Digital Stockpile Management Implementation

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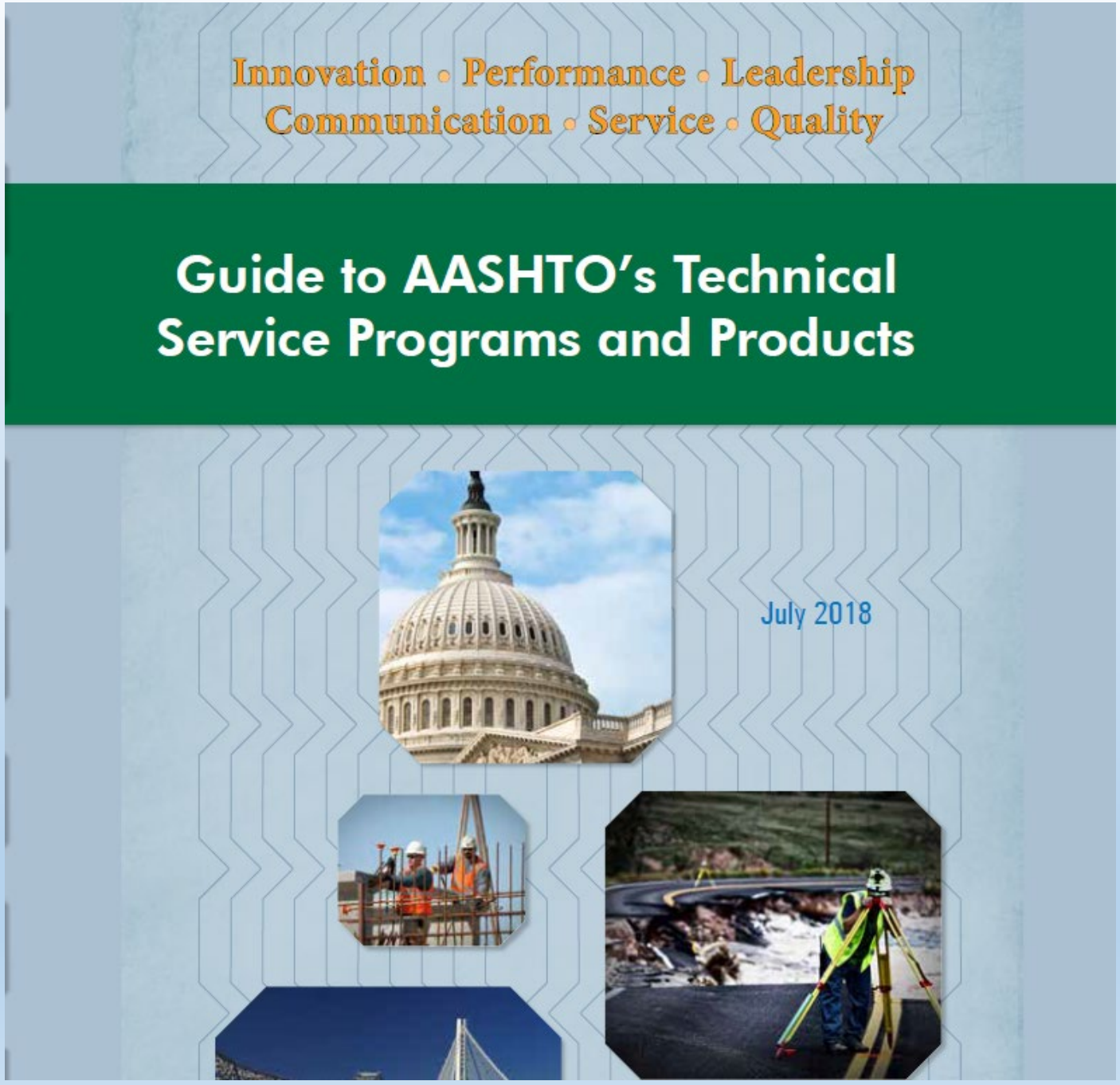
Travis Long, West Virginia Department of Transportation

Zoom Meeting Platform User Information

- Participants are currently muted
- Question and Answer Session will follow presentations
- Use Chat function to ask questions or raise your hand to be unmuted
- The meeting is being recorded and the recording will be shared on the AII website

AASHTO
Innovation Initiative



AASHTO Innovation Initiative (A.I.I.)

AASHTO Re:source

AASHTOWare

National Transportation Product Evaluation Program (NTPEP)

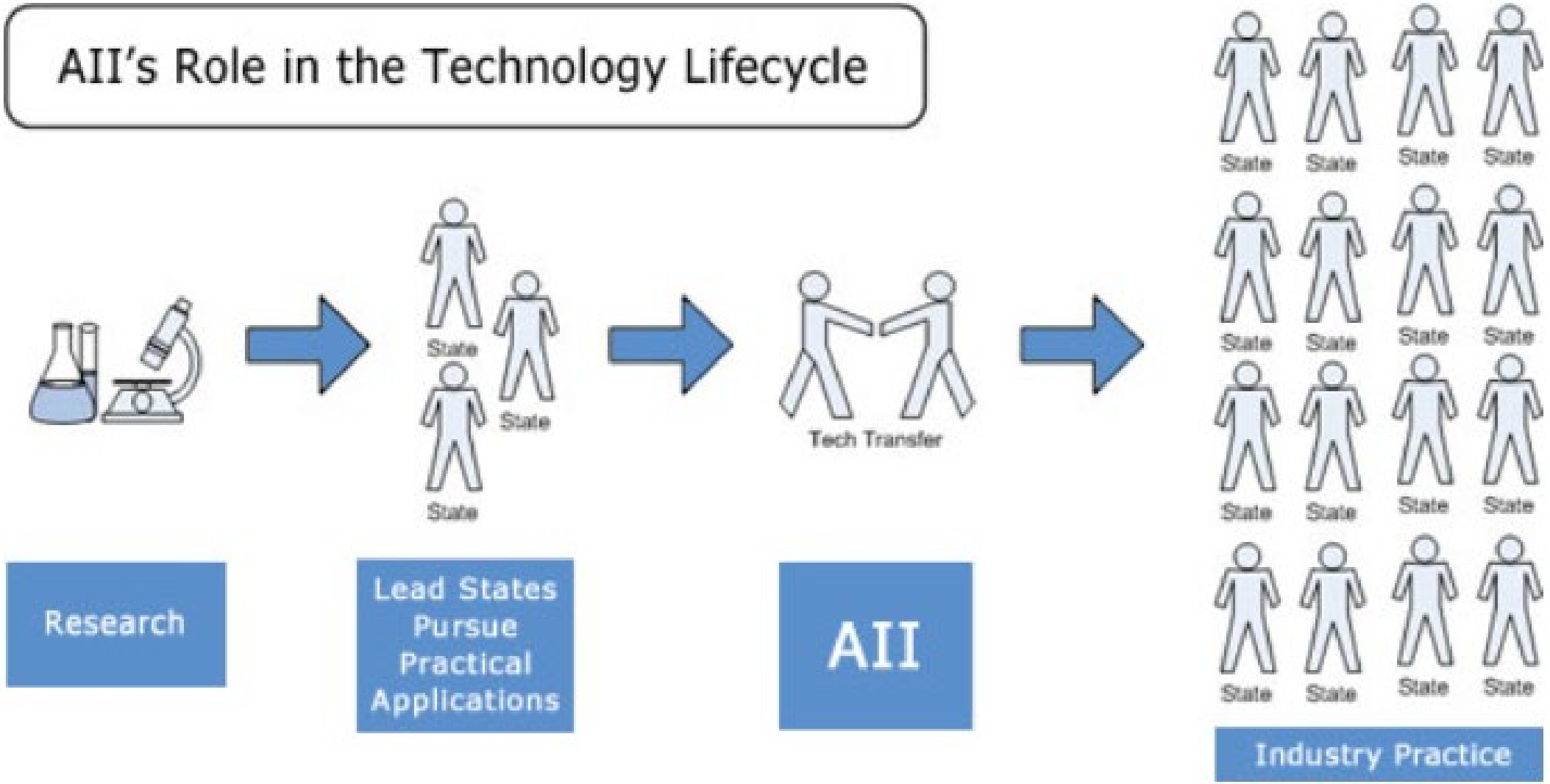
Development AASHTO Materials Specifications (DAMS)

All about All – *The AASHTO Innovation Initiative*

- Established in 1999 & Operating since 2000
- Previously called the *Technology Implementation Group (TIG)*
- Facilitate the implementation of **high-payoff**, **ready-to-use**, **innovative technologies**
  - Focus Technologies
  - Additionally Selected Technologies

Support the implementation of 100+ technologies since 2001

AII's Role in the Technology Lifecycle



All Technologies

Focus Technologies

Additionally Selected Technologies

Current Active Focus Technologies

- Steel Press-Brake-Formed Tub Girder
- Beam End Repair Using UHPC
- Dynamic Friction Testing
- On-Demand Microtransit
- Improved Project Delivery with GIS & Surveying
- Laser Ablation Coating Removal
- Digital Stockpile Management
- Online Auction of Surplus Property
- Wrong Way Driving
- Electrically Conductive Concrete Heated Pavement System

Focus Technologies

What is AII?

Formerly the AASHTO Technology Implementation Group, AII advances innovation from the grassroots up: by agencies, for agencies, peer-to-peer.
More >>

Active Focus Technologies | **Previous Focus Technologies** | **Additional Technologies**

Nominate a Technology | **Contact Us**

Submit Your Nomination Today!

AASHTO Innovation Initiative

Active Lead States Teams Focus Technologies

- Steel Press-Brake-Formed Tub Girder
- On-Demand Microtransit
- Beam End Repair Using Ultra-High Performance
- Digital Stockpile Management
- Dynamic Friction Testing with Three Wh
- Improved Project Delivery with GIS & Surveying
- Laser Ablation Coating Removal
- Online Auction of Surplus Property
- Systemic Approach to Wrong Way Driver Safety

Access earlier Lead States Team Focus Technologies

Resources

Digital Stockpile Management Brochure (2022)

Digital Stockpile Management Overview Video

aii.transportation.org

Digital Stockpile Management Implementation Technical Brief

Digital Stockpile Management (DSM)

INTRODUCTION

Highway agencies measure the size of stockpiles of materials, such as earthwork, aggregates, salt, and debris. They track their stockpiles of materials for a variety of reasons: inventory management, environmental, compliance, construction, and operations planning. The agencies have traditionally relied on either simple estimating techniques, such as walking wheels, bills of lading, planimetries etc., or resource-intensive survey grade measurements. Nevertheless, the traditional techniques of stockpile measurements are more expensive, less accurate, less efficient, and time-consuming.

Current materials management practices are improving at a remarkable pace due to recent innovations in digital technologies. DSM is a stockpile management process that uses digital technologies to measure and analyze material quantities efficiently, accurately, and consistently in real time.

The available digital technologies include smartphone applications, unmanned aerial systems, fixed wing aircraft photogrammetry, terrestrial laser scanning and mapping, and cloud-based platforms which are used in place of and, in some cases, in conjunction with traditional methods. The digital technologies facilitate capture, transfer and storage of real-time measurements of stockpiles which can be quickly calculated, verified, analyzed, and reported.

STATE OF THE PRACTICE

State DOTs have traditionally measured stockpiles using a variety of tools and methods. According to a survey of 33 DOT staff performed by the Digital Stockpile Management Lead States Team, the most widely-used methods are:

- **Walking Wheel Estimation – 15%**
- **Mobile Devices – 15%**
- **Bills of Lading – 13%**
- **GNSS RTK Rovers and Handheld Devices – 11%**
- **Laser – 10%**

Data from these methods are largely paper-based, however some data is represented as images and electronic or digital files.

