Drones - A New Tool for the Environmental Professional

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Texas Association of Environmental Professionals

August Luncheon

August 23, 2018

Agenda

- Drones and Sensors
- Software
- Drone Aerial Survey Workflow
- Photogrammetry and Elevation Modelling
- Jersey Village White Oak Bayou Project
- Select Sands Stockpile Volumetrics
- Summary of Actionable Data Products
- Q&A

Drones In Service

DJI Phantom 4 Professional

Weight – 3.1 lbs (including battery and props)
Diagonal Size – 14 inches
Operating Frequency – 5.8 GHz
Max Operating Distance – 4 miles
Max Speed – 45 mph
Max Flight Time – 30 min (20 min)
Battery – LiPo 4S, 5870 mAh, 15.2V
Camera – Fixed, 1” CMOS Sensor, 20 MP

DJI Inspire 2

Weight – 7.58 lbs (including batteries and props)
Diagonal Size – 23.8 inches
Operating Frequency – 5.8 GHz
Max Operating Distance – 3.1 miles
Max Speed – 58 mph
Max Flight Time – 27 min
Battery – LiPo 6S, 4280 mAh, 22.8V
Camera – Zenmuse X4S, X5S & Sentera Double-4K

DJI Matrice 210

Weight – 11 lbs (including battery and props)
Dimensions – 34.9×34.6×16.1 inch
Operating Frequency – 2.4 GHz, 5.8 GHz
Max Operating Distance – 2-3 miles
Max Speed – 51 mph
Max Flight Time – 24 min (20 min)
Battery – LiPo 6S, 7660 mAh, 22.8V
Camera – DJI Zenmuse X4S ,X5S, Z30 and XTR
Operating Temperature - -4° to 113° F
IP Rating – IP43

Cameras/Sensors In Service

Zenmuse X4S

Zenmuse X5S

Zenmuse Z30

Zenmuse XTR

Sentera Double 4K RGB/NDVI

Drone Equipment - DJI Wind 4 (Future?)

Weight – 24 lbs (including battery and props)
Dimensions – 42 inch diagonal length, 34 inches x 34 inches x 21 inches
Operating Frequency – 2.4 GHz, 5.8 GHz
Max Operating Distance – 2-3 miles
Max Speed – 40 mph
Max Payload – 22 lbs
Max Flight Time – 25 min with 9 lbs payload (with 2 DZ-12000mAh Batteries)
Battery – DZ-12000mAh
Camera – ZENMUSE X3/Z3/XT/X5/X5R/Z30
Operating Temperature 14° F to 122° F
IP Rating – IP56 Water and Dust Resistant

Other Types of Drones

Hybrid VTOL Fixed-Wing Drone

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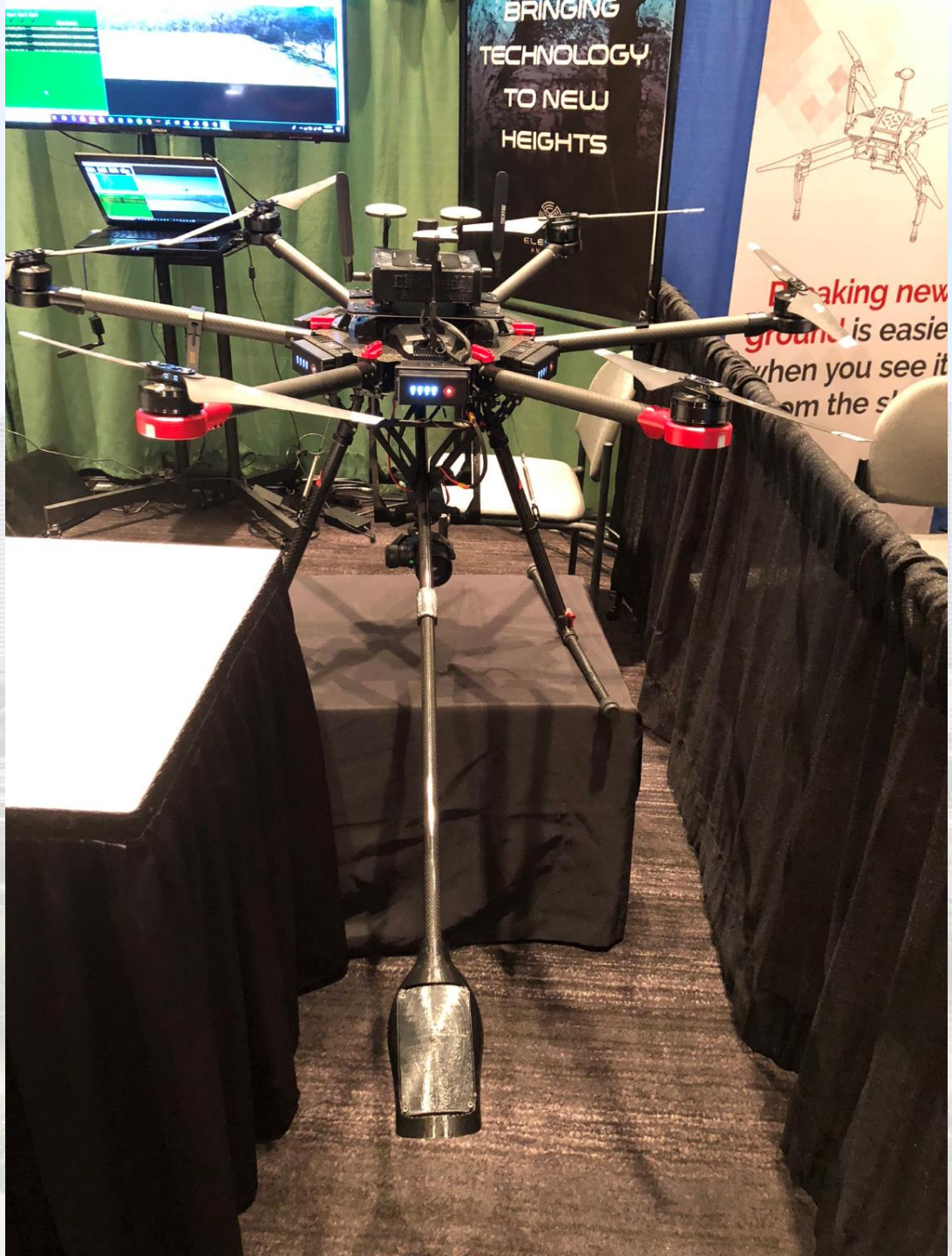
Increase Sales, Reduce Costs, Save Time, Improve Safety



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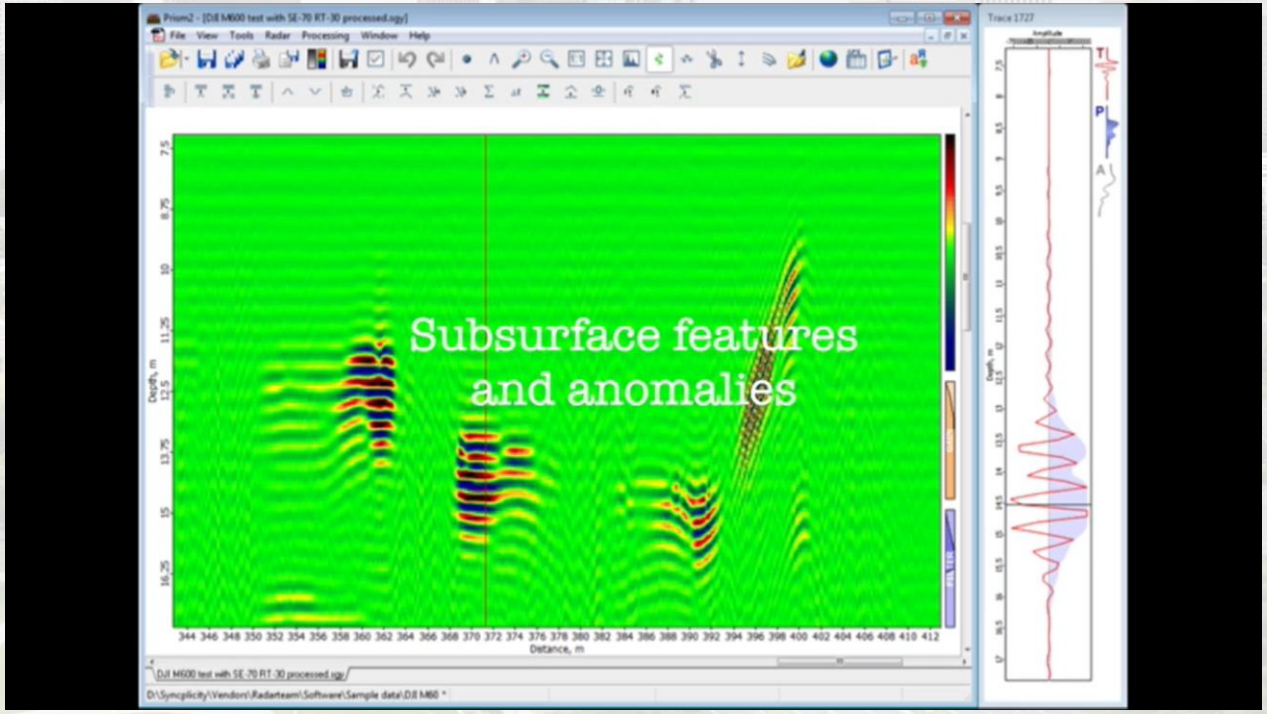
Airborne (UAV) Ground Penetrating Radar (GPR)



