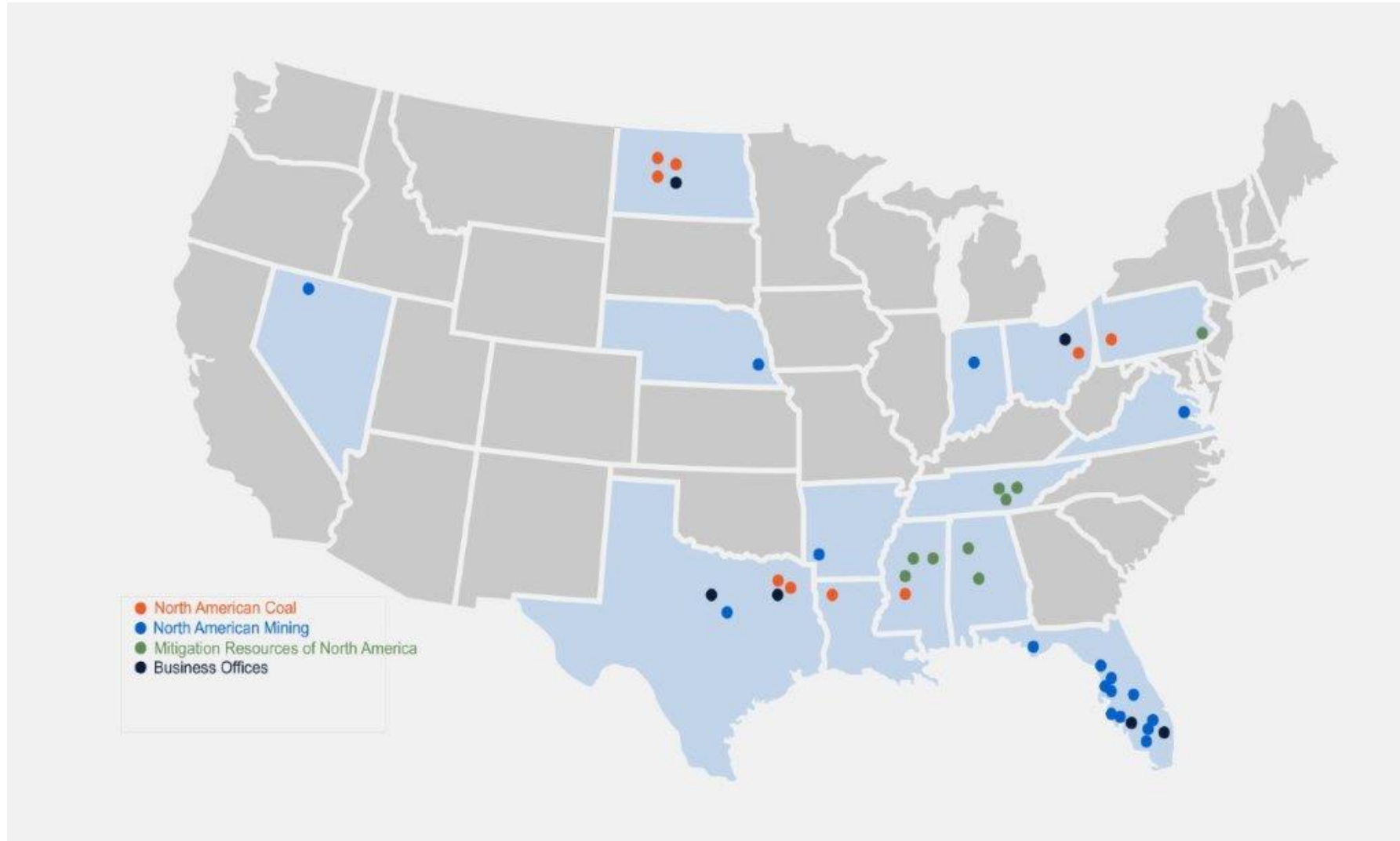




Selective Mining Methods Case Studies

Benson Chow, PG

Trusted partners delivering aggregates, minerals, reliable fuels, and environmental solutions.