Challenges that DOTs face using the traditional methods include accuracy of inventory data, training staff to use systems, inefficient use of time and labor, and keeping staff safe during the measurement process. Due to amount of labor and time involved, stockpiles were measured yearly. Additionally, the accuracy of a surveys and cross sections is very low compared with newer methods of measurement, such as using a point cloud and 3D model to calculate volumes. Furthermore, there is often no inventory system to manage stockpile data.

AASHTO Innovation Initiative

Outline of Presentation

1. Montana – Benefits, Cost and Business Case
2. Texas – Business Case (Safety), Training and Desk Reviews
3. Oregon – Application of Unmanned Aerial Systems (UAS)
4. National Perspective – Digital Delivery

Paul Rieger, Chris Harris, Daryl Starkes, Frances Fletcher, Leighann Heine, Lance Parve

Montana Department of Transportation

Paul Rieger

DSM Benefits, Cost and Business Case

MONTANA
Department of Transportation

Digital Stockpile Management

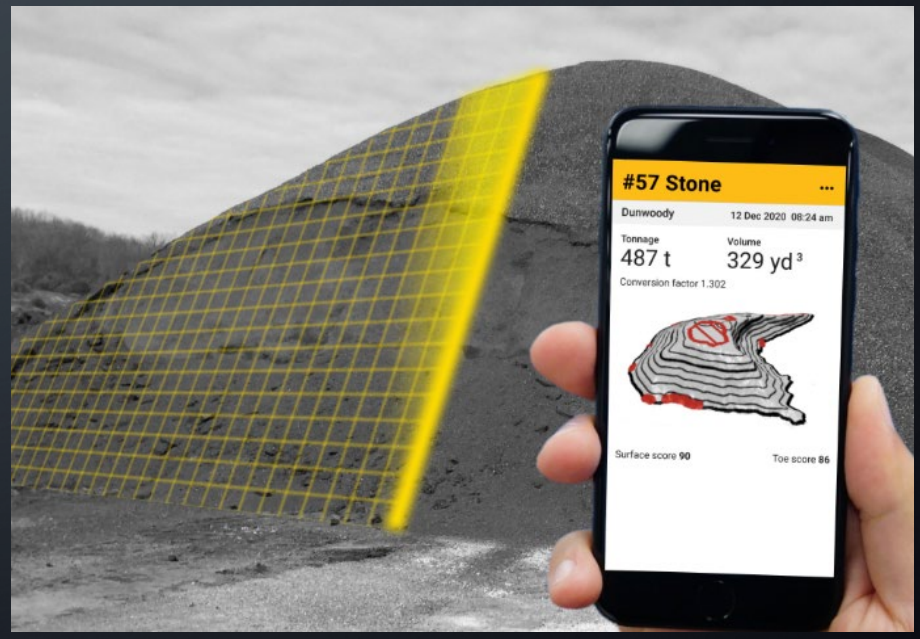
Montana's Legacy Process

MONTANA
Department of Transportation

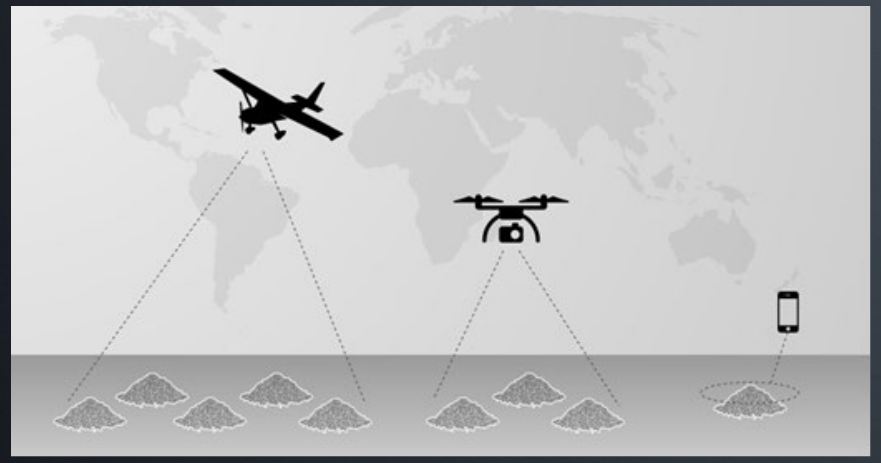
WHY?

- Safety
- Legacy Process Did Work Very Well
- Efficiency
- Cost

MONTANA MDT DEPARTMENT OF TRANSPORTATION + STOCKPILE REPORTS®



Data Capture



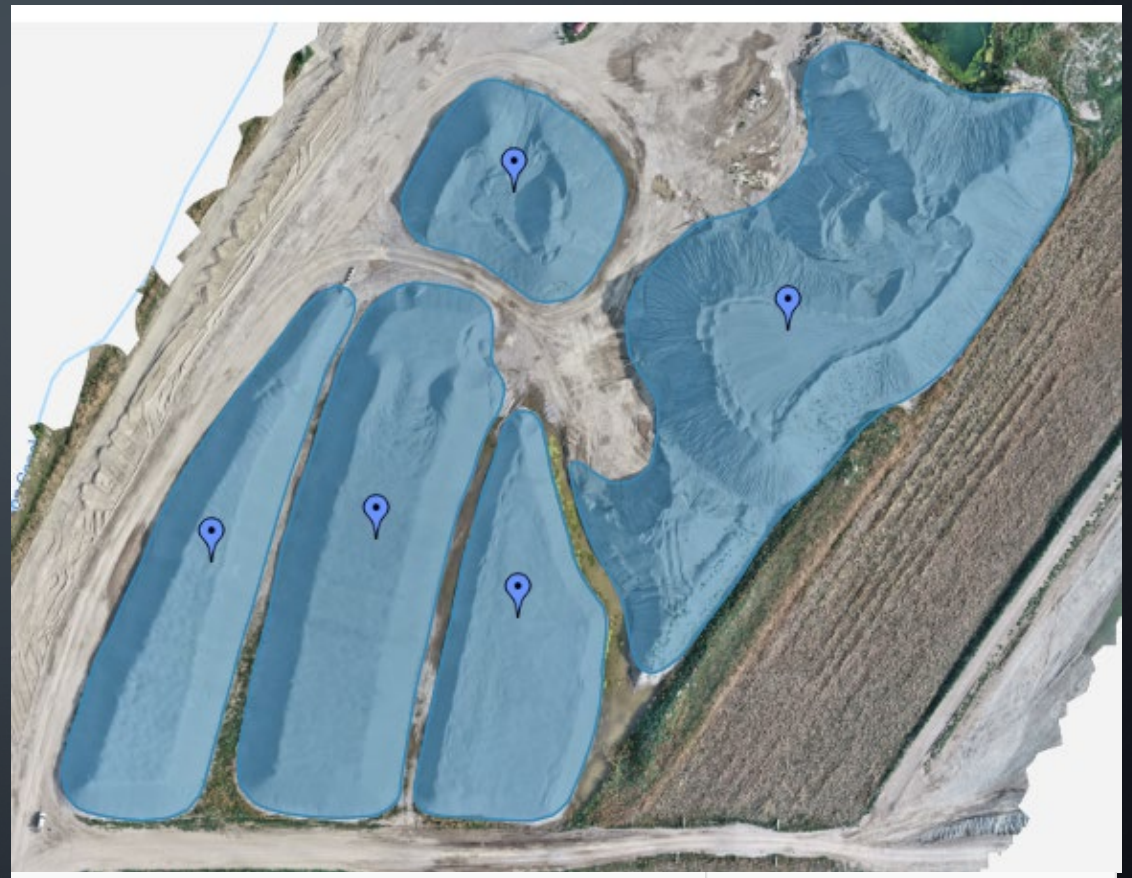
iPhone Measurements

- Using a UAV to measure a stockpile or a stockpile pit
- Measure multiple piles at once
- Fast and Efficient