Airborne (UAV) Magnetometers and Gradiometers

Software

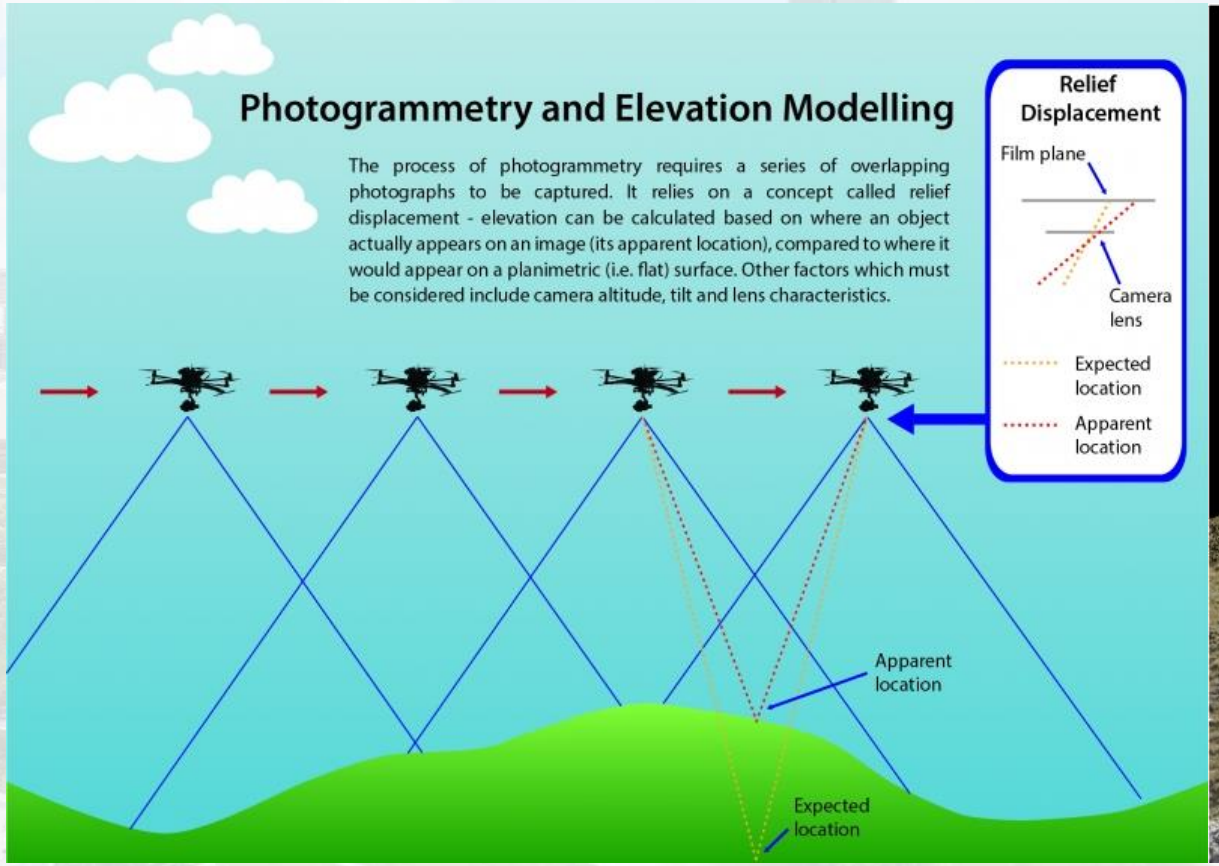
- Google Earth Pro (Aerial Survey Planning)
- DroneDeploy (Mission Planning and Flight Automation)
- DJI GS Pro (Mission Planning and Flight Automation)
- DJI GO 4 (Drone Settings, Compass Calibration and Photography)
- DJI Pilot (Inspection)
- SimActive Correlator3D (Processing)*
- EOSToolsPro/ICMTGIS PRO (GCP Positioning)
- Blue Marble's Global Mapper GIS (General Mapping)
- Virtual Surveyor (Visualization, 3D Measurements including Volumes)
- FLIR TOOLS (Thermal Imagery)

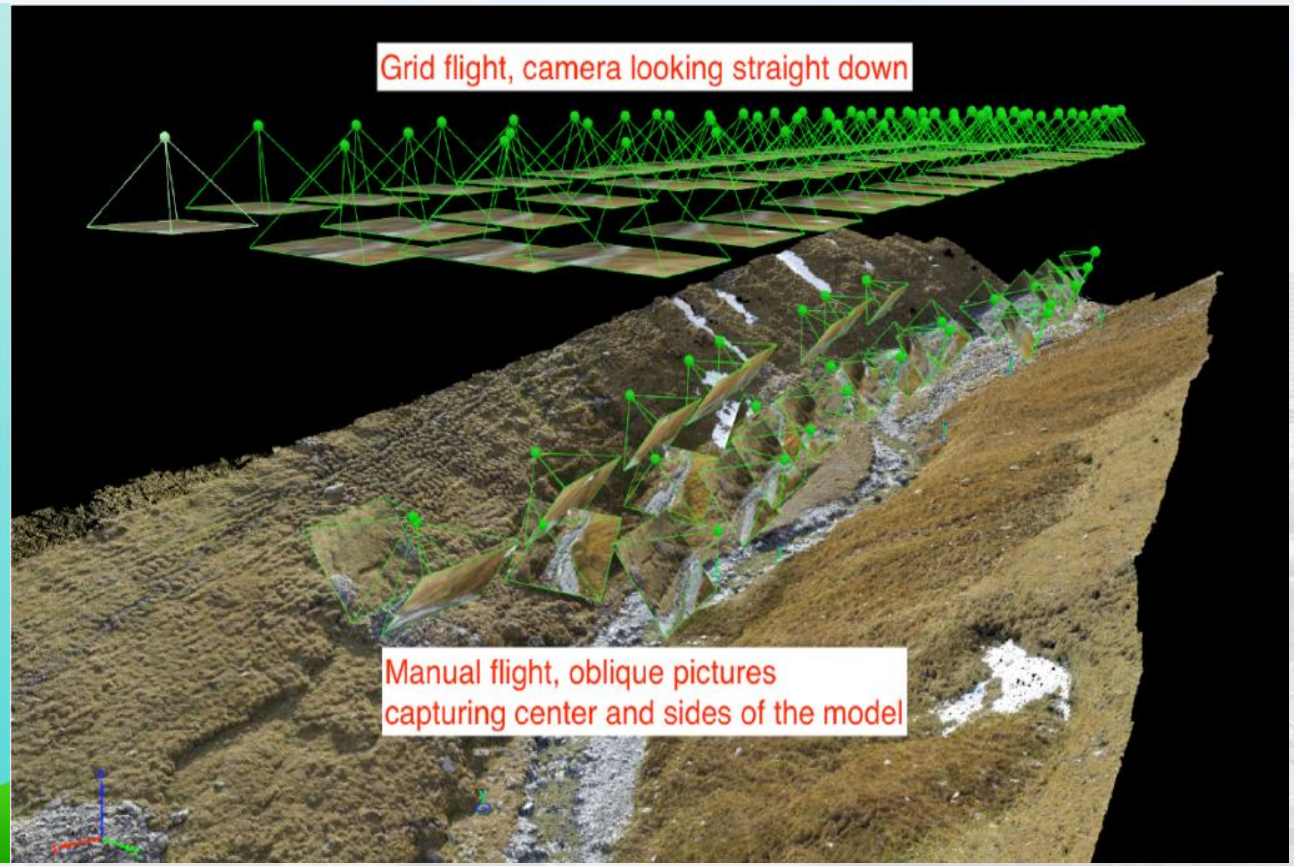
*Pix4D, Agisoft PhotoScan, Maps Made Easy, Datumate Suite

Drone Aerial Survey Workflow

- Pre-Flight Meeting
- Flight Planning
- Laying Out and Positioning GCPs
- Drone Aerial Survey Data Acquisition
- Process Images (Locally or Cloud Computing)
- Generation of Orthomosaic and Digital Surface Elevation Model
- Profile and Cross Section Generation
- Large Format Hardcopies

Photogrammetry and Elevation Modelling





Understanding Elevation Data

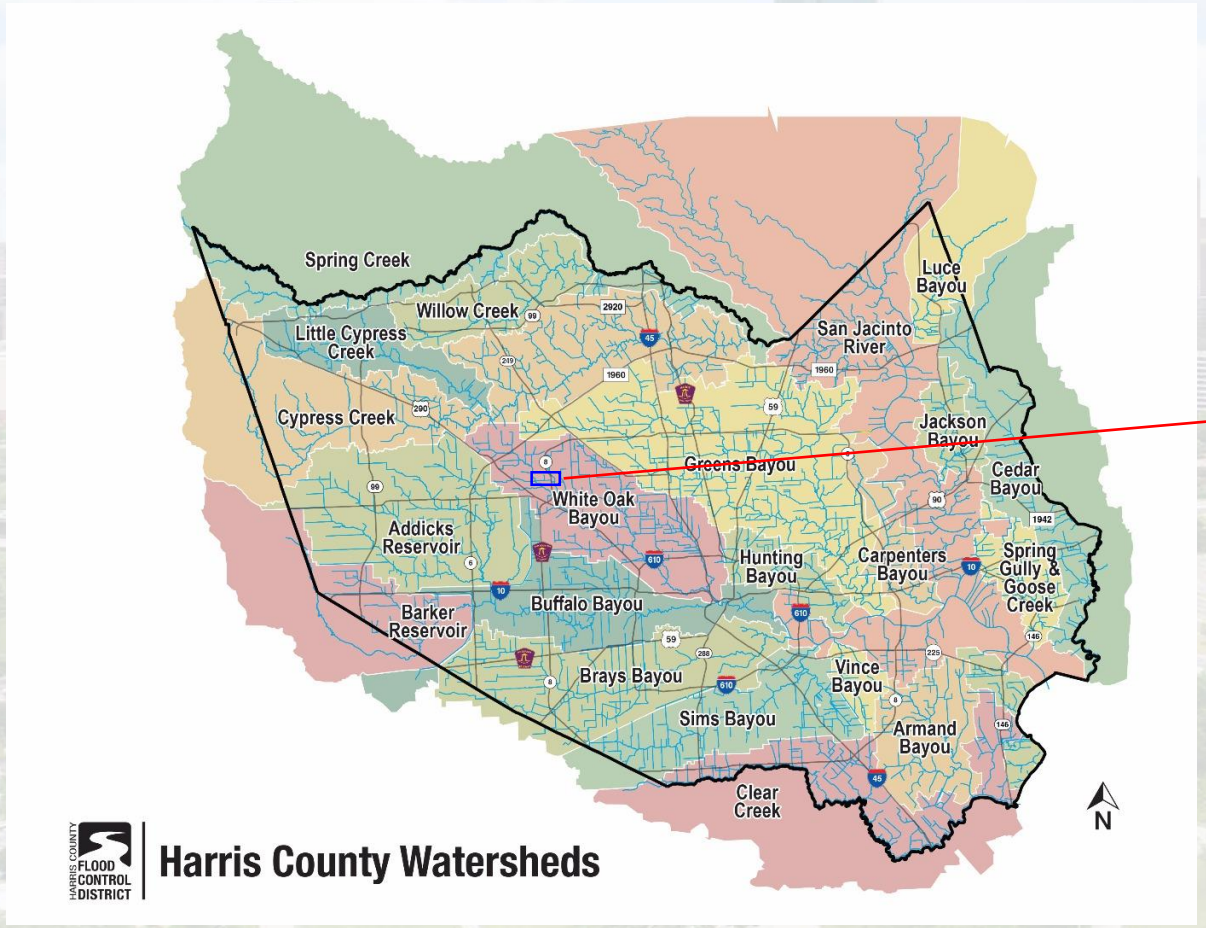
- Elevation maps are created using standard geo-referenced information embedded in your drone imagery.
- By applying some advanced math, you can figure out the elevations by looking at differences in perspective between two or more overlapping images.
- By default, maps show elevation data relative to your drone's take-off location.
- If you want to view elevation data expressed in height above average mean sea level (MSL) or relative to your project coordinate system, you can either add Ground Control Points (GCPs) to your map or you can use the elevation calibration tool to easily adjust the elevations in your map in just a few clicks.