Precision Mining Tools

Ore Control

GPS

Surface Miners



Ore Control

- Drilling or Channel Sampling
 - Supplements exploration drilling
 - Incremental sampling and selective sampling to identify low grade zones
- Use of hand held scanners
 - XRF/LIBS
- Data incorporated into short-range model and planning

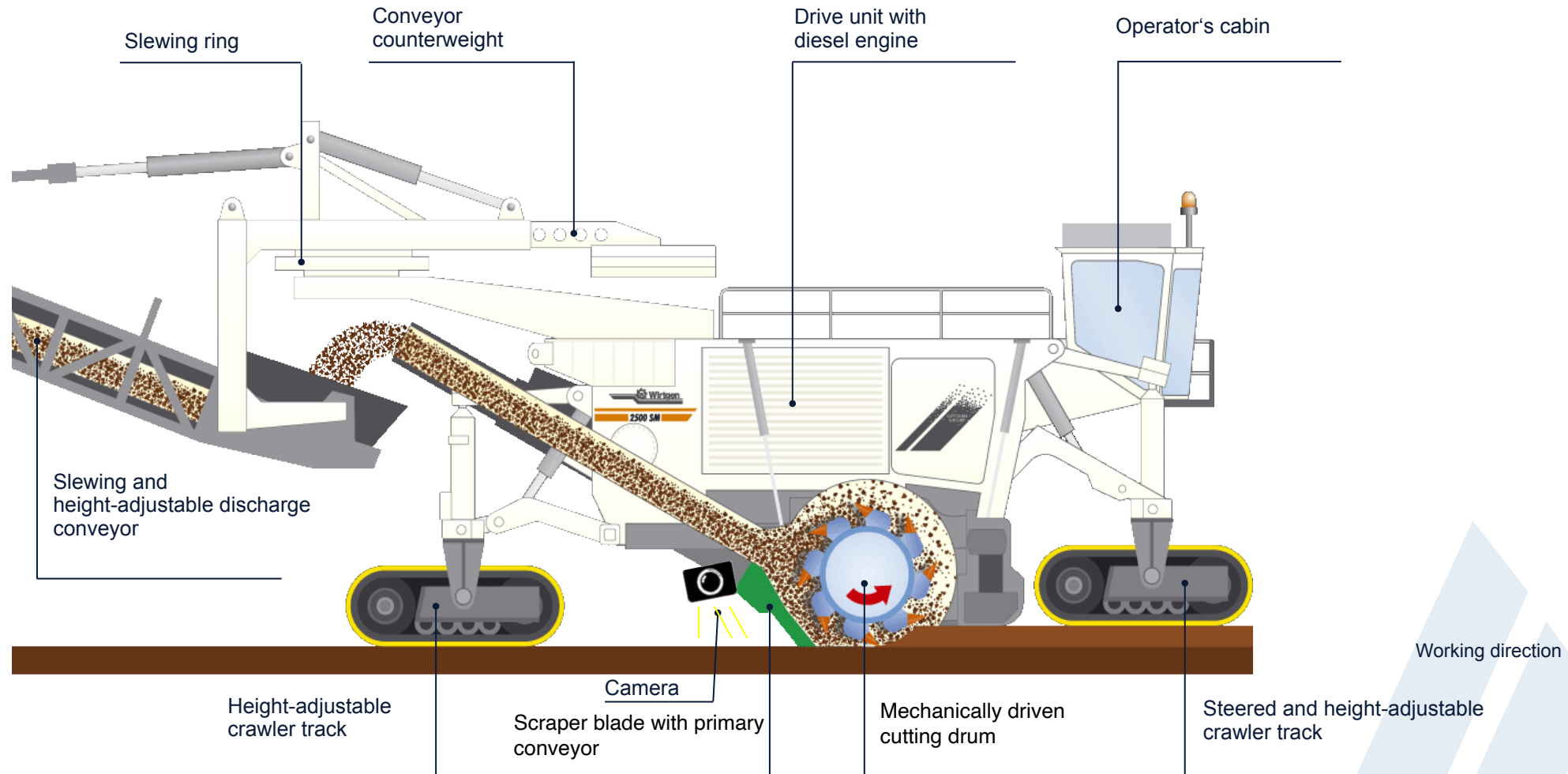


GPS

- Grids are developed from the short-range model, previous pit surveys, in-pit ore control data, and fault mapping
- GPS mounted to the top of all dozers, supervisor trucks, and side-by-side