MONTANA MDT DEPARTMENT OF TRANSPORTATION + STOCKPILE REPORTS®

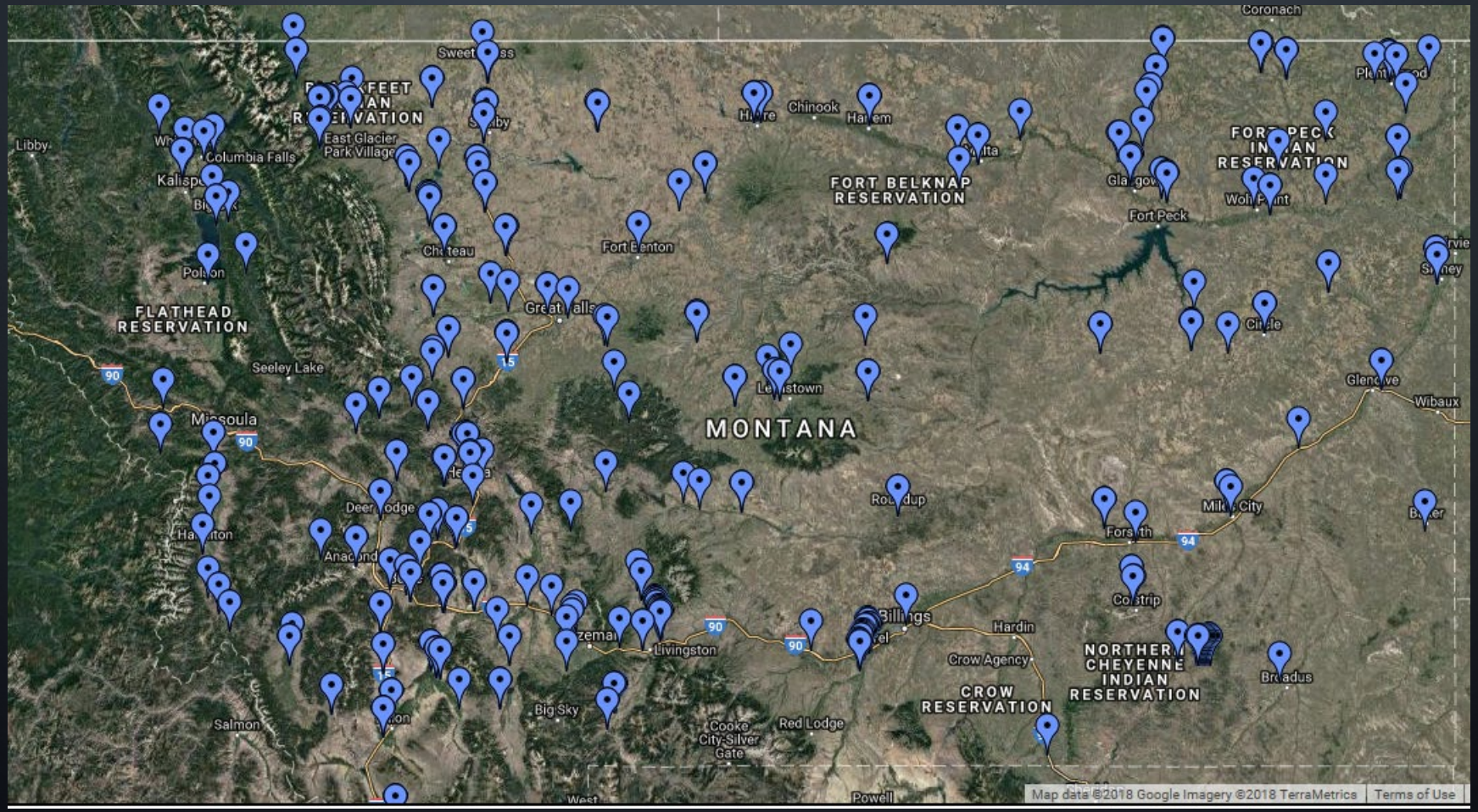
Results

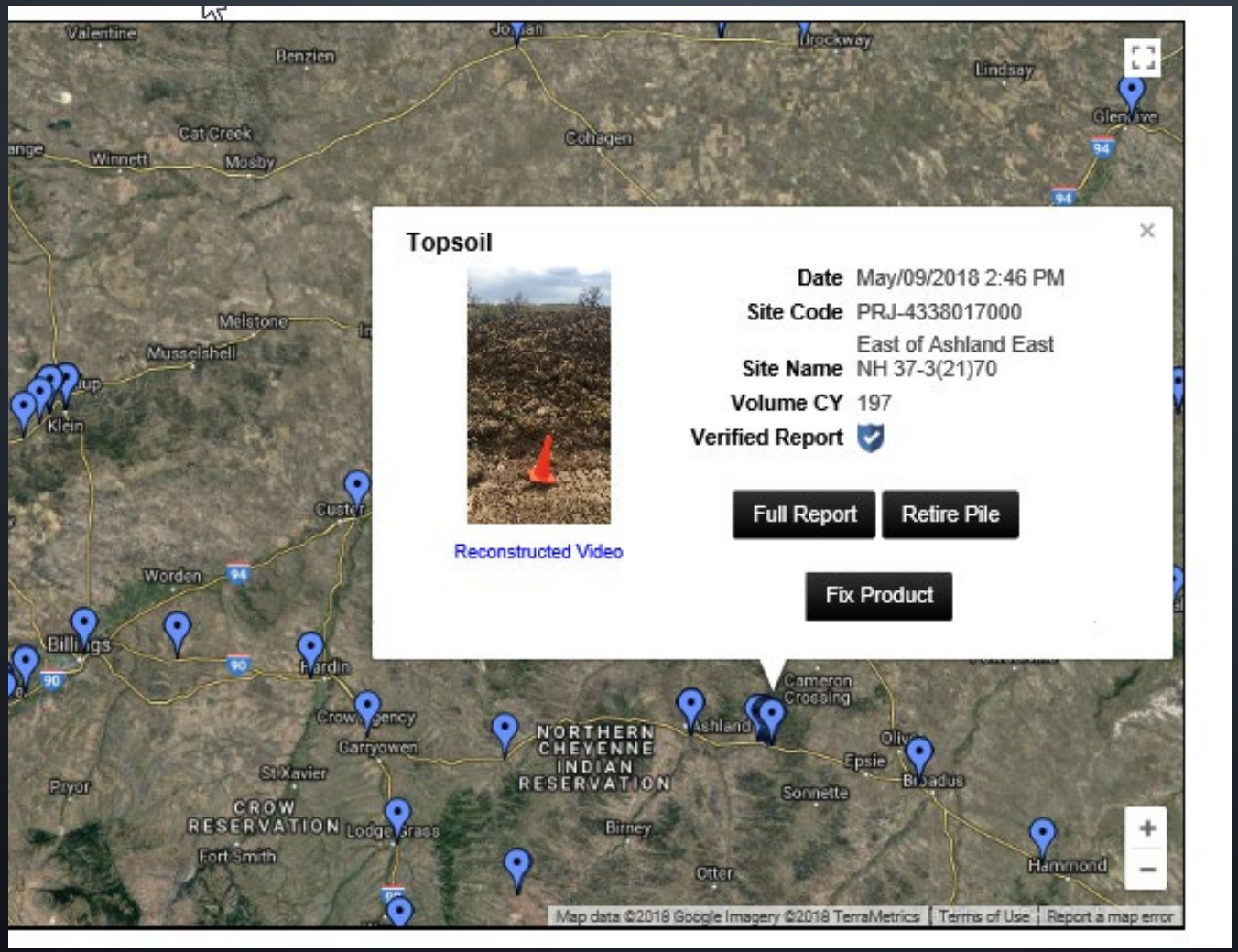
- 16.5 acres site measured
- Flight time 7 minutes
- >1 hr total labor (field and office)
- Measured 5 stockpiles
- Total Quantity of 229,981 yd3



Product Name	Volume
Aggregate	18,994
Aggregate	118,809
Aggregate	30,027
Aggregate	45,633
Aggregate	16,518

Montana's Stockpiles




Topsoil
Date May/09/2018 2:46 PM
Site Code PRJ-4338017000
Site Name East of Ashland East NH 37-3(21)70
Volume CY 197
Verified Report
Full Report
Retire Pile
Fix Product
Reconstructed Video
Valentine
Benzien
Cat Creek
Winnett
Mosby
Melstone
Musselshell
Klein
Worden
Billings
Hardin
Crow Agency
Garryowen
St Xavier
Pryor
CROW RESERVATION
Lodge Grass
Fort Smith
NORTHERN CHEYENNE INDIAN RESERVATION
Ashland
Cameron Crossing
Epsie
Sonnette
Birney
Otter
Hammond
Lindsay
Cohagen
Map data ©2018 Google Imagery ©2018 TerraMetrics
Terms of Use
Report a map error

MDT

Download PDF

18,994 Cubic Yards

Verified Report

Pile Details

Collected By Paul Rieger
Date Aug/24/2018
Time 9:22 AM
Method Drone

Request Inquiry

ROCKVALE - LAUREL (2 LANES) (FED #NHIP-HSIP 4-1(61)44): Aggregate (AGG)

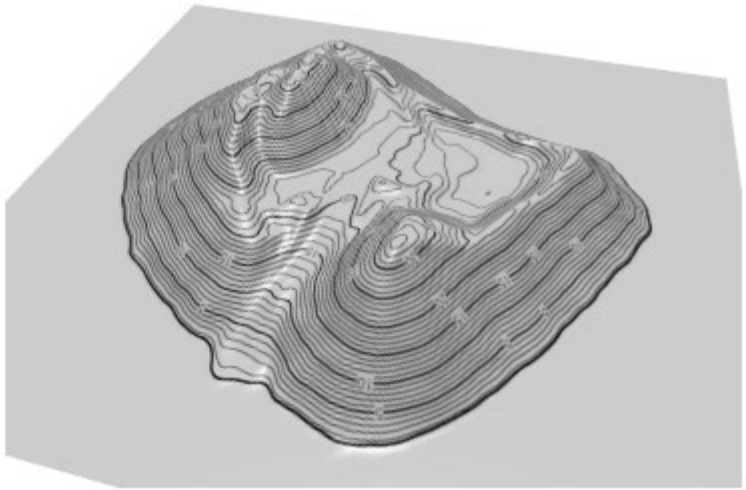
HIGH Toe Coverage Confidence

HIGH Surface Coverage Confidence

Possible Risks

- Combined Piles
- Standing Water
- Debris
- Equipment Obstruction
- Vegetation
- Highwall
- Snow
- Lighting Issues
- Buried Base

Contours | Toe | Surface | All | 3d



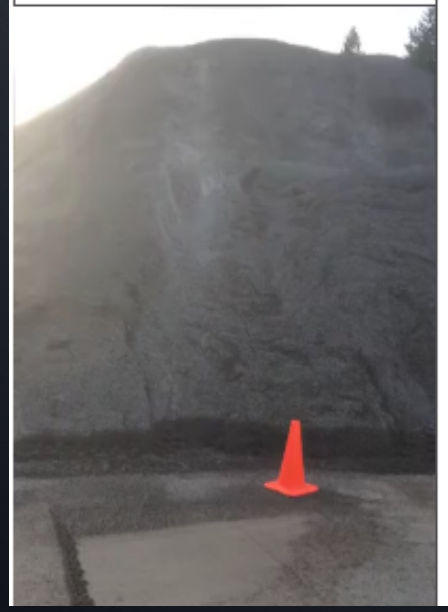
1,340 Cubic Yards

Manually Verify

Pile Details

Collected By	Dave Rauser
Date	Apr/20/2018
Time	7:49 AM
Duration	04m 46s
Cone Distance	25.0 feet
Method	iPhone 5s

Request Inquiry



FERNDALE SHOP: Sanding Material (02SM)

Toe Coverage Confidence

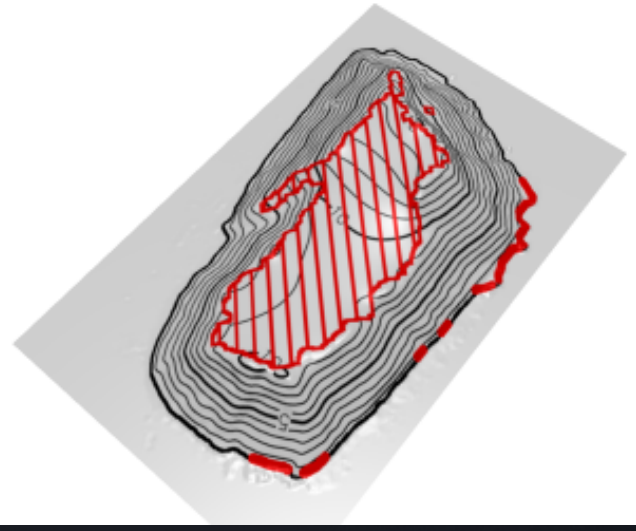
Surface Coverage Confidence

Possible Risks

- Combined Piles
- Standing Water
- Debris
- Equipment Obstruction
- Vegetation
- Highwall
- Snow
- Toe out of view
- Top out of view
- **Lighting Issues**
- Blurry or hazy imagery
- Buried Base
- Pile top surface not captured

Contours | Toe | Surface | All | 3d

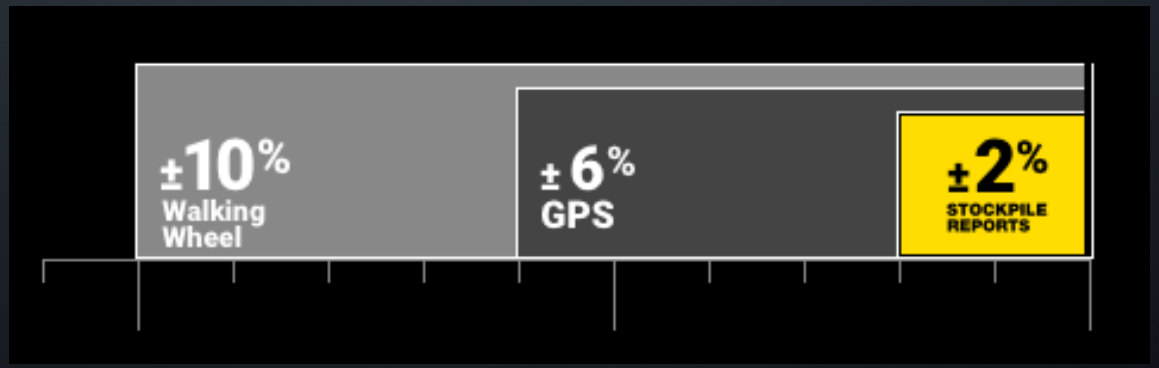
Potential Risks



Accuracy

Benchmark Measurement – Lidar Scan
Stockpile Reports +/- 2% of Lidar Scan
GPS Topo Survey +/- 6% of Lidar Scan

Repeatability:
Within +/- 2% of repeated measurements



Cost Analysis – GPS Survey vs. Stockpile Reports iPhone App

GPS Topo Survey
Equipment: GPS and Data Collector
Software: Microstation and GeoPak
Labor Cost: $400 per Stockpile

Stockpile Reports
Equipment: iPhone and subscription of Stockpile Reports
Software: iPhone App
Labor Cost: $24 per Stockpile

Cost Analysis – GPS Survey vs. Stockpile Reports UAV (Quarry with multiple stockpiles)

GPS Topo Survey
Equipment: GPS or Total Station and Data Collector
Software: Microstation and GeoPak
Labor Cost: $1800 per Site