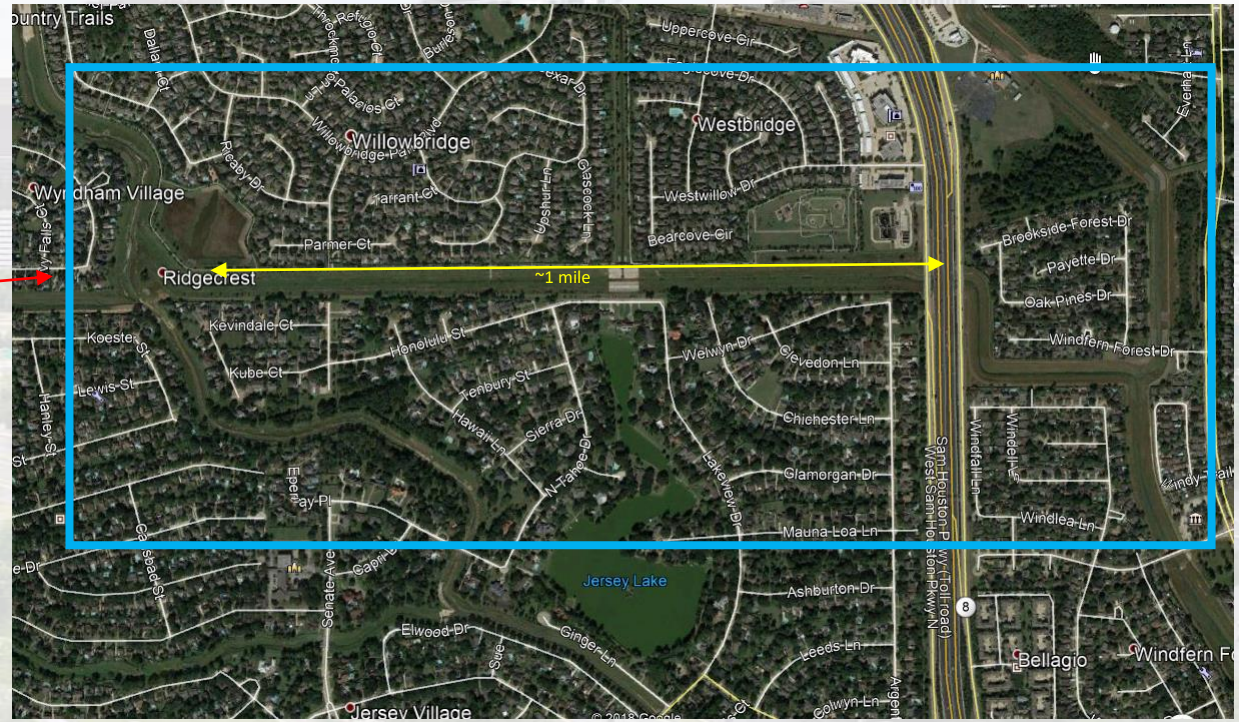
Jersey Village White Oak Bayou Project

White Oak Bayou Background/History

- Jersey Village has experienced flooding issues since 1998, when 300 homes were flooded.
- Then again in 2001 (TS Allison), 2002 and most recently during the Tax Day Flood in 2016.
- Citizens' Committees have been formed several times to bring awareness to the problem and suggest real solutions.
- Citizens observed the ByPass, particularly after the Tax Day Flood, was not performing as efficiently as they felt it should and that silting may have changed the grade of the channel from its original slope.
- Raptor Aerial Services was contacted to perform a drone aerial survey to determine if this or other issues were the causes.

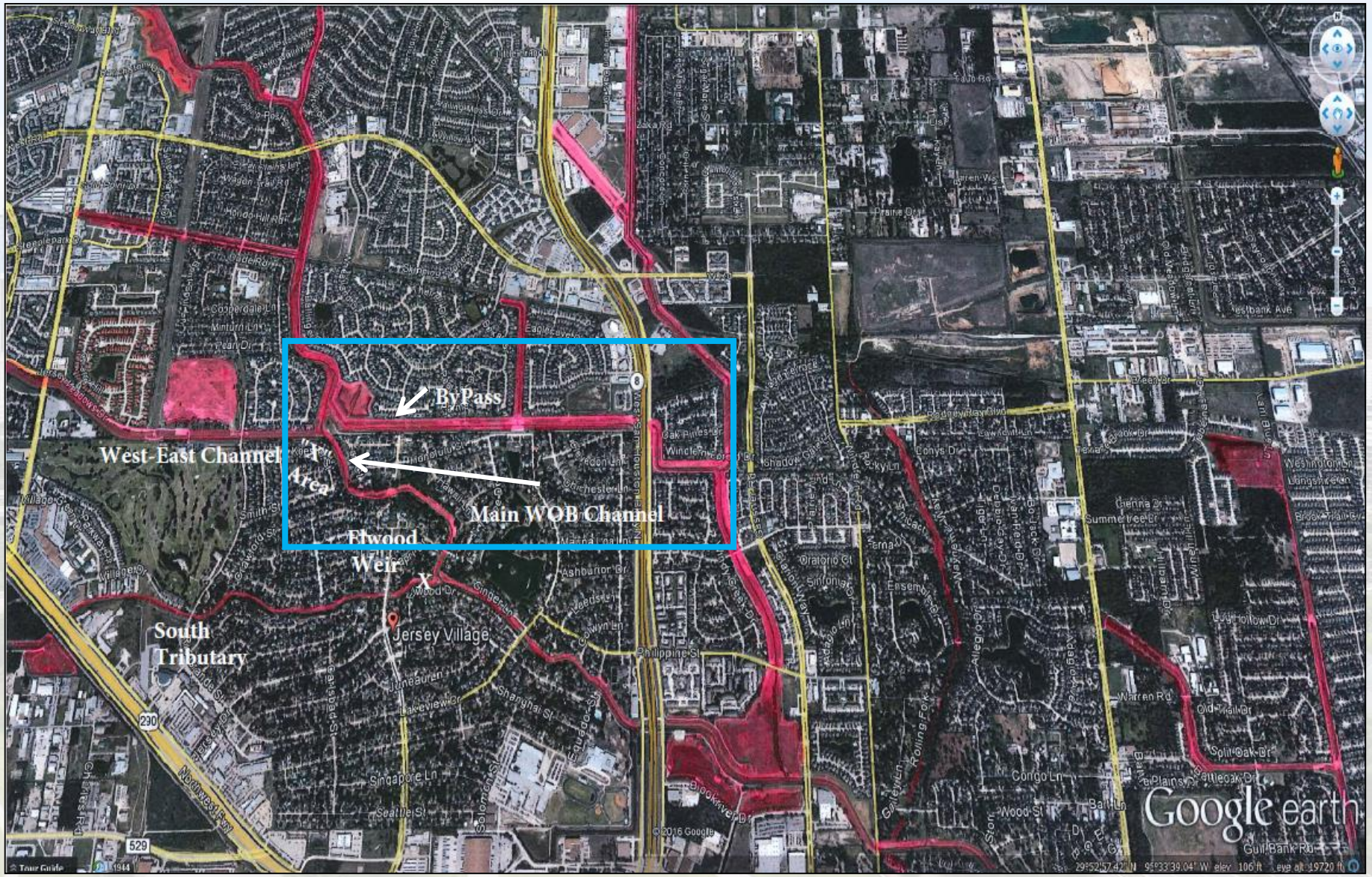
White Oak Bayou Project Area (273 Acres)