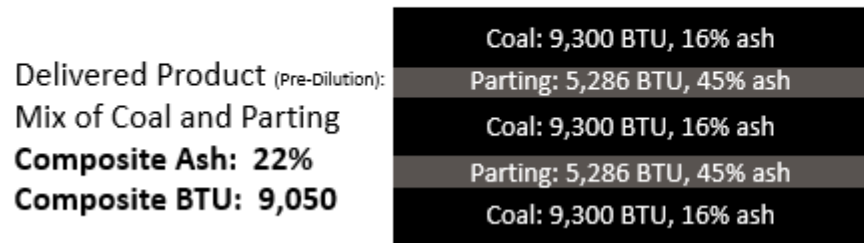
Wirtgen 4200 Surface Miner



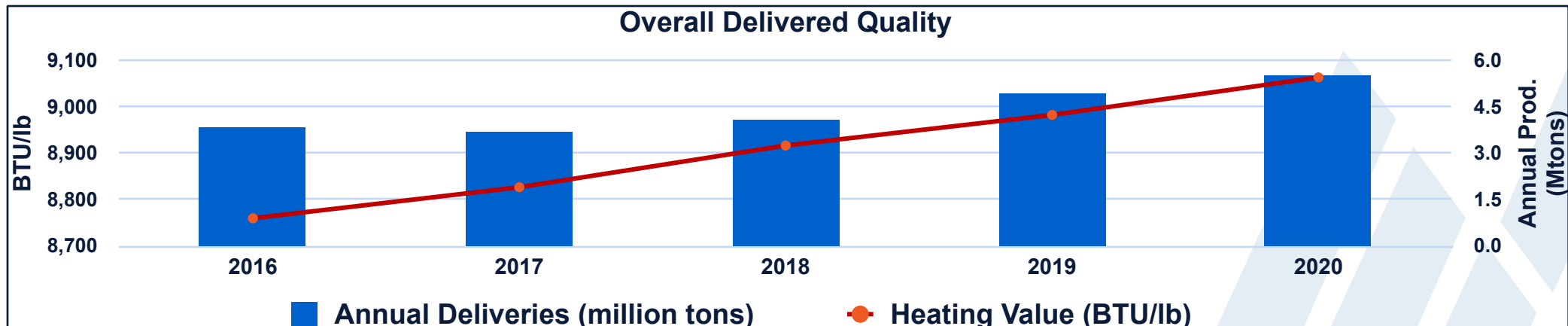
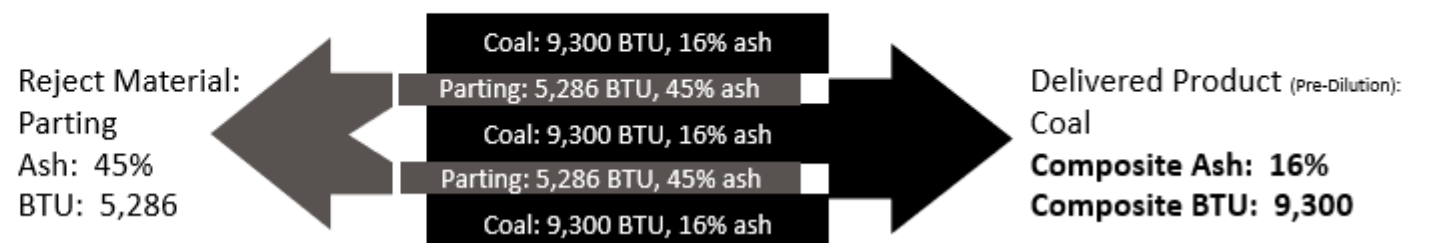
Bisti Fuel Study