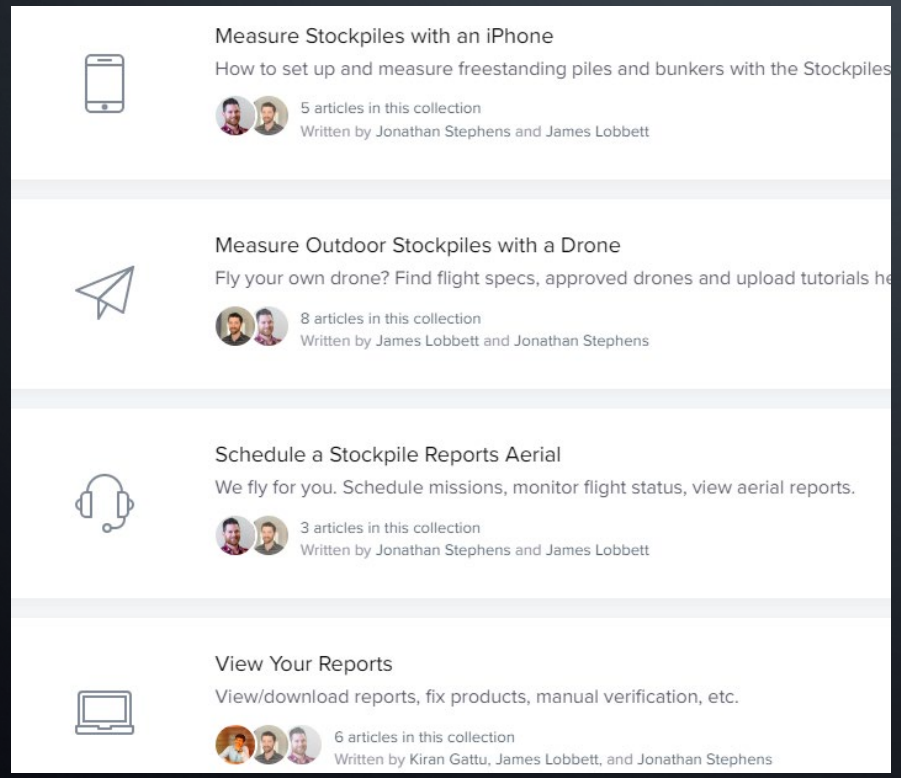
Stockpile Reports
Equipment: UAV, Mobile Device
Need Subscription
Labor Cost: $130 per Site

Current Subscription Cost

- Annual license cost: $100 per pile
- 400 piles, $40,000
- Includes training and support, unlimited users, sites, products, unlimited measurements

Montana's Training

- One day training – Train Crew Leads
- Training led by Stockpile Reports Experts
- Stockpile Reports Training Materials



Benefits:

- SR backs-up and secures all data (video, picture, other data)
- Provides time and cost savings
- Easy to implement, user friendly, requires minimal training
- Minimal equipment requirements
- Accuracy is better than GPS topo survey
- All stockpiles can be managed within Stockpile Reports
- Offers improved stockpile management tools
- “Risks” to the measurement are identified
- Much safer way to measure stockpiles
- Stockpile Reports provides an independent 3rd party measurement

Negatives:

- Limitations include: need space around piles, clean piles, sun flare, submerged materials

Participant Poll #1

Texas Department of Transportation

Daryl Starkes, Frances Fletcher, Leighann Heine

Business Case (Safety), Training and Desk Reviews

TXDOT Digital Stockpile Management

December 2022

Support Services Division-Materials Management
Daryl Starkes, Frances Fletcher, & Leighann Heine

Motivation for DSM Usage

TXDOT's main intent for changing to digital stockpile measuring (DSM) system was to implement and utilize a safe and unified method statewide for measuring roadway material that provided measurable accuracy rates and technological enhancements.

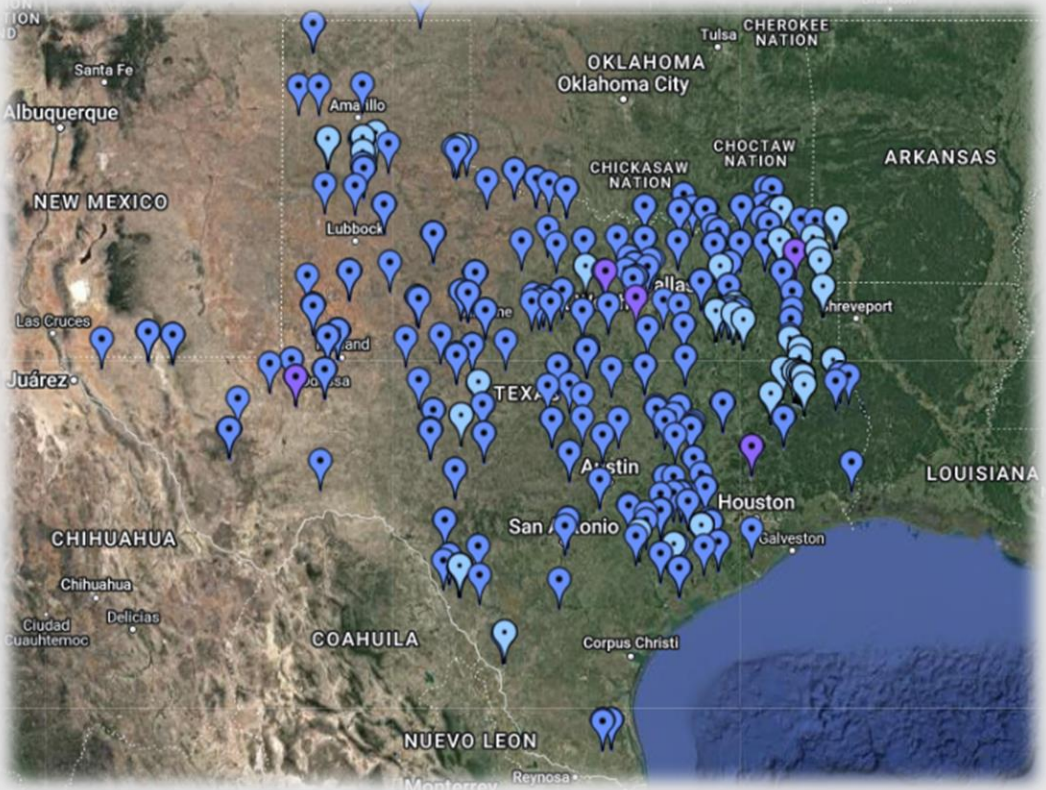
Prior to 2016, measuring methods varied greatly statewide resulting in accuracy concerns. Lack of computerized data, coupled with inconsistent recordkeeping and reporting methods, proved to be administratively problematic. Training for measuring material, stockpile management, and administrative recordkeeping was also found to be inconsistent or non-existent.

Recognized Results:

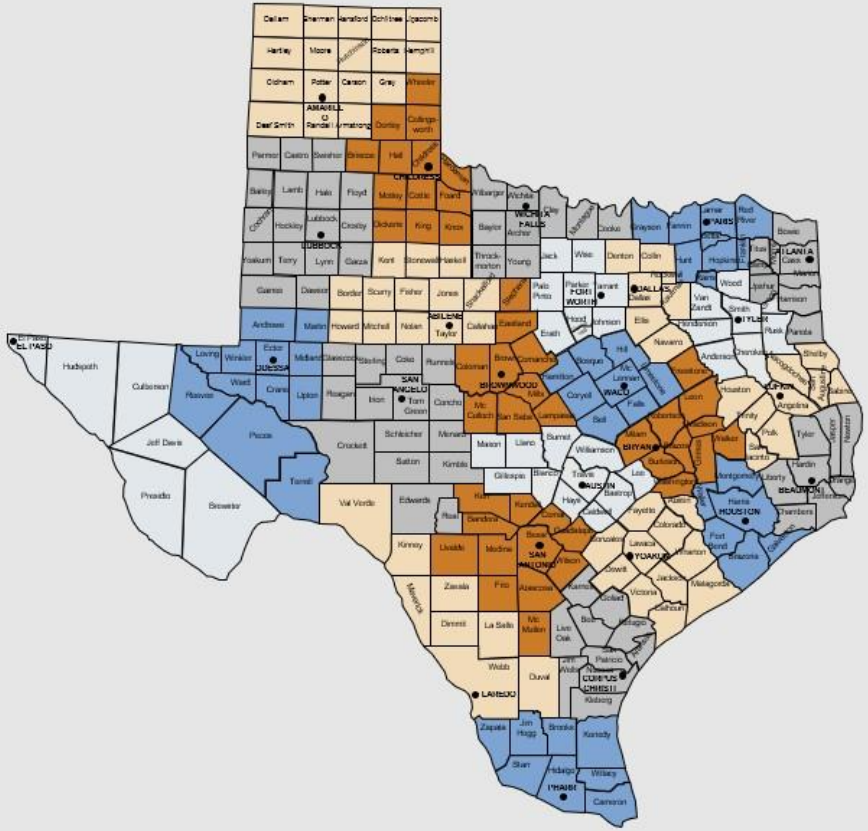
Statewide consistent measuring methods, improved accuracy rates, and trackable data translates to significantly improved inventory management.

Disclosure of Endorsement:

Texas Department of Transportation (TXDOT) does not endorse or sponsor any products or services. TXDOT's provision of goods and services does not constitute endorsement by TXDOT. Nothing in this presentation should be construed to imply that TXDOT authorizes, supports, endorses, or sponsors any product or service regardless of the fact that such products or services may used by TXDOT.



Texas Department of Transportation (TXDOT)



- Introduced DSM system in 2015 and implemented statewide usage in 2016
- Oversee 400+ Maintenance sections within 254 Texas counties
- Manage approx. $145K of inventory daily; 75-80% is roadway material
- Currently stock over 500 materials approved for roadway maintenance including, but not limited to: Aggregates, Flex Base, Rip Rap, Sand, Limestone, Filter Stone, and Salt.

Texas Department of Transportation (TXDOT)

- Governs approximately 4500 stockpiles/bunkers, annually. In FY22, TXDOT managed 4667 stockpiles and bunkers; and 4542 in FY21, per data records.
- TXDOT manages stockpile inventory by performing routine cycle counts performed at the local level and random spot inventory inspections conducted by Inventory Specialist, statewide. Inventory Specialist also perform administrative desk reviews to monitor measuring results and data.
- Training gaps are identified and addressed via email and/or in-person guidance to continuously improve and expand User knowledge and skills using DSM technology.

Challenges of Digital Stockpile Measuring

- **'Buy-In'** - initial Administration and End-User buy-in

- **Technology Challenges** – while most think everyone has a cellphone, when DSM was originally launched, several employees lacked the knowledge and experience of using a cellphone. How to correctly setup, identify functions, and use a cellphone was incorporated into TXDOT training material.

- **Statewide Training** – all agencies face turnover; keeping new Users trained at a statewide level remains challenging, especially due to distance and travel time.

- **COVID Restrictions** – like other agencies worldwide, the COVID epidemic halted travel and congregating for 2 years, disrupting training and inventory management. Being able to review measurement videos and online reports provided an excellent training resource and inventory management tool.

Benefits of Digital Stockpile Measuring

Manageable Statewide Oversight

- TXDOT wanted a safer, faster, cost effective, and more efficient measuring method for stockpile material which could be implemented and monitored statewide via on-demand and exportable dashboard data and reports.

Consistency & Accountability

- TXDOT was looking for a consistent and efficient stockpile measuring method for all 25 districts to utilize which had a measurable accuracy rate.

Searchable On-Demand Exportable Online Data & Reports

- TXDOT needed a reliable data collection source in a user-friendly format with the ability to provide on-demand searchable and exportable data for tracking, reviewing, reporting, and archiving purposes. Reports are consistent, easily accessible, customizable, and easy to read.