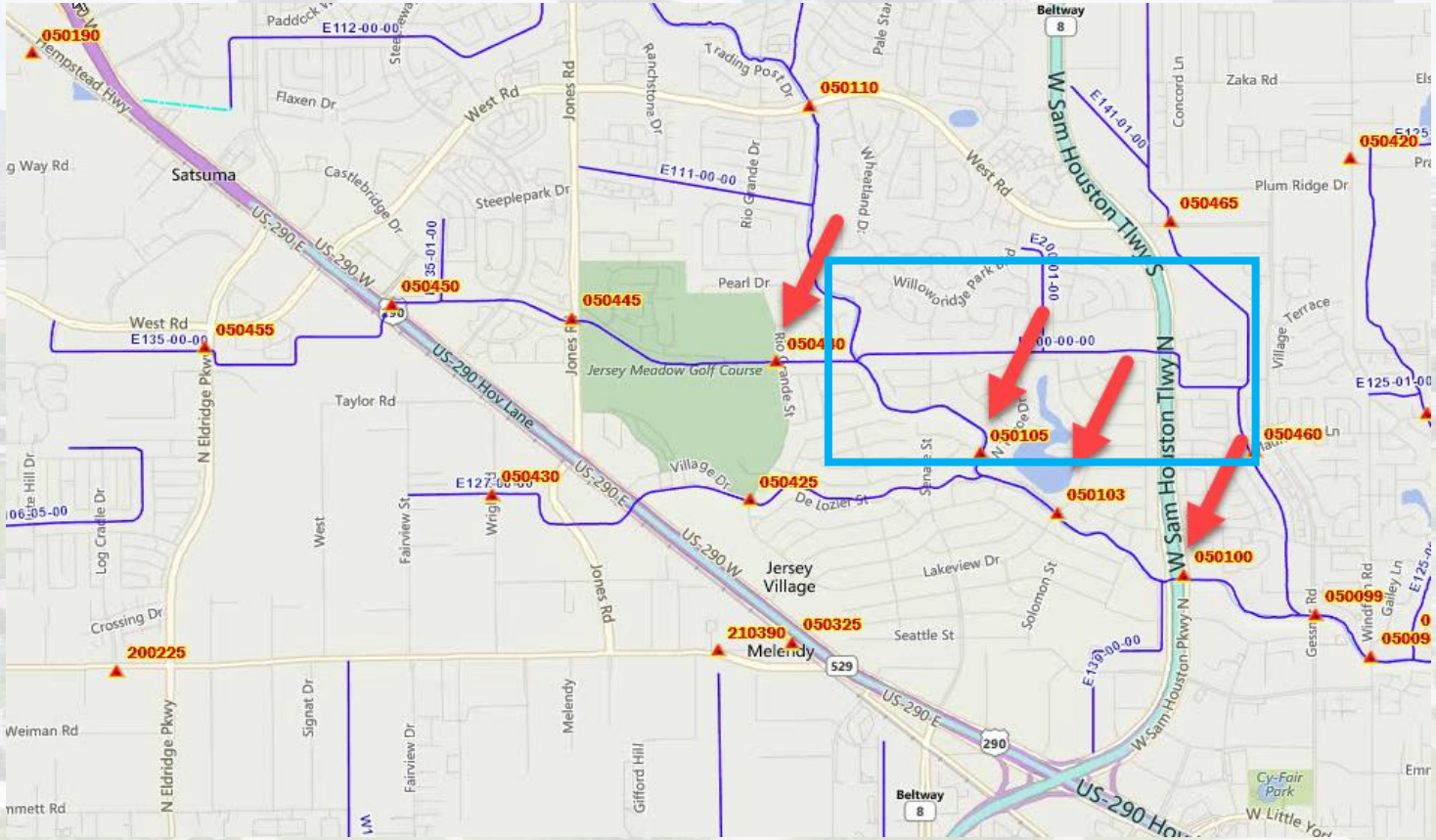
White Oak Bayou Channel Nomenclature

Channels Above & Below JV Are Large; But Narrower Thru JV



White Oak Bayou Project Area (273 Acres)

Harris County Floodplain Reference Marks



HARRIS COUNTY FLOODPLAIN REFERENCE MARKS

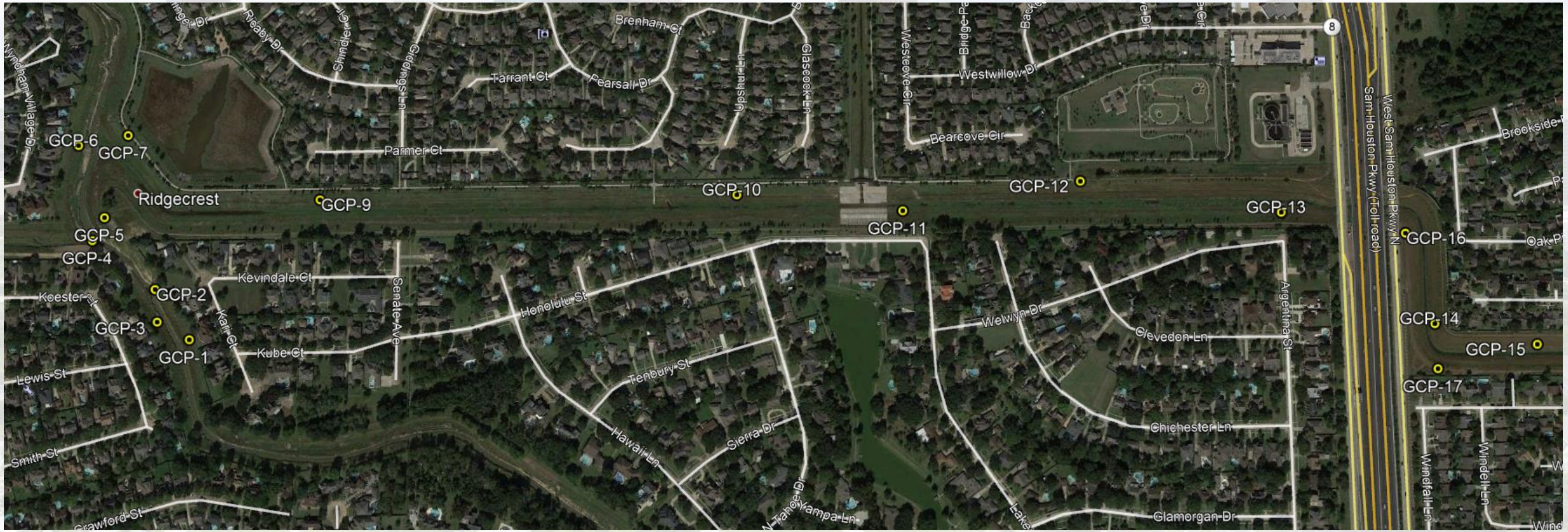
Floodplain RM No.:	050440	**Reference Mark Status**	
Stream Number:	E135-00-00	**Date:**	6/4/2013
		Condition:	Recovered
County: Harris	**State:** Texas	**Established By:**	Landtech Consultants, Inc.
Key Map No.:	409L	**Date Established:**	5/1/2003
NGS Classification[1]:	Range VI	**Watershed:**	White Oak Bayou
RM's Directly Tied:	050425,050105,050445	**Survey Method Horz:**	GPSOBS
Units of Measure:	US Survey Foot	**Survey Method Vert:**	GPSOBS
Horizontal Datum:	NAD83	**Vertical Datum:**	NAVD88
Horizontal Adj.[2]:	2001 Adjustment	**Vertical Adj.[3]:**	2001 Adjustment
Projection Zone:	Texas South Central 4204	**Geoid Model Used:**	GEOID99 (CONUS)
Station Name:	050440	**Contractor PID:**	83
Marker:	BRASS DISC	**Rod Depth:**	NA
Stamping:	E135-01 BM01	**Sleeve Depth:**	NA
Mark Logo:	HCFCD	**Geoid Height:**	-89.74
Latitude:	29° 53' 44.09550" N	**Northing:**	13889097.15
Longitude:	95° 34' 21.12695" W	**Easting:**	3054364.40
Ellipsoid Height:	18.91	**Elevation[4]:**	108.91
Convergence:	1° 40' 45"	**Scale Factor:**	0.99991097
Satellite Observable:	YES	**Elevation Factor:**	0.99999909
NGS PID (if applic):	NA	**Combined Factor:**	0.99991007

Notes:

1. This is NGS' new classification system. Range VI indicates that this position meets the 0.02m-0.05m Accuracy Standard for Horizontal Position, Ellipsoidal Height, and Orthometric Height (elevation) at the 95% confidence level (m=meters).
2. Horizontal Adjustment - This survey is constrained to the NGS Published Horizontal positions of the geodetic stations adjusted by NGS in 2001.
3. Vertical Adjustment - This survey is constrained to the NGS Published Elevation for Northeast 2250 CORS ARP adjusted by NGS in 2001 and as published in PID AJ6430. Epoch Date 1997.00.
4. The elevation shown equals the Ellipsoid Height minus Geoid Height (from GEOID99) plus a constant of 0.253 feet.
5. The elevation is established by differential leveling techniques, utilizing the published elevations from nearby Reference Marks.

Station Recovery Data: Report an Issue with a Reference Mark - submit to Harris County Flood Control

