
- Drone solution options
  - Service provider
  - Operator flies, Firmatek processes
  - Operator flies and processes





# APPLYING DRONE TECHNOLOGY

## A Case Study

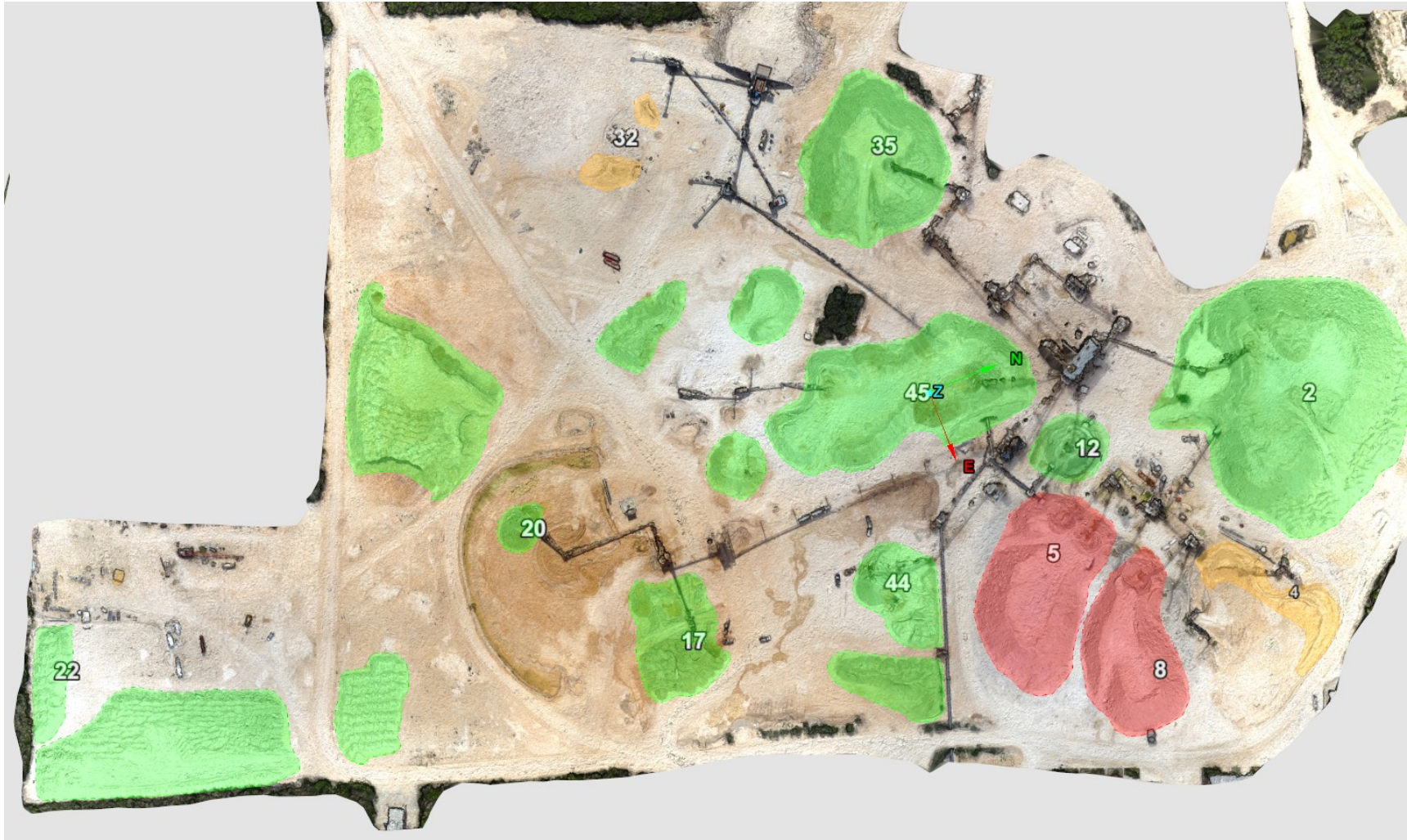
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- The Problem:
  - Aggregate producer in Mexico moves a lot of material
  - They need accurate inventory numbers on a weekly basis
  - It has historically been difficult and time consuming for the manager to do these measurements
  - It is expensive and impractical to bring in a third party on a weekly basis
- The Solution:
  - Weekly drone flights on Tuesdays
    - 20 minutes per plant vs. the 4 hours he was spending previously
  - Uploads data to Firmatek
  - By Thursday, he has inventory numbers
  - Preps for his Friday morning meeting and presents them in that meeting
  - 2 times per year, LiDAR measurements
    - They still want a complete 3<sup>rd</sup> party audit of their inventory