Additional Benefits of Digital Stockpile Measuring

Built-in iPhone Technology & Resource Tools

- Measurement tools and reports include GPS data, scoring information, risk identifiers (water, vegetation, etc.), 3-D models which can be used to identify stockpile problems and/or discrepancies, address stockpile maintenance, and improve User skills.

On-Demand Measurement Data and Videos

- Inventory Specialists can review reports/videos on-demand via a searchable database that serves as an excellent resource for one-to-one training and assistance which leads to increased User knowledge/skills, improved measurement techniques, safer walks, and increased accuracy.

Safety

- DSM provides a safe stockpile measuring method for employees potentially exposed to weather, vegetation, roadway traffic, and other risk factors.

In-Person & Online Training

It was quickly recognized an ongoing in-house training plan needed to be developed for cost effectiveness, statewide efficiency, and continuous personnel development.

TXDOT developed a comprehensive 4-hour training course specific to agency requirements and safety standards and facilitated in-person onsite training, statewide until COVID restrictions halted travel and congregating for 2 years.

During COVID, an online course was developed which covers correct iPhone setup, basic walking paths and measuring techniques to aid Users.

Training Remains TXDOT's Biggest Lesson Learned

Initially, the vendor provided a mini 'how-to' training onsite at a few locations.

TXDOT quickly recognized the need for ongoing training due to turnover and/or changes in job duties, technology advancements, and software enhancements.

Texas learned training is most important and beneficial, whether in-person, via phone, or email. TXDOT began a comprehensive stockpile training program which includes in-house developed courses and onsite in-person training. Training brochures are created and distributed via email as the need is identified such as: correct cone placement, varying stockpile and bunker walking paths, the importance of stockpile maintenance, etc. to increase knowledge and improve stockpile management and measuring skills.

Keeping new Users trained at a statewide level remains challenging, especially due to the vast distances between facilities and travel time.

Utilizing DSM Reports

District Summary Reports provide an overview of stockpile measurement activity which helps identify districts in need of assistance, training, and/or more in-depth reviews to improve measurement success rates.

The report also contains an overview of total stockpiles and pile types in each district which aids in inventory management.

District	Total Piles	Free Standing Piles	Bunker Piles	Free Standing Collects	Bunker Collects	Solved Collects	Failed Collects	Success Rate	Free Standing Volume	Bunker Volume	Total Volume
Texas DOT -	49	46	3	74	13	79	8	91	28785	1176	29961
Texas DOT -	22	14	8	16	17	32	1	97	3172	1770	4942
Texas DOT -	9	6	3	11	6	15	2	88	2598	283	2881
Texas DOT -	6	5	1	6	1	7	0	100	4156	115	4271
Texas DOT -	37	32	6	33	8	40	1	98	26177	838	27015
Texas DOT -	27	26	1	33	1	34	0	100	4923	70	4993
Texas DOT -	22	22	0	26	0	24	2	92	7879	0	7879
Texas DOT -	14	9	5	19	19	28	10	74	3335	713	4048
Texas DOT -	13	7	8	11	14	25	0	100	3468	2306	5774
Texas DOT -	19	16	3	16	3	19	0	100	3162	441	3603
Texas DOT -	36	35	1	38	1	39	0	100	27985	67	28052
Texas DOT -	6	5	1	5	1	6	0	100	14621	38	14659
Texas DOT -	55	51	4	54	5	58	1	98	22301	1881	24182
Texas DOT -	9	9	0	11	0	11	0	100	1560	0	1560
Texas DOT -	5	5	0	5	0	5	0	100	730	0	730
Texas DOT -	30	30	0	34	0	33	1	97	29376	0	29376
Texas DOT -	16	12	4	14	10	21	3	88	1393	529	1922
Texas DOT -	18	18	0	26	0	26	0	100	14123	0	14123
Texas DOT -	2	2	0	2	0	2	0	100	1078	0	1078
Texas DOT -	3	3	0	8	0	7	1	88	2491	0	2491
Texas DOT -	10	10	0	15	0	15	0	100	11242	0	11242
Texas DOT -	17	13	4	18	6	23	1	96	3098	640	3738
Texas DOT -	11	7	4	9	8	14	3	82	2218	1084	3302
Texas DOT -	6	6	0	6	0	6	0	100	2245	0	2245
Grand Total	442	389	56	490	113	569	34	94	222116	11951	234067

Utilizing DSM Reports for One-to-One Assistance

Reviewing stockpile measurement data is an excellent way to identify and address errors and help improve User skills. ‘Actions’ function provides the ability to review video measurements to provide guidance and recommendations regarding techniques and best practices which can improve the accuracy of future measurements.

Site Code	Site Name	Product Code	Product Name	User Name	Type	Date	Volume	Verified Report	Actions
013	[redacted]	74514630602	LIMESTONE ROCK ASPHALT PAVEMENT COLD MIX, SS T9210, PP, TYPE I, GRADE B	[redacted]	iPhone	Nov/14/2022 10:35 AM	149	Toe: 98 Srfc: 98	
0		75052280544	FLEXIBLE BASE, TYPE A, GRADE 4. (RETAINED ON SIEVE: 1-3/4 IN. 0, 7/8 IN. 10-35, 3/8 IN. 30-50, NO. 4 45-65, NO. 40 70-85, MAX LL 35,)		iPhone	Nov/14/2022 10:27 AM	1,184	Toe: 90 Srfc: 80	
0		75052280544	FLEXIBLE BASE, TYPE A, GRADE 4. (RETAINED ON SIEVE: 1-3/4 IN. 0, 7/8 IN. 10-35, 3/8 IN. 30-50, NO. 4 45-65, NO. 40 70-85, MAX LL 35,)		iPhone	Nov/14/2022 10:28 AM	1,180	Toe: 98 Srfc: 78	
0		74565423048	ASPHALTIC CONCRETE PATCHING MATERIAL, ALL SEASON PRE-COATED PATCHING MIXTURE (ASPPM), SAC-B OR BETTER		iPhone	Nov/21/2022 8:30 AM	32	Toe: 95 Srfc: 100	
0		74568105758	ASPHALT, RECYCLED, RAP, TYPE A, TREATABLE/RECYCLABLE, RECLAIMED ASPHALT PAVEMENT		iPhone	Nov/14/2022 9:32 AM	401	Toe: 100 Srfc: 90	

Next Steps...

TXDOT is looking to continue DSM usage and has expanded the program to include:

Strategic Salt Sheds

TXDOT implemented strategically located salt sheds for emergency use only and had fixed cameras installed by the vendor in 2021 which has improved winter weather inventory maintenance by providing visual monitoring and on-demand data results.

In-Person Training Restart

TXDOT recently updated and rewrote the in-house training course and will begin teaching in-person statewide in fiscal year 2023. (COVID travel restrictions lifted)

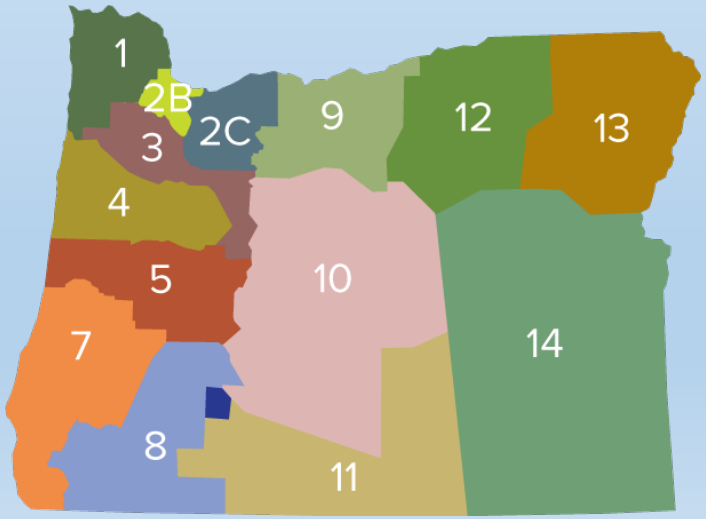
Oregon Department of Transportation

Chris Harris

Unmanned Aerial Systems and DSM

Who's got piles?

- Construction Regions (5)
  - Project materials
    - Material production
    - Materials on hand payment
    - Removal quantities
    - Waste material purchase

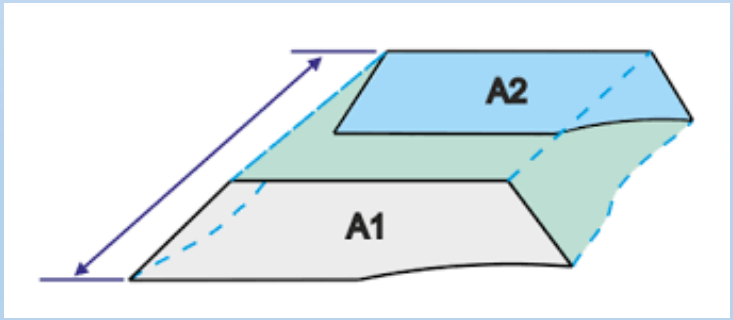


- Maintenance Districts (14)
  - Material production verification
  - Material management
    - Topsoil, Aggregate, Asphalt Grindings
    - Salt, Sand, Cinder

“Analog Measurements”