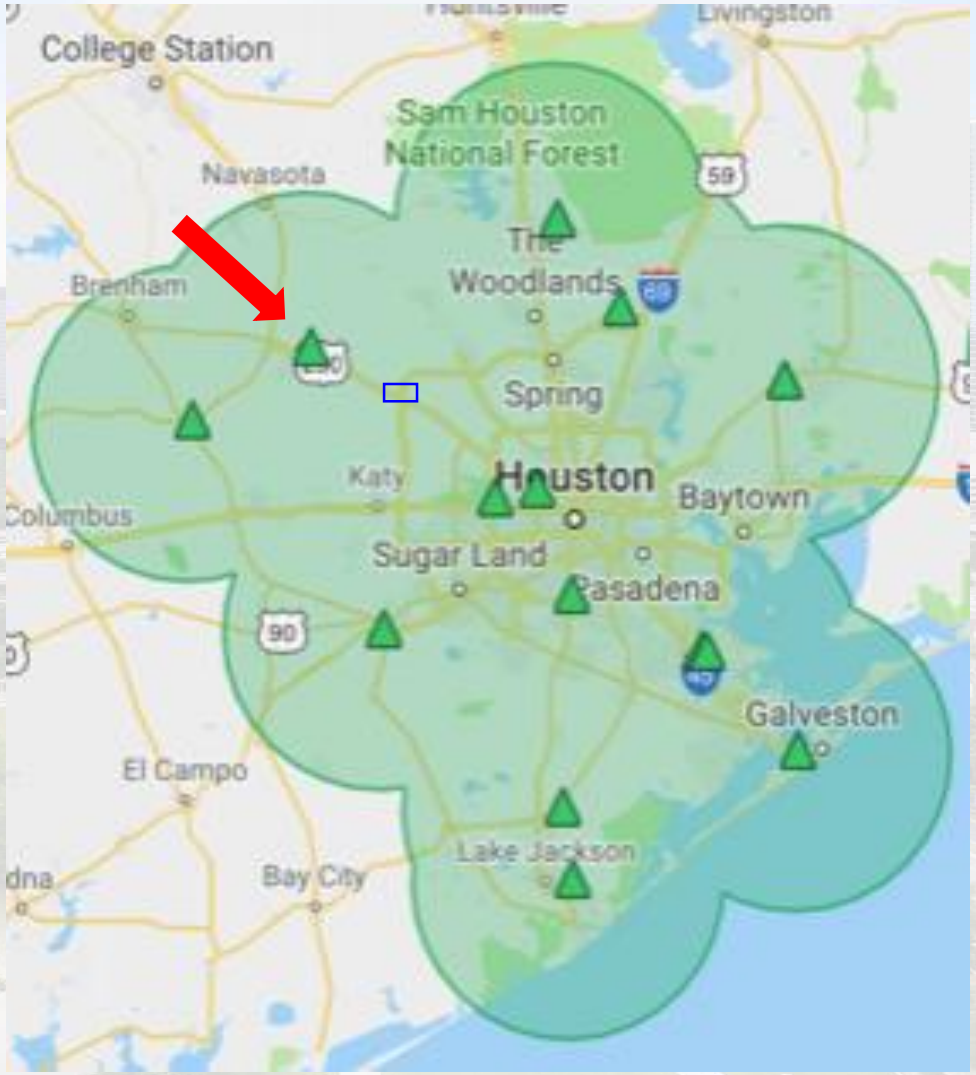
White Oak Bayou GCP Layout



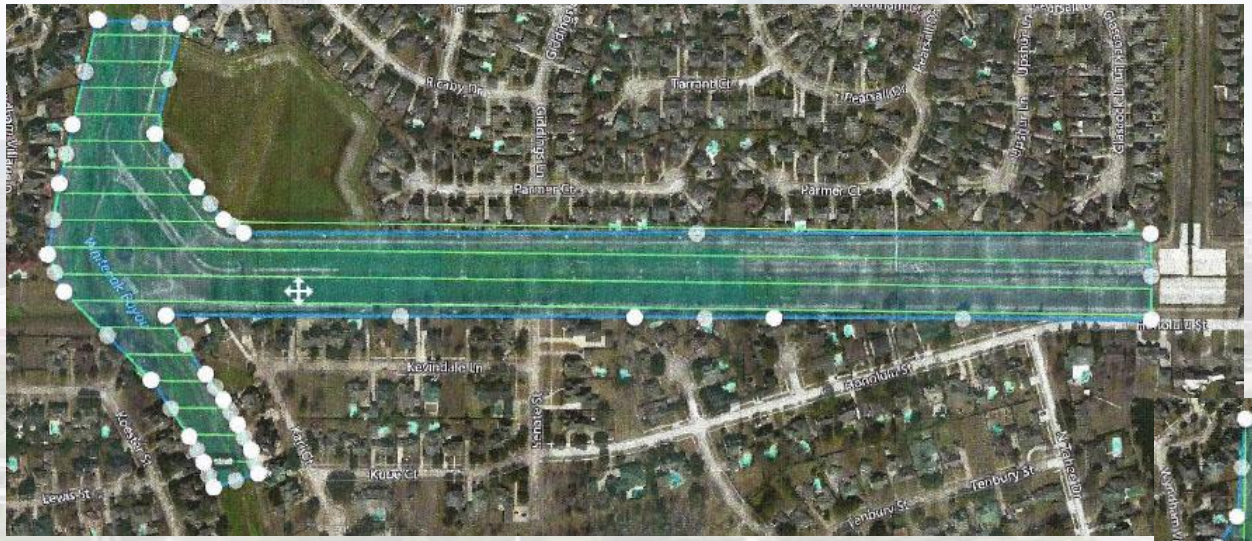
White Oak Bayou Drone Aerial Survey Specs

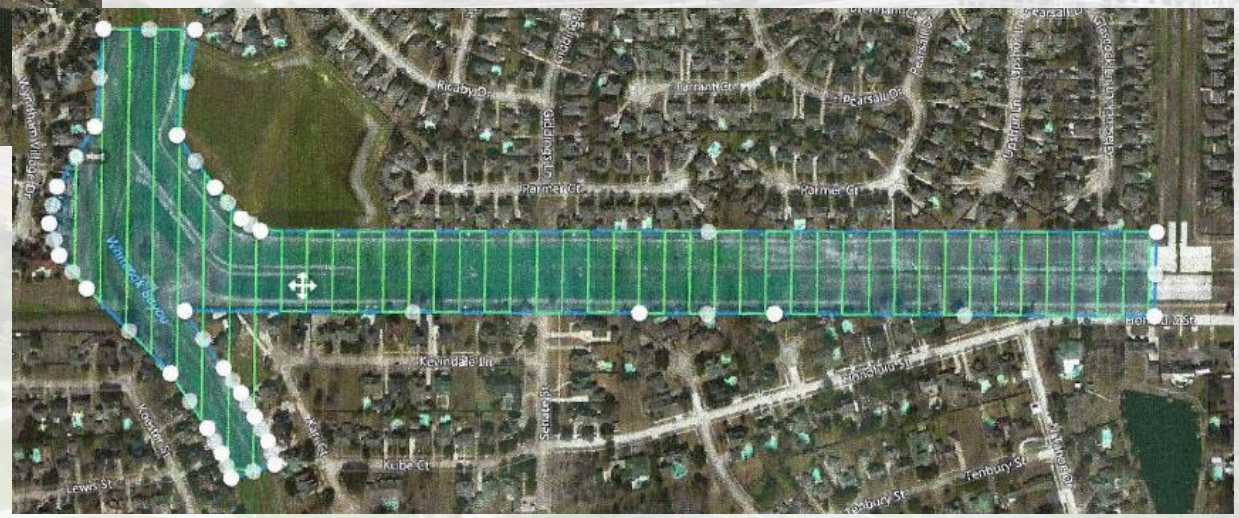
- 273 Acres Total Area
- 18 (17) Ground Control Points Surveyed using RTK
- 250’ Above Ground Level (AGL)
- 80% Sidelap
- 80% Frontlap
- Phantom 4 Pro Built in 20 MP Camera
- 0.9 Inches/Pixel Ground Sample Distance (GSD) or Resolution
- 3 Sections, 2 Passes Each, Perpendicular Grid Pattern

TopNET live Americas RTK Network (GeoNet)



White Oak Bayou Drone Aerial Survey Specs



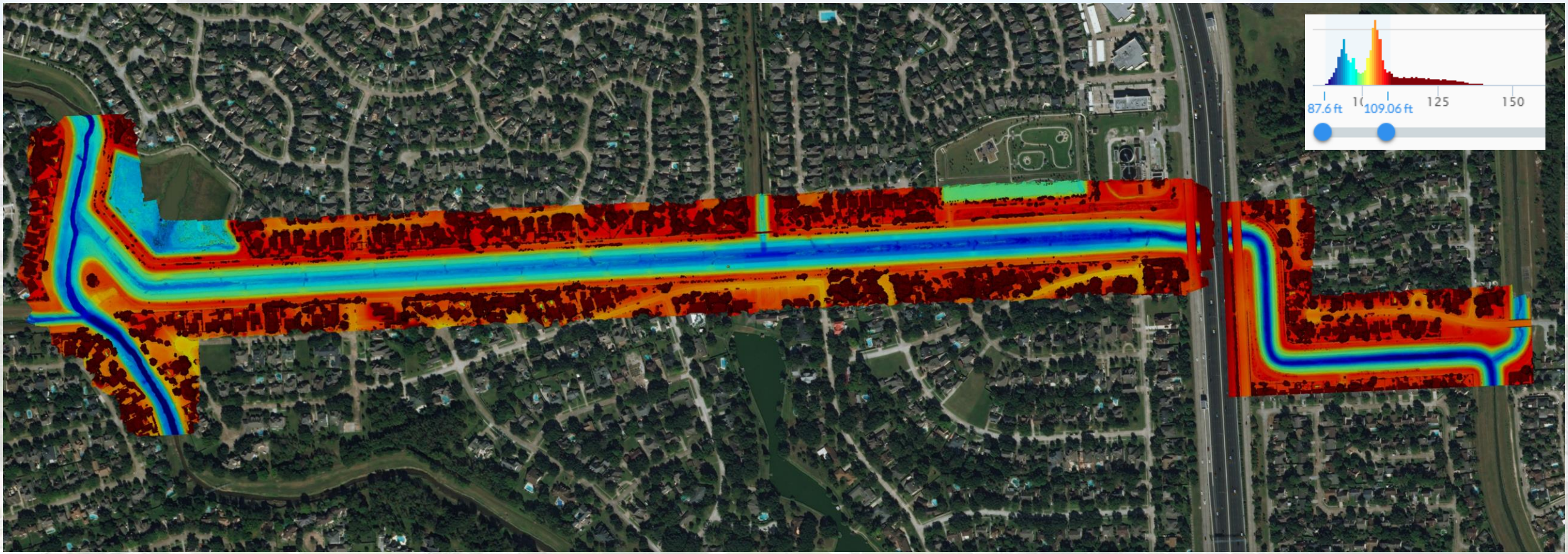


White Oak Bayou Project Area (273 Acres)