- In 2017 at Navajo Mine near Farmington, NM, NACoal successfully transitioned coal loading fleets from conventional dozer/loaders to surface miners
- For seam 2, heating value improved from 9,050 to 9,300 BTU/lb and ash content from 22% to 16%

Original Option (Seam 2) - Ripping with Dozers



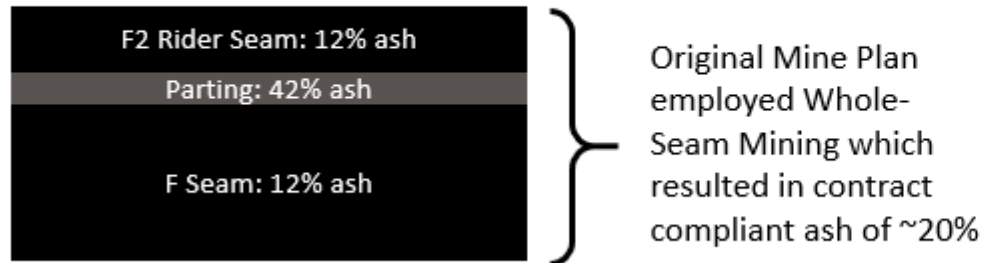
Final Solution (Seam 2)– Wirtgen 4200 Surface Miner



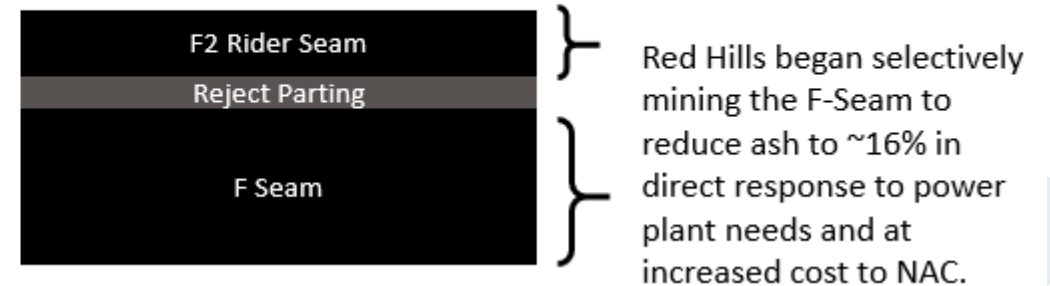
Red Hills Mine Study

- NACoal successfully transitioned the coal recovery process at Red Hills from conventional hydraulic excavator to Surface Miners
 - Power Plant designed to handle up to 23%
 - Original mine target for ash was 20% (There was no need to separate parting)
 - After operations started, the plant was forced to derate when ash exceeded 18% due to ash handling systems
- The transition to a surface miner recovery method eliminated the need to derate the plant due to ash content

Original Option (F-seam) – hydraulic excavator



Final Solution (Seam 2)– Wirtgen 4200 Surface Miner



- Additionally, the installation of gamma detectors improved the process by selectively mining the coal seams by ash content (approx. 3% incremental reduction of ash content)

Gamma Ray Detector

- The gamma detector is also known as the clay/coal avoidance system
 - Detects variances in gamma radiation between coal and carbonaceous clays
 - Real-time information is transmitted to an in-cab monitor
 - Monitor displays a percentage of ash content
 - Precise gamma differences enable the operator to accurately follow the coal floor
- Original system developed by Geosteering Mining Services
 - Red Hills Mine provided the testing environment and operator feedback
 - Gamma detector box is a self contained unit
 - Very little maintenance is required
 - Replacement is every 2+ years
- Since installation in 2010
 - 3% improvement in overall recovery
 - Coal quality has consistently improved

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Avg. Ash (%)	15.9%	15.5%	14.3%	13.8%	15.0%	14.2%	13.6%	13.5%	13.7%	13.3%	13.4%	13.6%
Total Recovery	86.7%	87.5%	87.8%	89.6%	92.6%	91.4%	91.8%	89.9%	94.4%	92.1%	95.3%	94.2%