Bucket Capacity

Belt Scales



Geometry

Calibrated Eye

Digital Methods

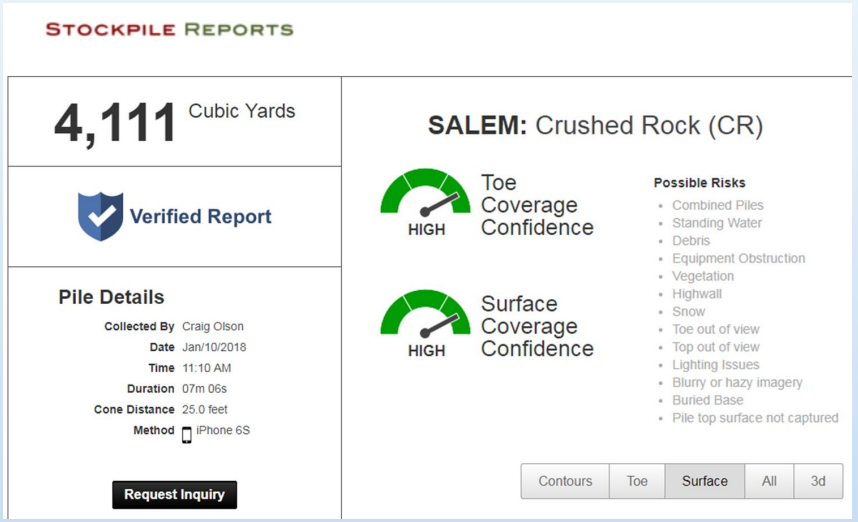
Cell Phone

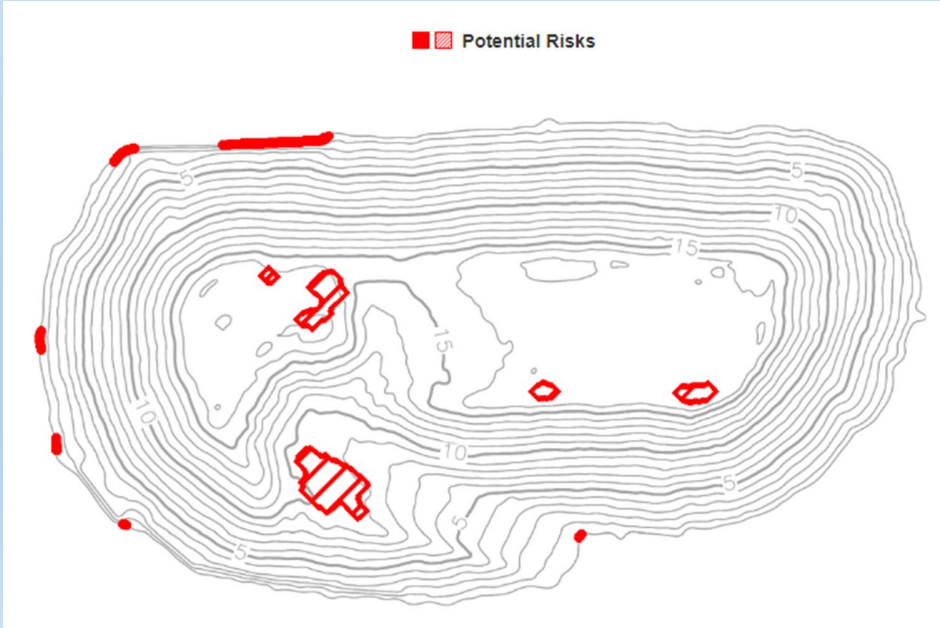
GPS Rover

UAS

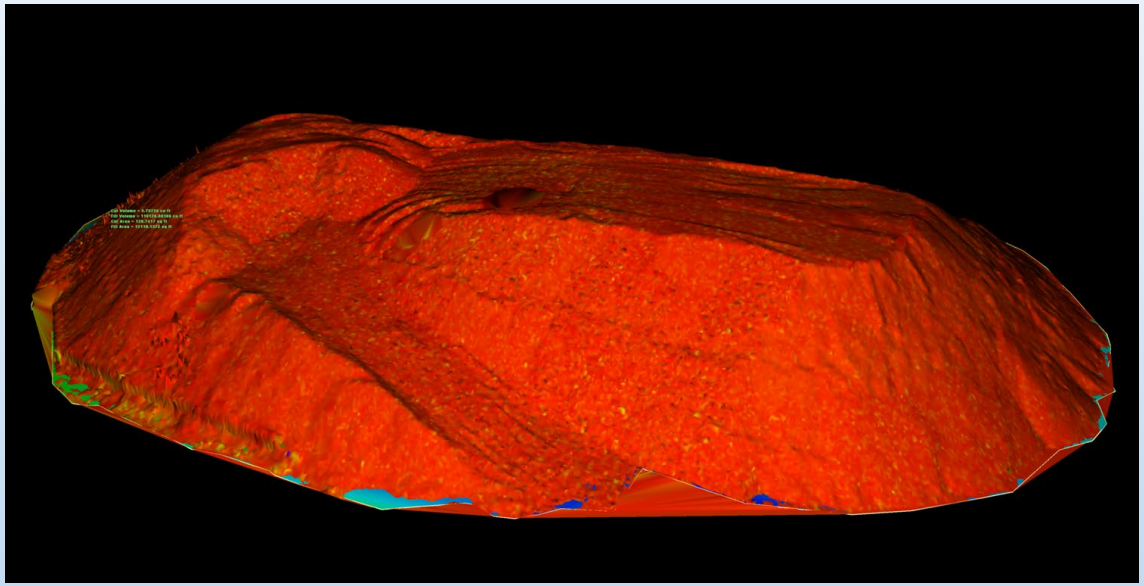
Lidar

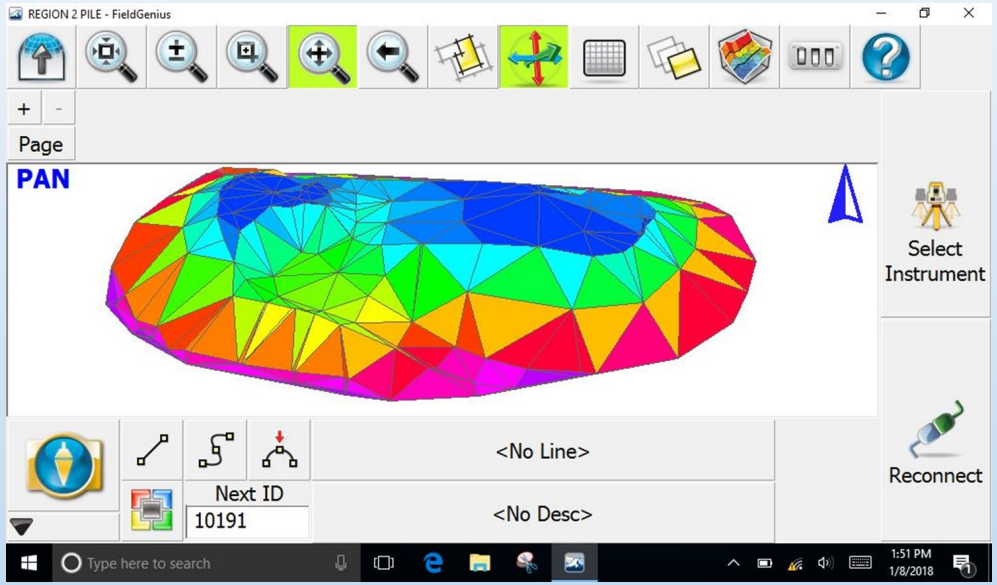
Mid-Size Aggregate Stockpile





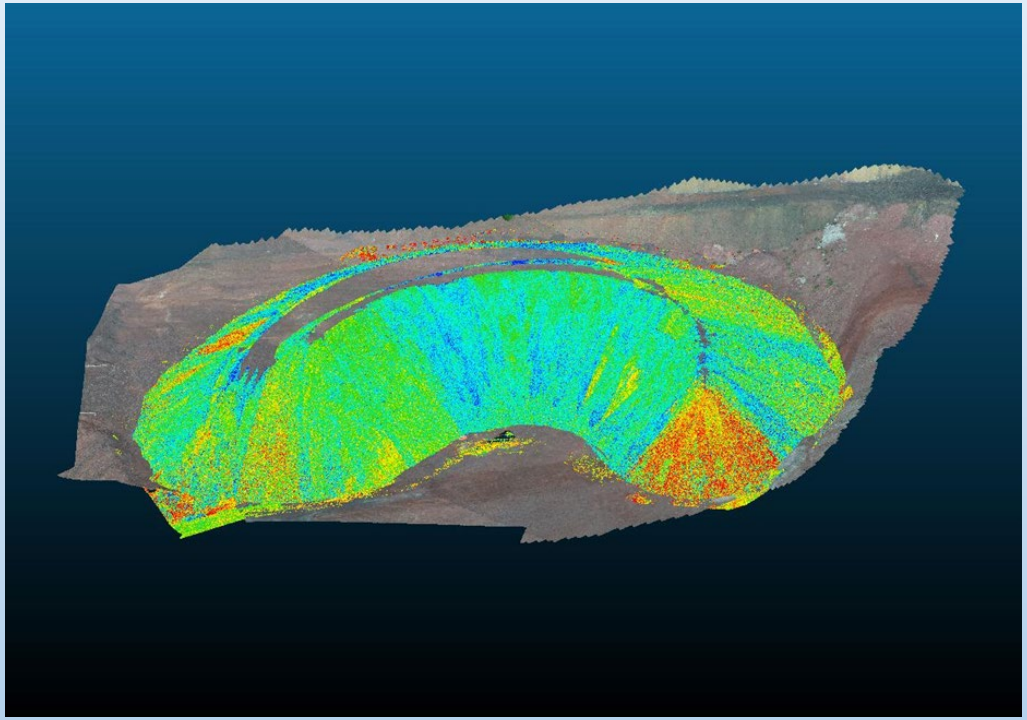
Mid-Size Aggregate Stockpile





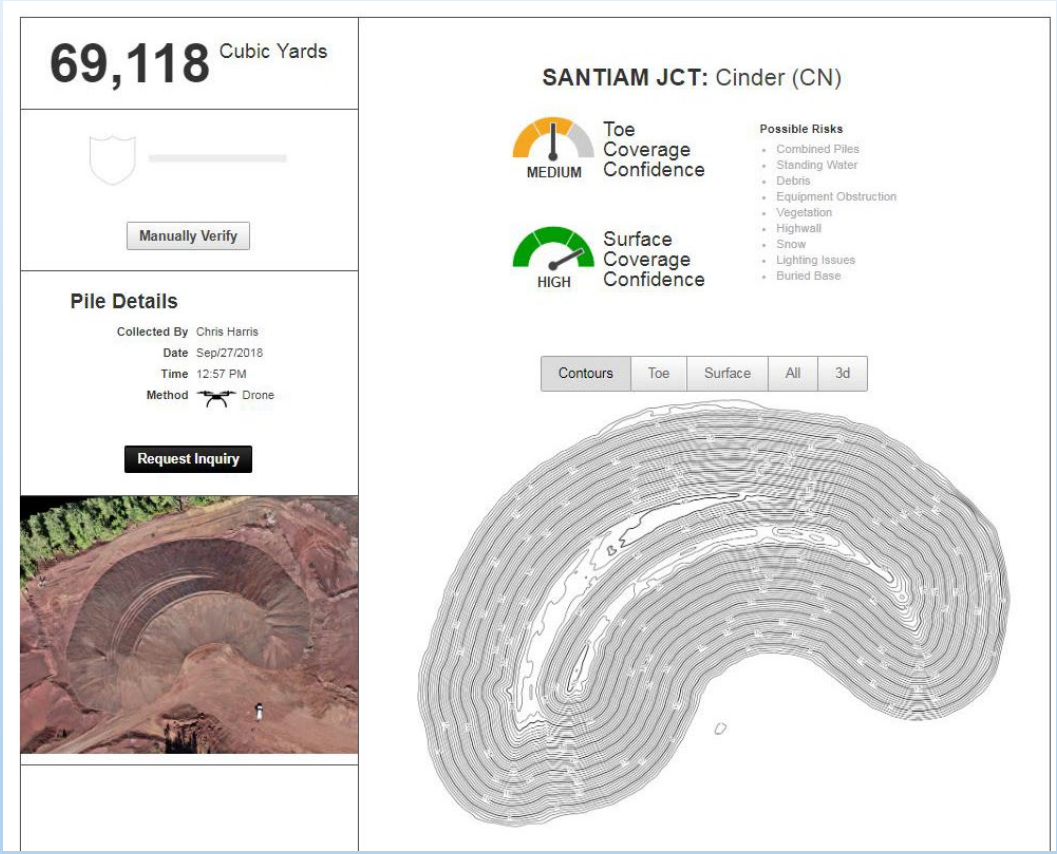
Method	Collection Time	Turnaround Time	# of Staff	Volume (cu. yard)	% Difference from Scanner
Static Scanner	2 hours	2 hours	2	4079	-
GPS Tablet	40 mins.	5 mins.	1	4013	-1.6%
Cell Phone	7 mins.	5 hours	1	4111	+0.8%