Orthomosaic

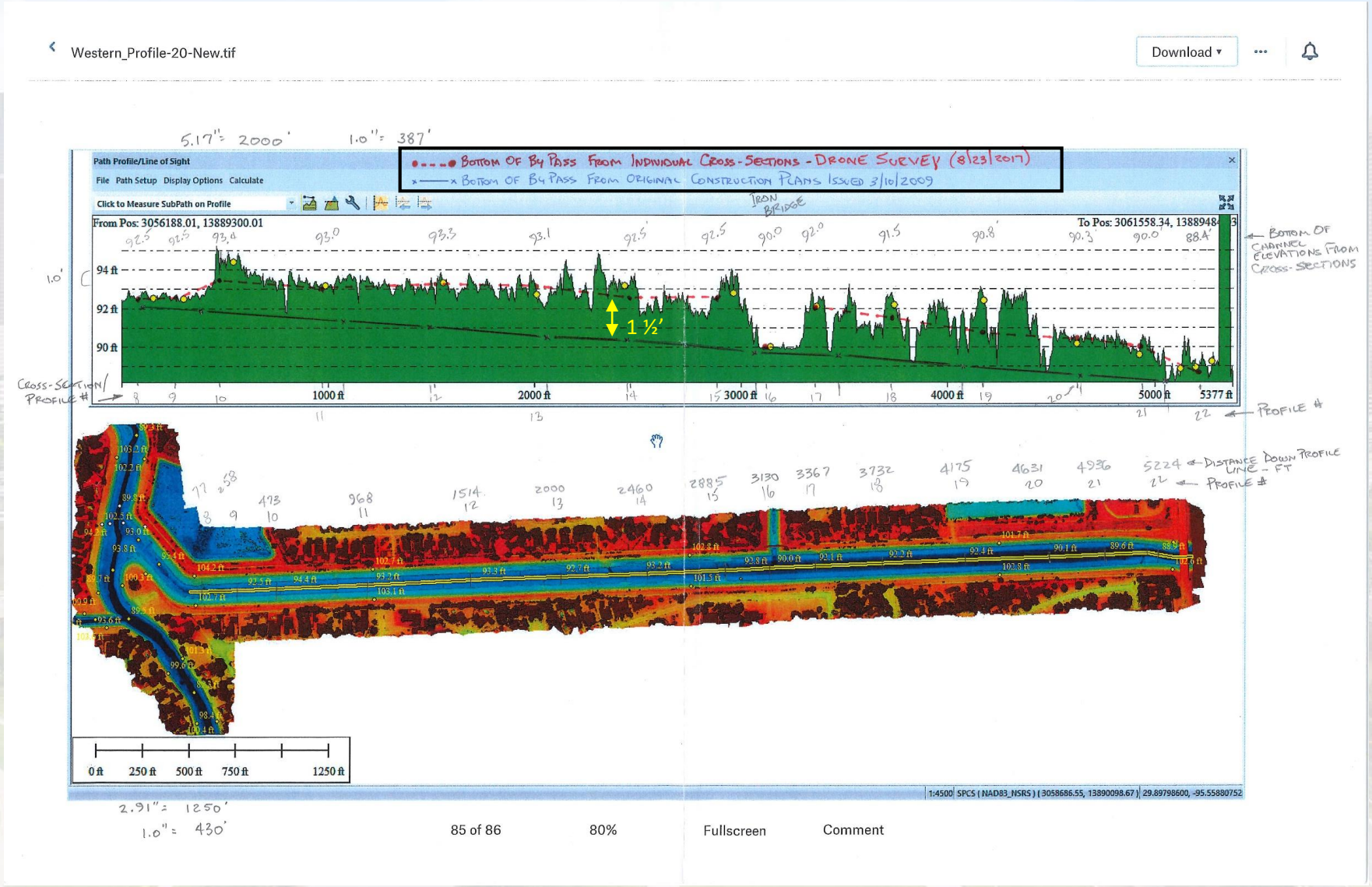
Jersey Village White Oak Bayou

White Oak Bayou Project Area (273 Acres)

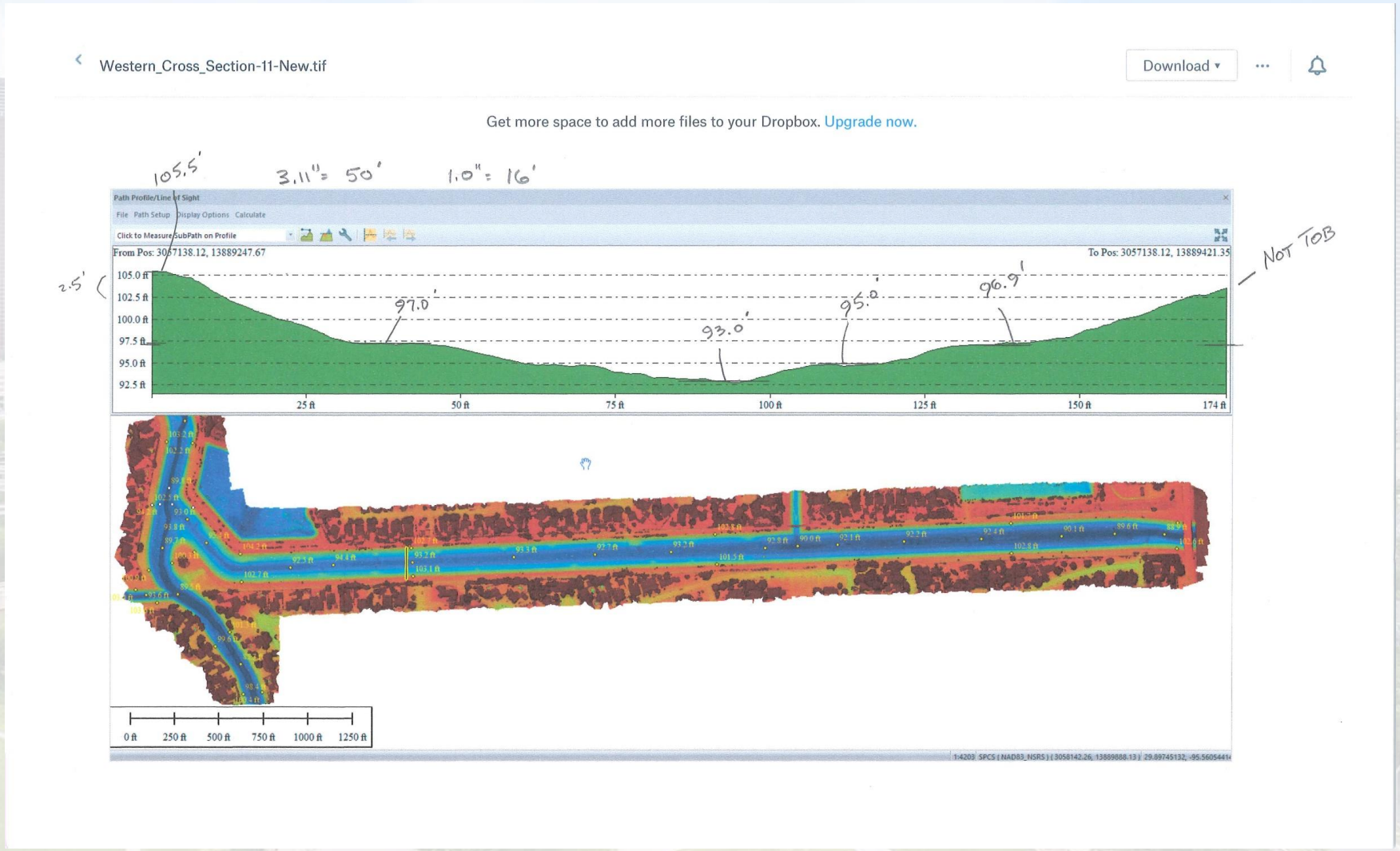


Digital Surface Elevation Model

White Oak Bayou Profile Work Product



White Oak Bayou Cross Section Work Product



Results

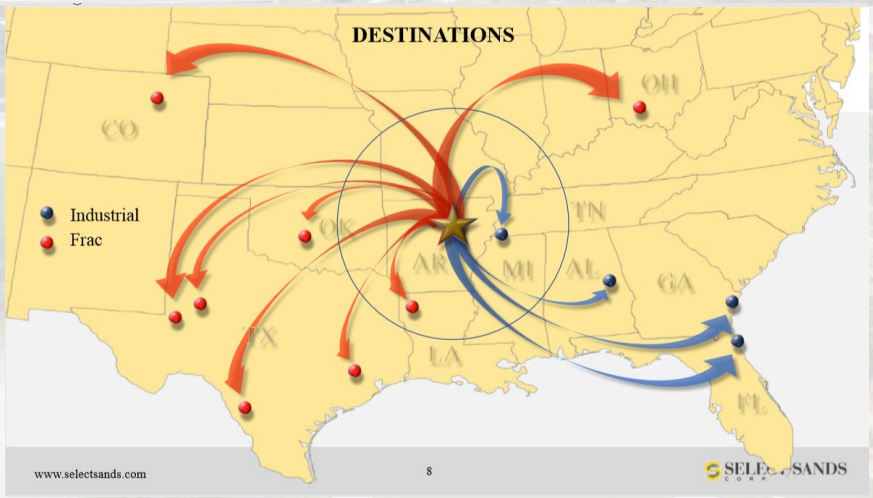
- The drone aerial survey accomplished its mission.
- The results of the survey indicated that the current bottom of the channel is flatter than originally constructed.
- It is 1-1/2 to 2 ft higher than on the original plans. This is most likely due to sedimentation (silting) and makes the ByPass work less efficiently than originally designed.
- The survey generated a lot attention which resulted in the ByPass Channel being de-silted by HCFCD.
- Drones are another important tool to help document and analyze flood potential, damage and solutions.