# Deliverables – Number Piles & Loops

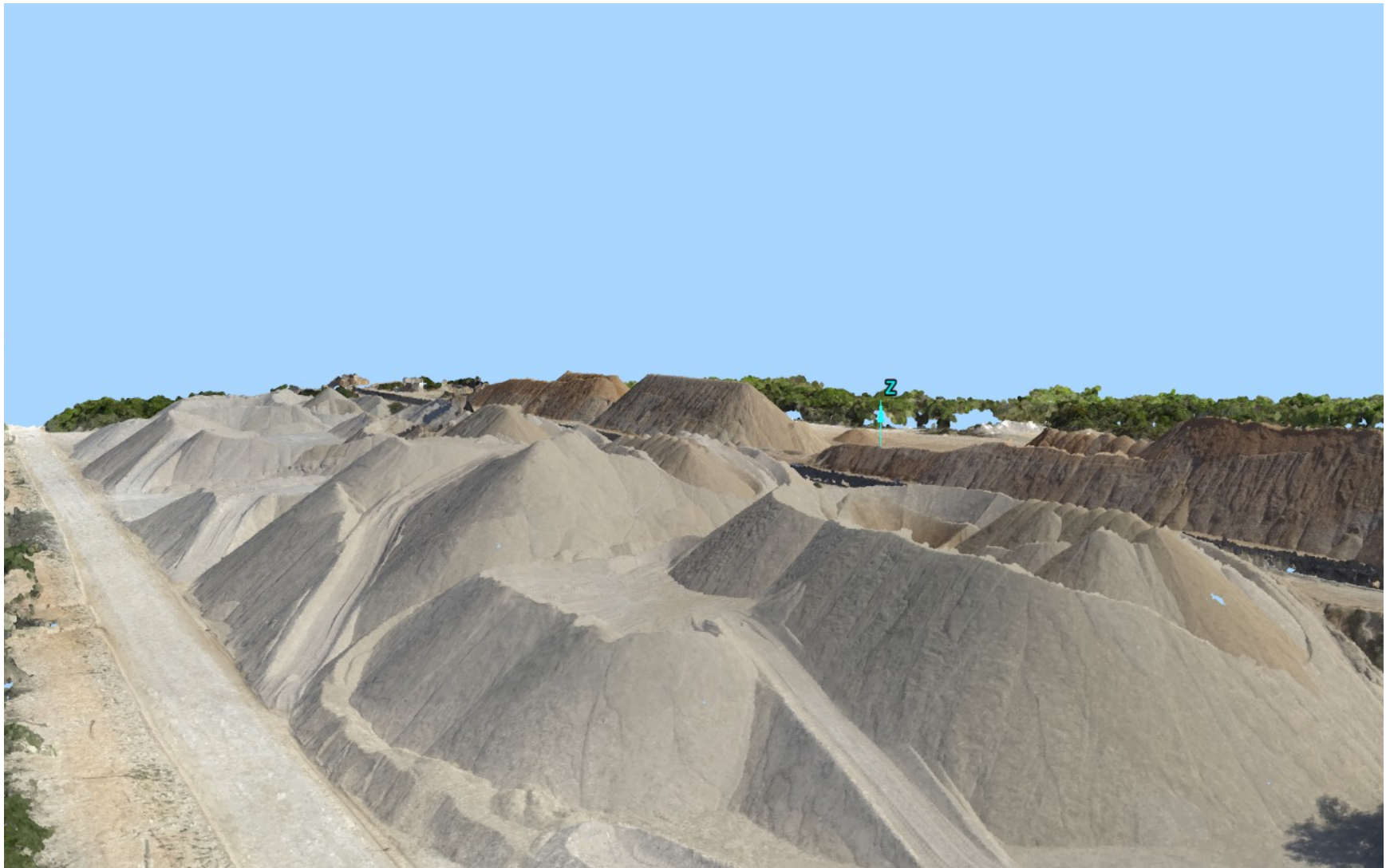


# Deliverables – Number Piles & Loops

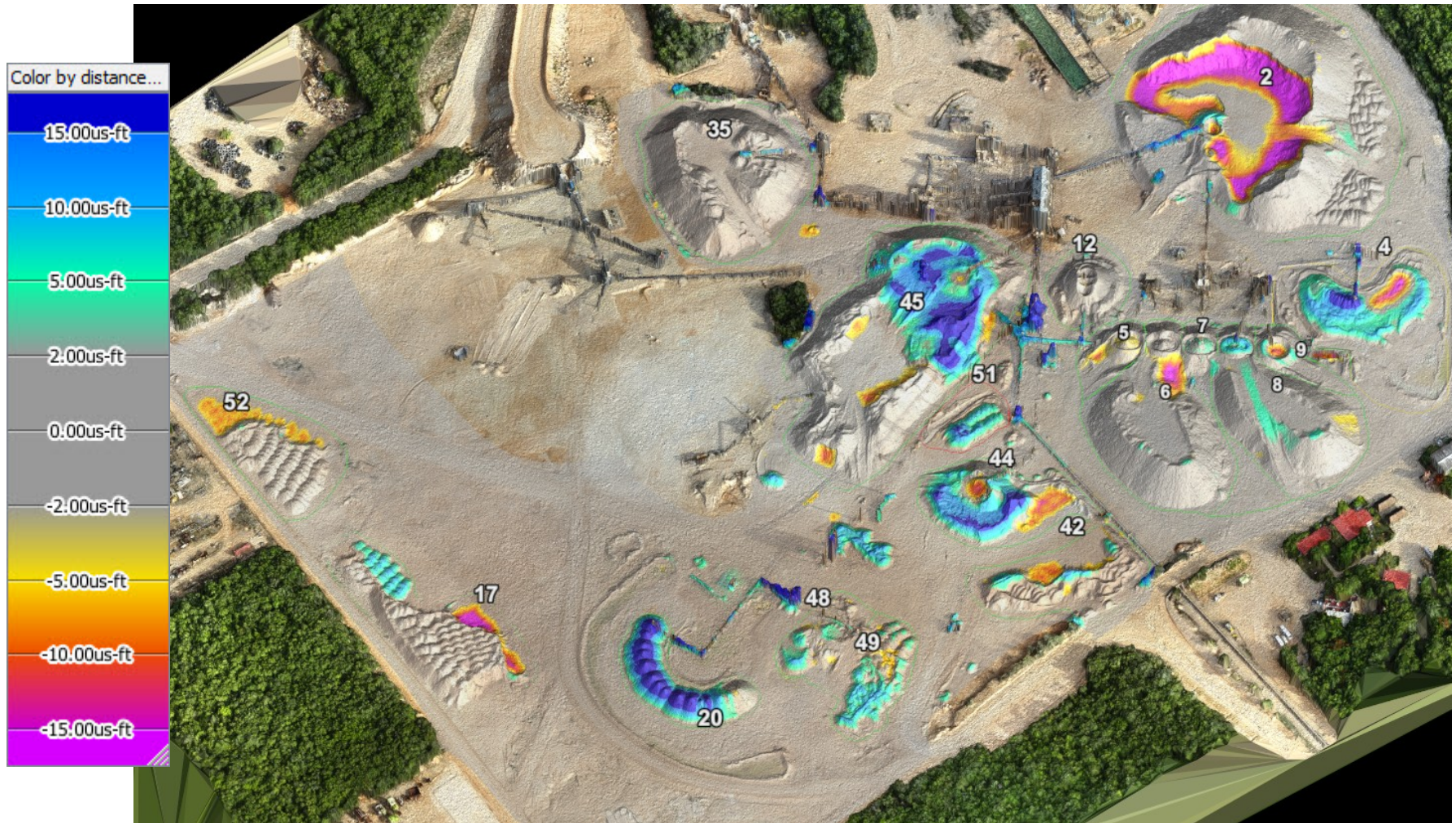


## Deliverables – Point Clouds

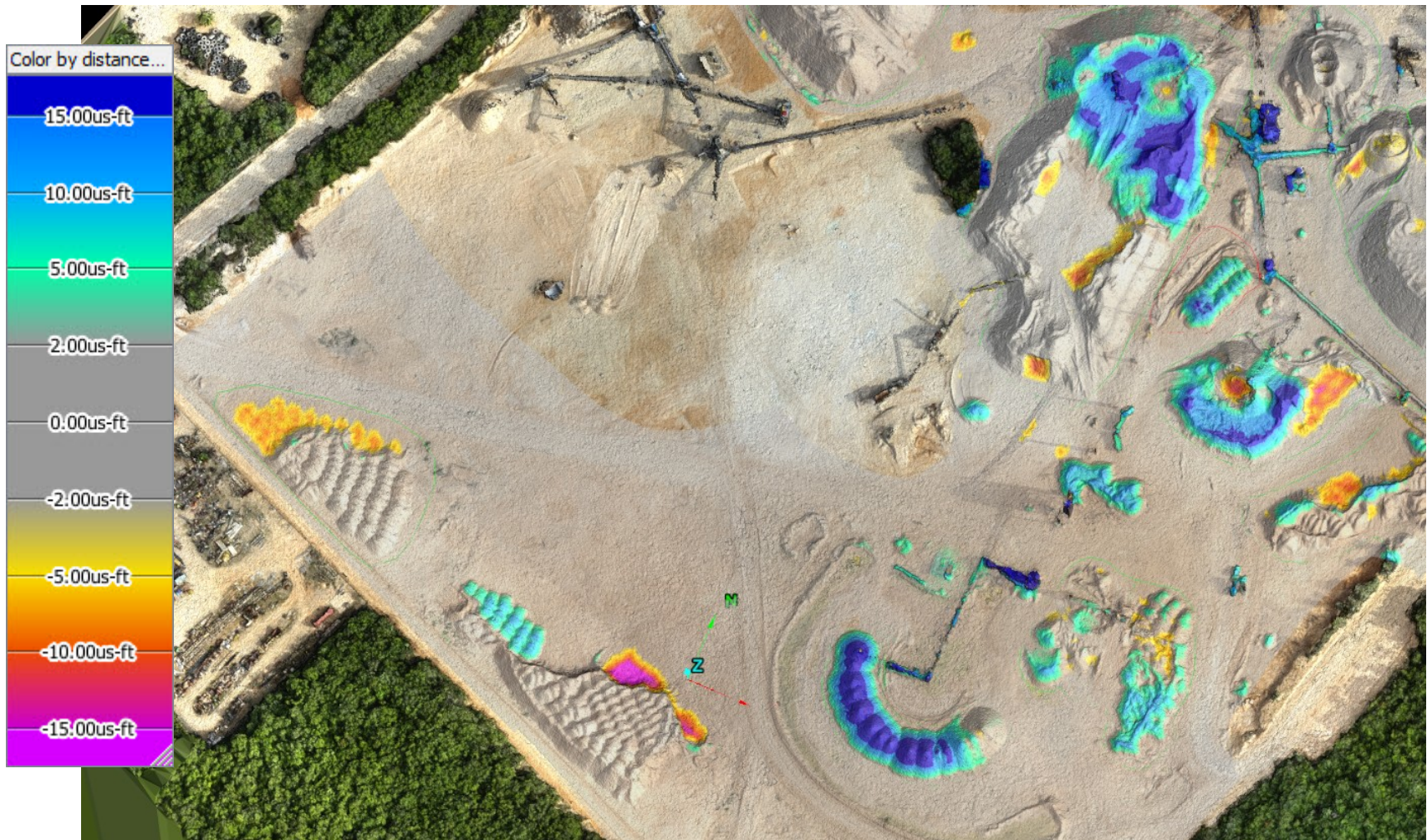
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# Deliverables – Change Detection



# Deliverables – Change Detection



## Case Study – The Results

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- Improved operational efficiencies
  - More accurate numbers on a weekly basis enable better decision-making and financial accountability
  - Manager has significantly more time doing high value tasks instead of walking piles
- Improved Safety
  - Flying a drone is much safer than an individual walking on piles with heavy equipment
- Confidence
  - Most importantly, the plant manager has confidence in his numbers. At one point they were close on whether they had enough material, but he had the confidence to say they would be OK, because he knew what he had. And he was right.
  - Upper management also has more confidence in what is coming out of the plant. “With other vendors there was always wiggle room, flexibility, but at Firmatek, you stick to your guns. That gives us more confidence in the numbers.”



## Drone Solutions Conclusions

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- Drone solutions make it easier to collect data, and therefore can help you manage you inventory better
- Pick the solution that makes sense for your particular operation
- The right solution can give you confidence in your inventory management and enables you to be more efficient and more confident in your decisions

# WRAPPING UP

## Financial Impacts

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- Improve your business through a better understanding of your operation
  - More accurate and timely measurements
- Fewer book adjustments
  - More accurate reporting and valuing of inventory means fewer adjustments later
- Visual reports help identify leakage and waste through follow-up measurements
- Miss fewer sales opportunities by having accurate inventory information

## Better information. Better business performance.

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- Understanding your inventory is key to managing it
- There are a variety of technology options for measuring your inventory
  - Choose the one that makes the most sense for your operation
- Using the best technology for your site will give you accurate inventory numbers and confidence in the decisions you make based on those numbers