Large Aggregate Stockpile



Lidar + Pre-crush DTM

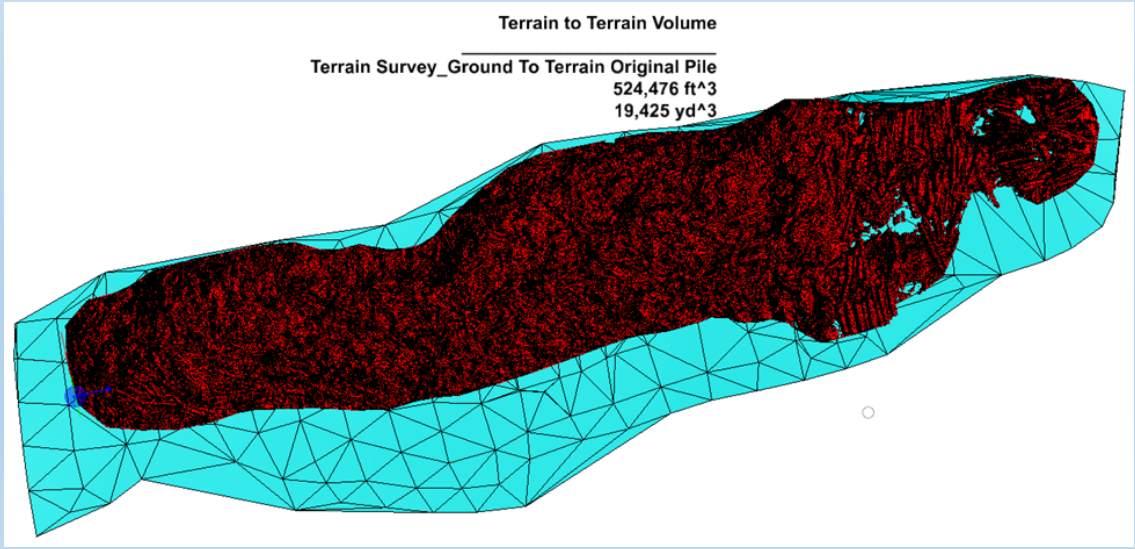
Volume = **67,696 cubic yards**

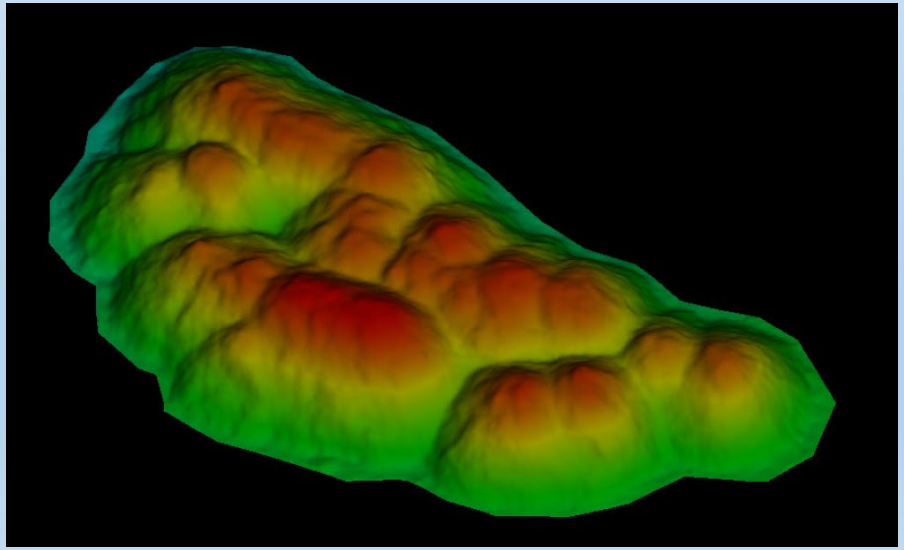


UAS + SfM (no base DTM)

+ 2.1%

Wildfire Support





Slash Pile

Wood Chips

Challenges

- Availability and Comfort level with technology
- De-centralized operations
- Provided a tool without long term program vision

What's Next

- Interviewing staff to understand why or why not using solutions
- Training UAS pilots to make measurements more accessible
- Show management the economic and efficiency gains by creating a statewide management program

Participant Poll #2

WSP

Lance Parve

National Perspective - Digital Delivery

All – DSM All about the Data

Digital living records:

- Updated during construction/post-construction
- Support digital design/construction/O&M/lifecycle asset/performance management

Lifecycle data contain:

- Structured, semi-structured & unstructured data + attributes + metadata

Asset data:

- Searchable & accessible
- Geospatial & contextual
- Reliable & durable
- Extractable & interoperable

Source: Creative Commons.

Why DSM - Overview

Improve Construction Management

Improve O&M

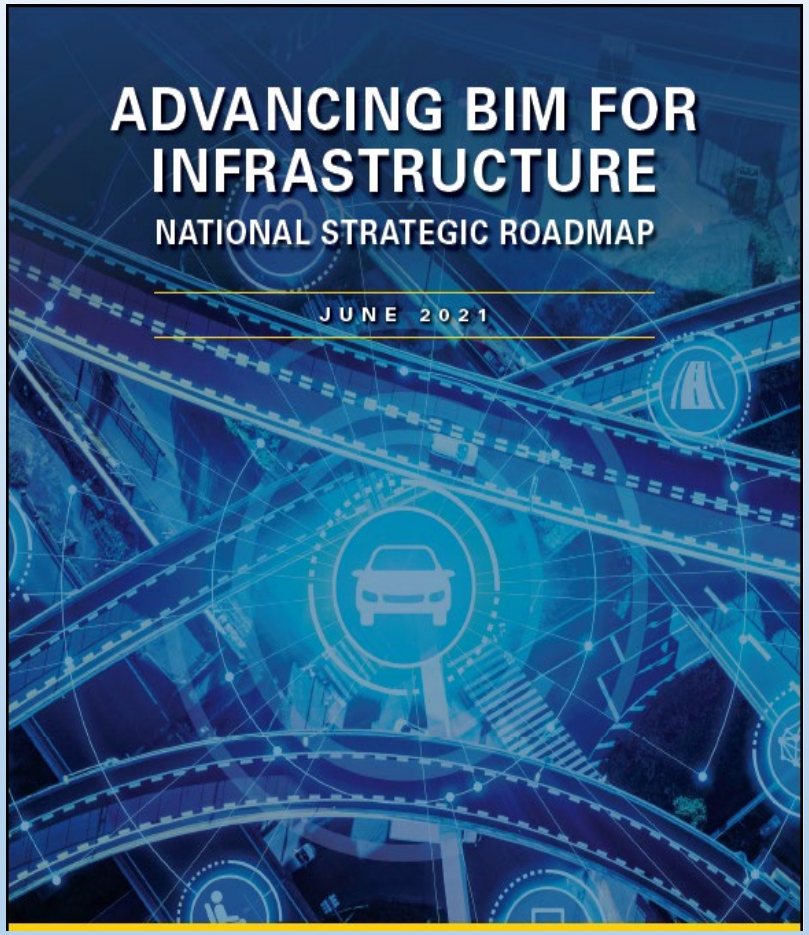
Improve Asset Management

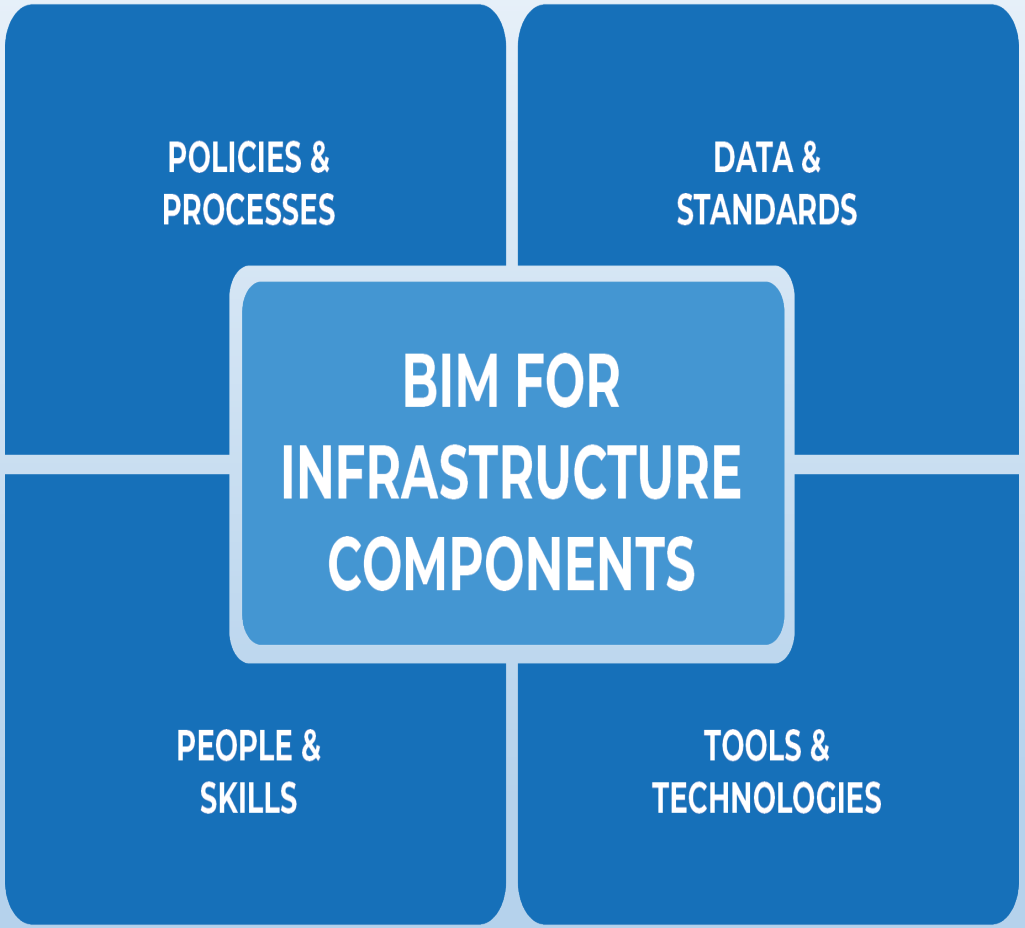
Improve Project Scoping

Complete Digital Delivery Process

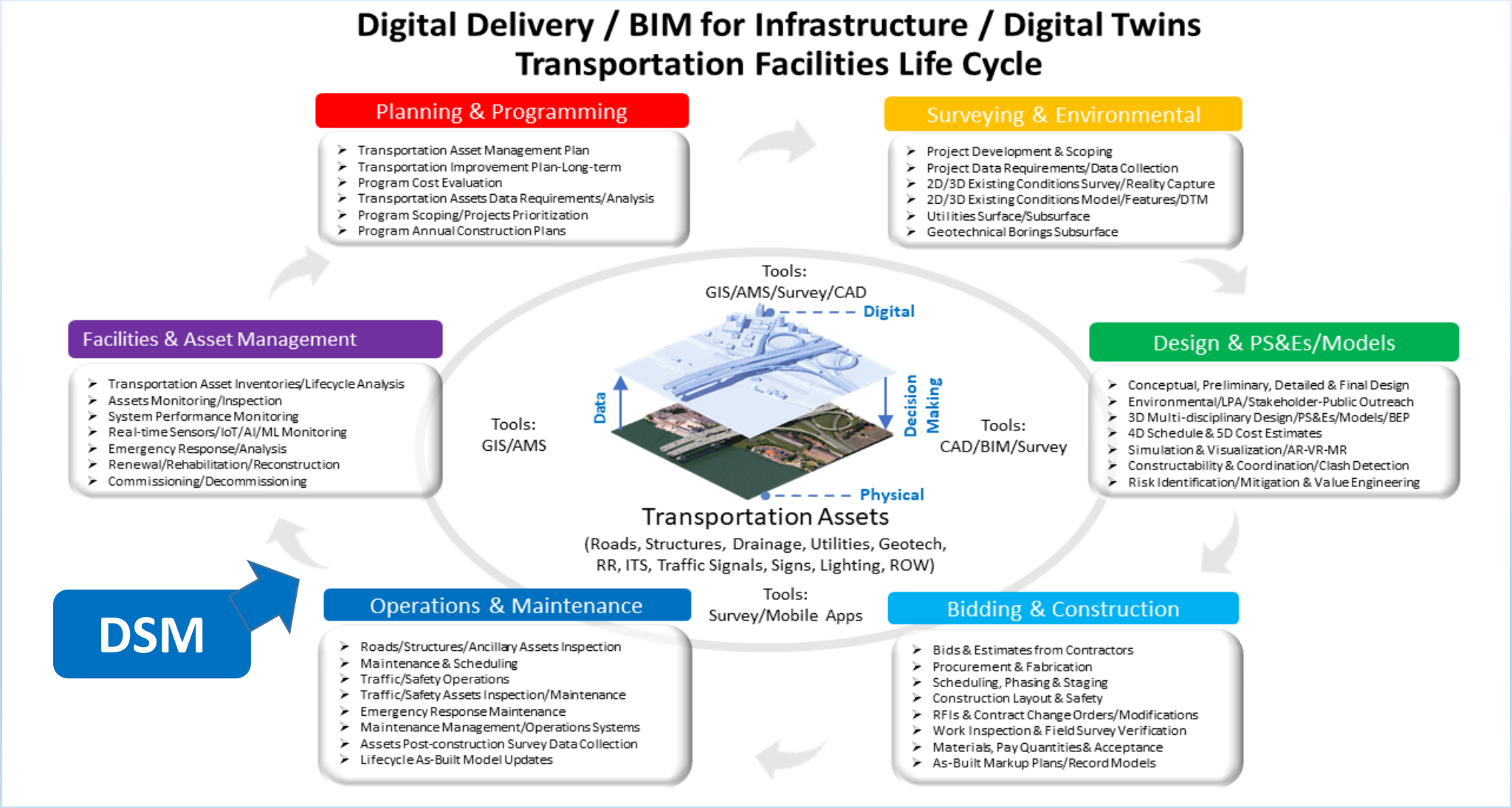
Collect data once & reuse often for many stakeholders/business areas

BIM4I National Strategic Roadmap and Key Components





All – DSM National Perspective Lifecycle Information Management



Source: Adapted from *Digital As-Builts – Getting Started*, WSP, Parve, 2022.