White Oak Bayou Maintenance

HCFCD did perform what they described as a “minor desilting maintenance” project of the ByPass

Select Sands History/Background

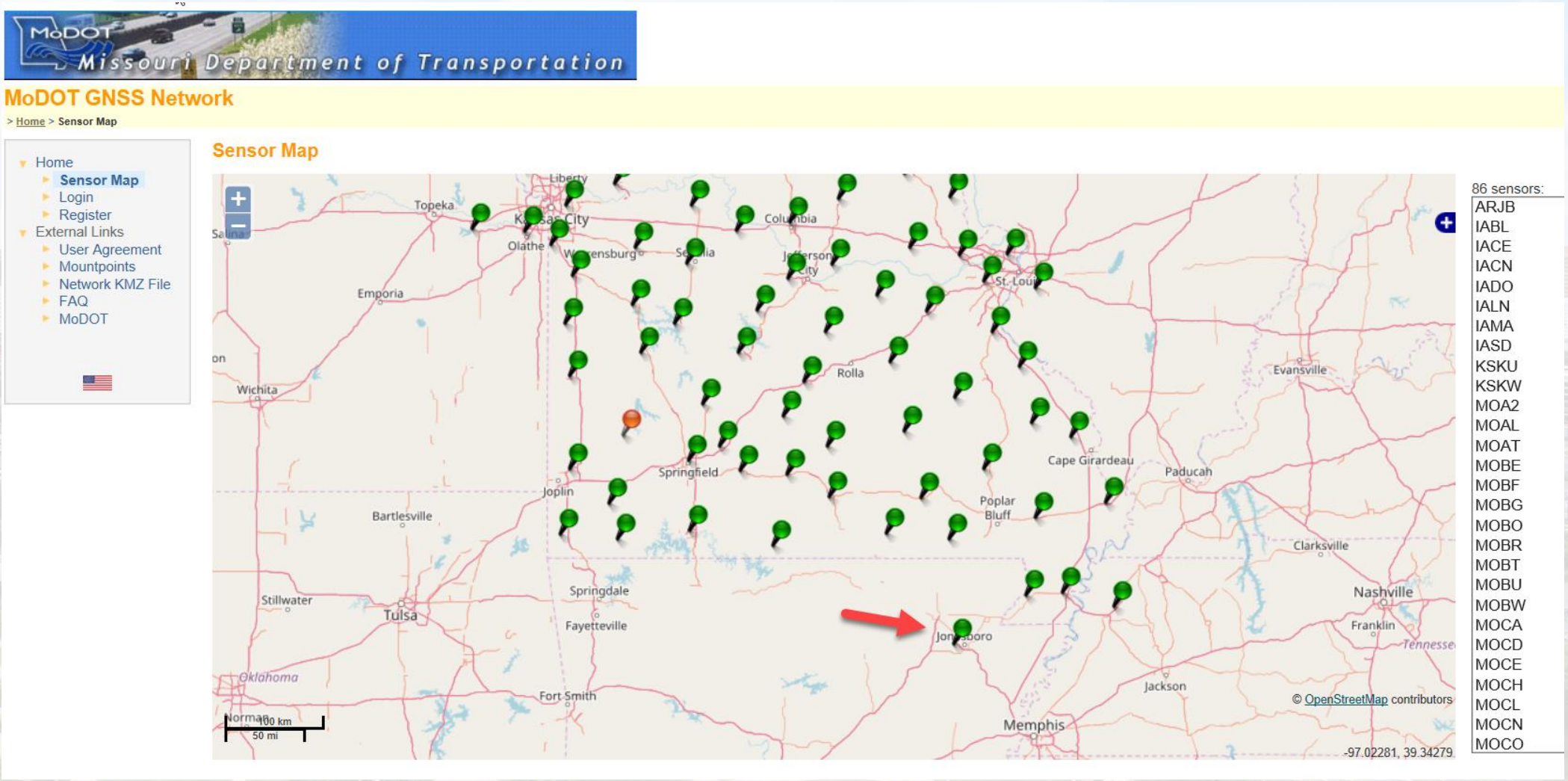
- Original Company – Ozark Premium Sand located in Newark, Arkansas
- Select Sands Corporation Acquires Ozark Premium Sand in December, 2016
- Mine White Silica Sand (99% SiO2) from the St. Peter Sandstone Formation
- Target markets are Oil & Gas and Industrial & Specialty Products
- Semi-regional Producer Utilizing Truck, Rail and Barge Logistics
- Serving the SCOOP/STACK/Woodford, Haynesville, Permian, DJ and Eagle Ford
- Expect to Produce ~600,000 Tons per Year From Current Operations with an Additional ~400,000 Tons of Production Capacity from Adjacent Property.



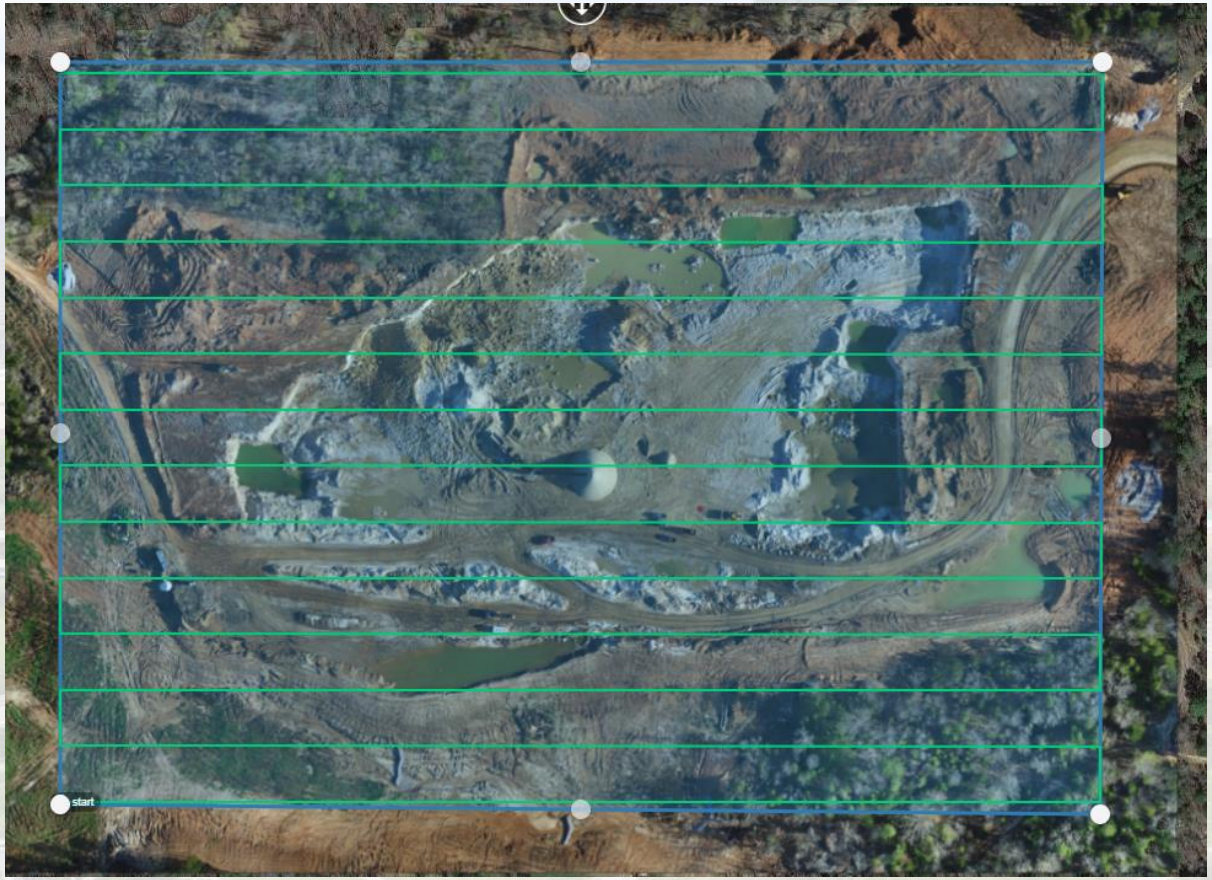
Select Sands Aerial Survey Specs

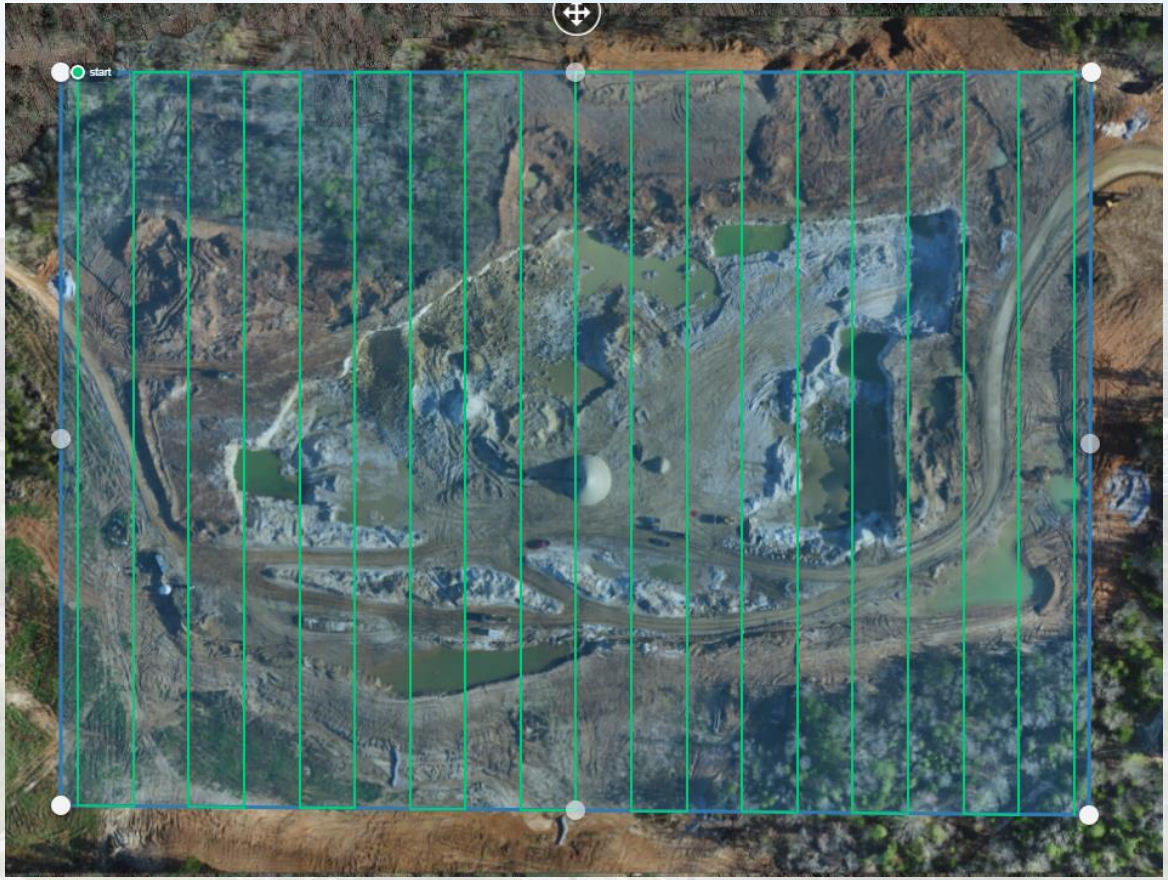
- 3 Sites Ranging from 30-125 Acres
- 6-7 Ground Control Points (GCPs)
- 250’ Above Ground Level (AGL)
- 80% Sidelap/Frontlap
- DJI Inspire 2 with X4S Camera
- 0.8 Inches/Pixel Ground Sample Distance (GSD) or Resolution
- 2 Passes Each, Perpendicular Grid Pattern