Technologies – AII / EDC

- E-Ticketing
- Digital As-Builts
- 3D Existing Conditions & Engineered Models
- E-Construction
- UAS
- Improved Project Delivery with GIS & Surveying
- Interactive Visualization
- Digital Stockpile Management

Geospatially Capture Digital Asset Data

❑ Construction Survey Methods:

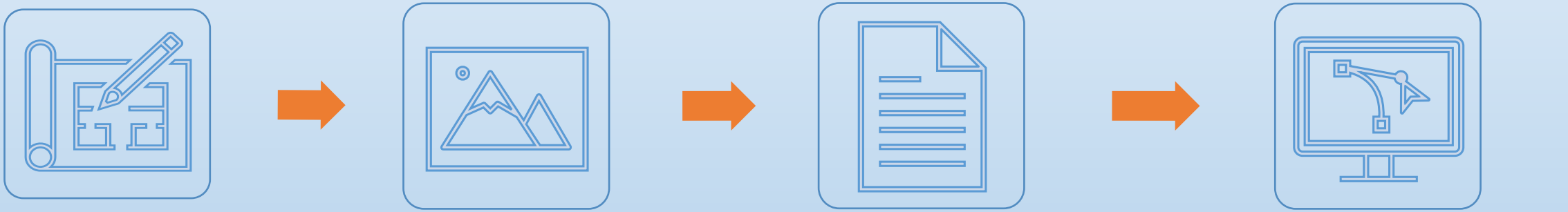
- RTS, RTK GNSS Rovers, Handheld Survey Devices, Smart Phone
- LiDAR – Mobile Van, Static Tripod, Aerial Fixed Wing, Aerial UAS
- Photogrammetry – Aerial Fixed Wing
- Subsurface utilities – GPR, SPAR, EM

❑ Post-Construction Survey Methods:

- LiDAR – Mobile Van, Aerial Fixed Wing, Aerial UAS
- RTS, RTK GNSS Rovers, Handheld Survey Devices, Smart Phone

Image Credits: WisDOT (upper left), MIDOT (lower left), Woolpert (upper middle), SAM (lower middle), Velodyne (upper right), & Ayres (lower right)

All – DSM DOT Agency Maturity – Types of Data



Paper

- Hard-copy (paper, mylar)
- Workflow: Isolated
- Dataflow: None

Paperless

- Image (jpg, png, tiff, pdf)
- Workflow: Imagery
- Dataflow: Shareable

Electronic

- Document (pdf/docx/pptx)
- Workflow: Electronic
- Dataflow: Collaborative

Digital

- Object (dgn/dwg/shp/ifc/xml/csv)
- Workflow: Digital/Intelligent
- Dataflow: Integrated/Interoperable

All – DSM Information Management ISO 19650

PIM

AIM

Image Credit: Adapted from ISO 19650 Standard No: 19650:1:2018

KEY

AIM Asset Information Model (AIM)
PIM Project Information Model (PIM)
A Start of delivery phase – transfer of relevant information from AIM to PIM
B Progressive development of the design model into the construction model – PIM
C End of delivery phase & Start of operational phase – transfer of relevant information from PIM to AIM
D Post-occupancy/implementation evaluation or performance review – AIM
E Trigger events during the operational phase – AIM
NOTE Information can be transferred between PIM & AIM during the delivery phase as well as at points A & B

All – DSM Information Requirements – AIM

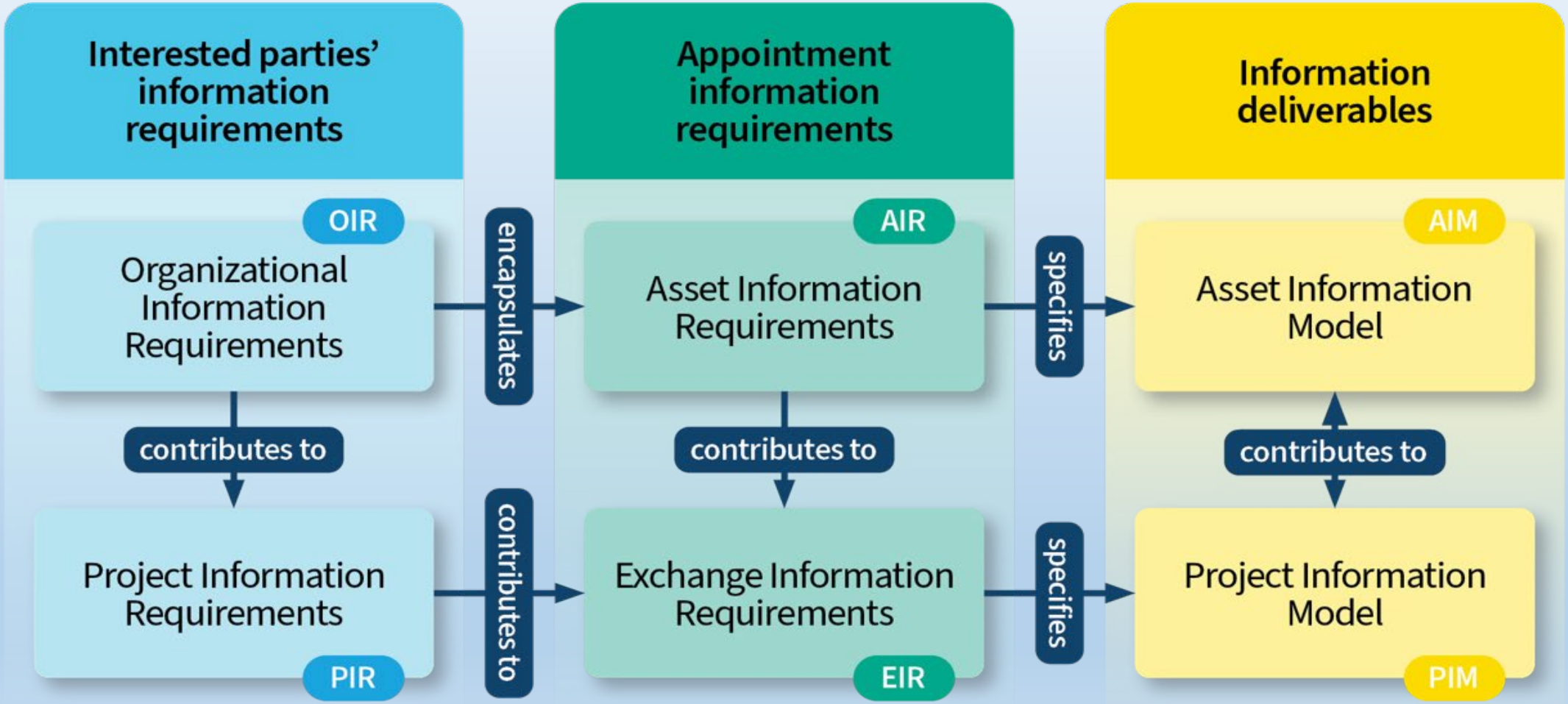
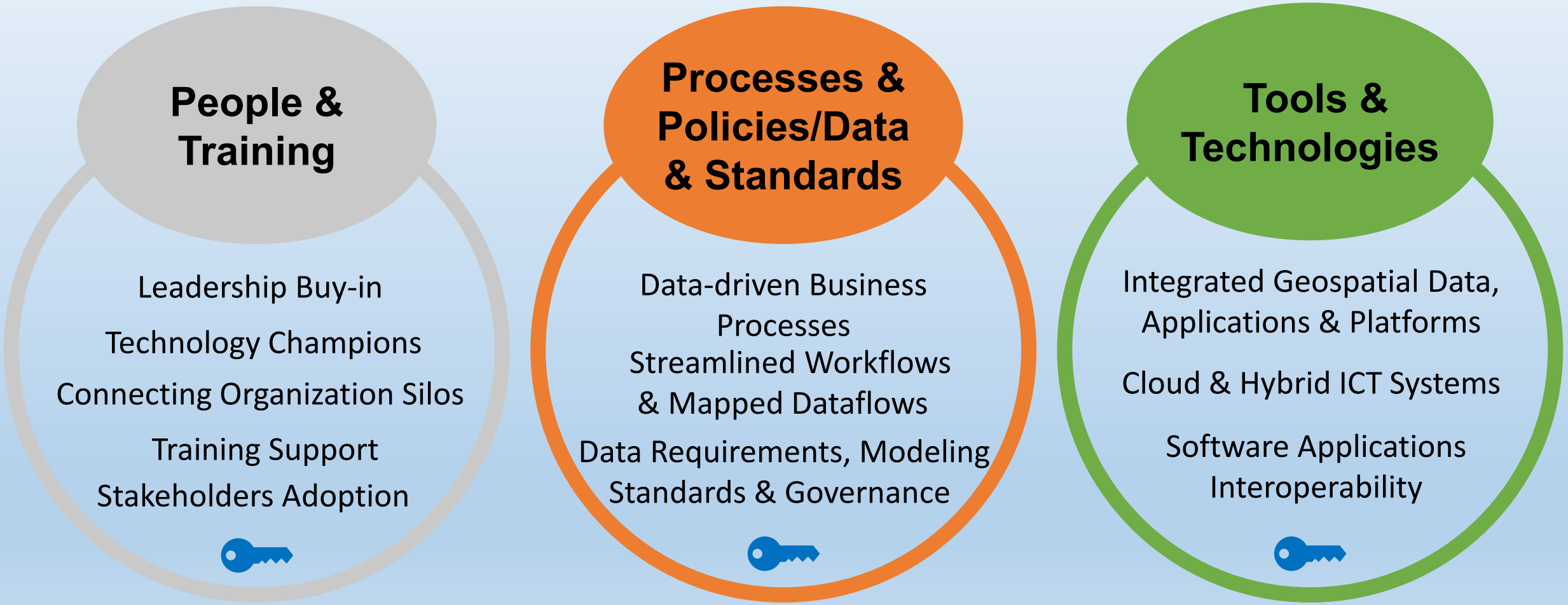


Image Credit: Adapted from ISO 19650 Standard No: 19650:1:2018.

All – DSM Keys to Success



Question and Answer Session

Thank you!

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