MDOT GNSS Network



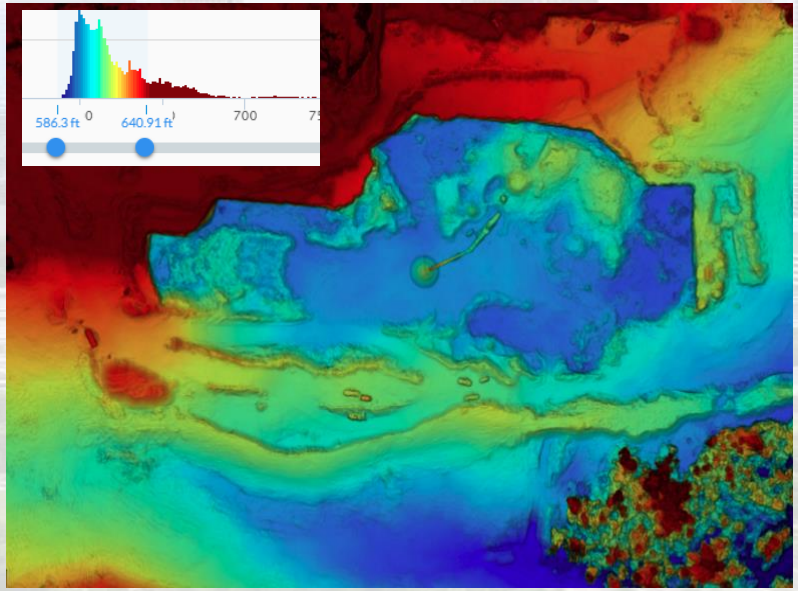
2 Passes, Perpendicular Grid Pattern



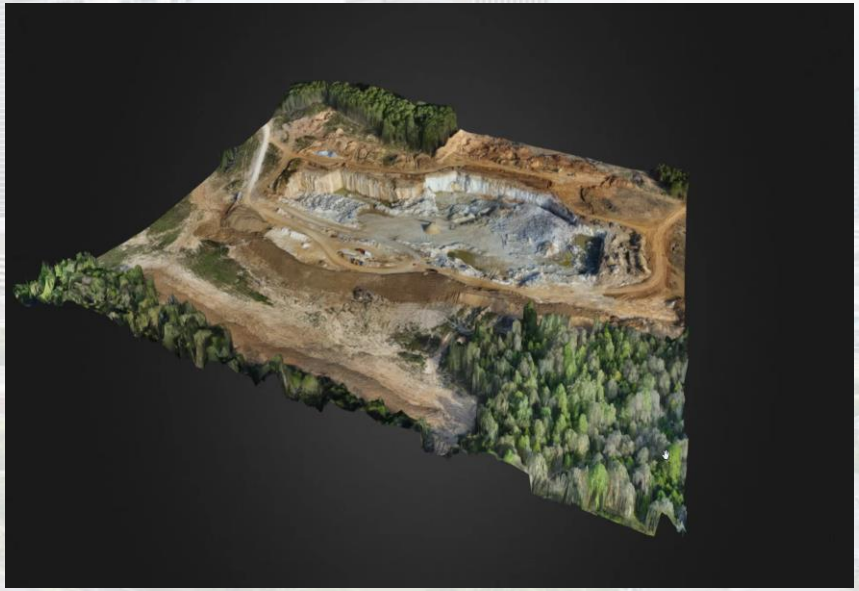


Sandtown Quarry (30 Acres)

Orthomosaic Photo



Digital Surface Elevation Model

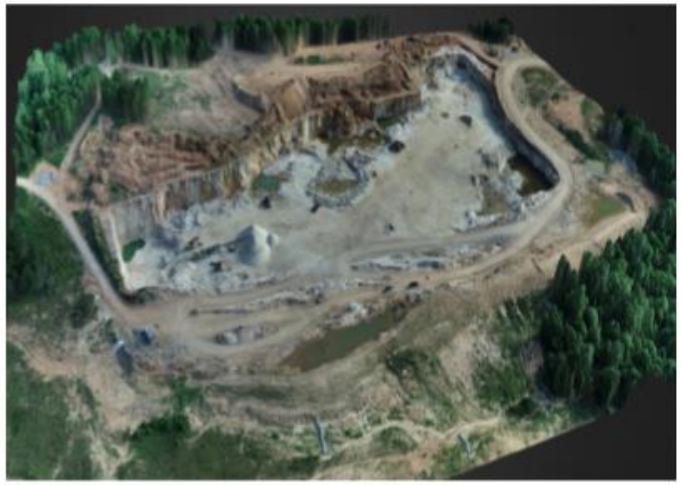


3D Model

Select Sands Mining Sites (30-125 Acres)

Orthophotomosaic – Sandtown Quarry

Orthophotomosaic – Possum Grape Dry Plant



3D Model – Sandtown Quarry

Orthophotomosaic – Freeze Bend Mine

Quarterly Volumetics Report

Site	Stockpile	Area (sq. ft.)	Volume (cu. Ft.)	Volume (cu. yd.)	Tons	Reference	Totals
Freeze Bend Mine	100 Mesh	15,682.00	45,372.00	1,680.44	2,150.97	3D Polygon	
Freeze Bend Mine	100 Mesh	3,520.00	6,192.00	229.33	293.55	3D Polygon	
Freeze Bend Mine	100 Mesh	4,490.00	11,714.00	433.85	555.33	3D Polygon	
Freeze Bend Mine	100 Mesh	10,704.00	56,885.00	2,106.85	2,696.77	3D Polygon	
Freeze Bend Mine	100 Mesh	14,914.00	143,527.00	5,315.81	6,804.24	3D Polygon	
Freeze Bend Mine	100 Mesh	9,983.00	79,011.00	2,926.33	3,745.70	3D Polygon	
Freeze Bend Mine	100 Mesh	281,733.00	478,962.00	17,739.32	22,706.32	Flat 10.51	38,952.87
Freeze Bend Mine	40-70	19,360.00	197,724.00	7,323.10	9,373.57	3D Polygon	9,373.57
Freeze Bend Mine	Rerun Overs	9,258.00	47,792.00	1,770.07	2,265.69	3D Polygon	
Freeze Bend Mine	Rerun Overs	15,003.00	101,589.00	3,762.55	4,816.07	3D Polygon	7,081.76
Freeze Bend Mine	Overs	8,056.00	41,224.00	1,526.81	1,954.32	3D Polygon	1,954.32
Freeze Bend Mine	Possum Grape Overs	5,200.00	34,449.00	1,275.89	1,633.14	3D Polygon	1,633.14
Freeze Bend Mine	Raw Feed	2,432.00	24,410.00	904.07	1,157.21	3D Polygon	
Freeze Bend Mine	Raw Feed	16,126.00	55,561.00	2,057.81	2,634.00	3D Polygon	3,791.21

Site	Stockpile	Area (sq. ft.)	Volume (cu. Ft.)	Volume (cu. yd.)	Tons	Reference	Totals
Possum Dry Plant	100 Mesh	1,505.00	10,121.00	374.85	479.81	Flat Minimum	
Possum Dry Plant	100 Mesh	5,988.00	53,385.00	1,977.22	2,530.84	Flat Minimum	3,010.65
Possum Dry Plant	40-70	1,259.00	8,570.00	317.41	406.28	Flat Minimum	
Possum Dry Plant	40-70	1,379.00	10,765.00	398.70	510.34	Flat Minimum	916.62
Possum Dry Plant	Overs	36,812.00	462,891.00	17,144.09	21,944.44	3D Polygon	
Possum Dry Plant	Overs	7,001.00	20,507.00	759.52	972.18	3D Polygon	22,916.62

Traditional Stockpile Inventory Method

- Performed Annually
- Time Consuming and Labor Intensive Resulting in Higher Costs
- 1-2 Weeks Turnaround from Start to Finish
- Safety Risks with Survey Team Climbing on Stockpiles
- Summarized Final Report for Each Site

Drone Stockpile Inventory Method

- Performed Quarterly
- 7 Days or Less Turnaround from Start to Finish
- Digital Data delivered via Dropbox including Georeferenced Orthomosaic Photo, Digital Surface Elevation Model and 3D Model for Each Site
- Stockpile Polygons for Each Site Visually Confirmed Collaboratively
- Detailed Final Report
- 34”x44” (ANSI E) Scaled Hardcopy Plots Provided for Each Site

Summary of Actionable Data Products from Drones

- High Resolution Aerial Photos and Videos
- 2D Orthophotomosaics (Photo Maps)
- Digital Surface Elevation Models
- Digital Elevation Models (DEM) - less structures and vegetation
- 3D Point Clouds
- 3D Surface Models
- Surface Contours and Topographic Maps
- Length, Area and Volume Measurements
- Surface Profiles and Cross Sections
- Multispectral and Thermal IR Maps
- Geophysical Surveys (Magnetic, Gravity, GPR, etc..)
- Methane (Gas) leak detection and gas sniffing
- Air sampling (hazardous sources, flare plumes, chemical)

Thank you!!

The Texas Association of Environmental Professionals for the Opportunity To Provide You a Brief Overview of the Jersey Village White Oak Bayou Drone Aerial Survey

Q&A

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