MINING, MANAGEMENT & SOFTWARE CONSULTANTS

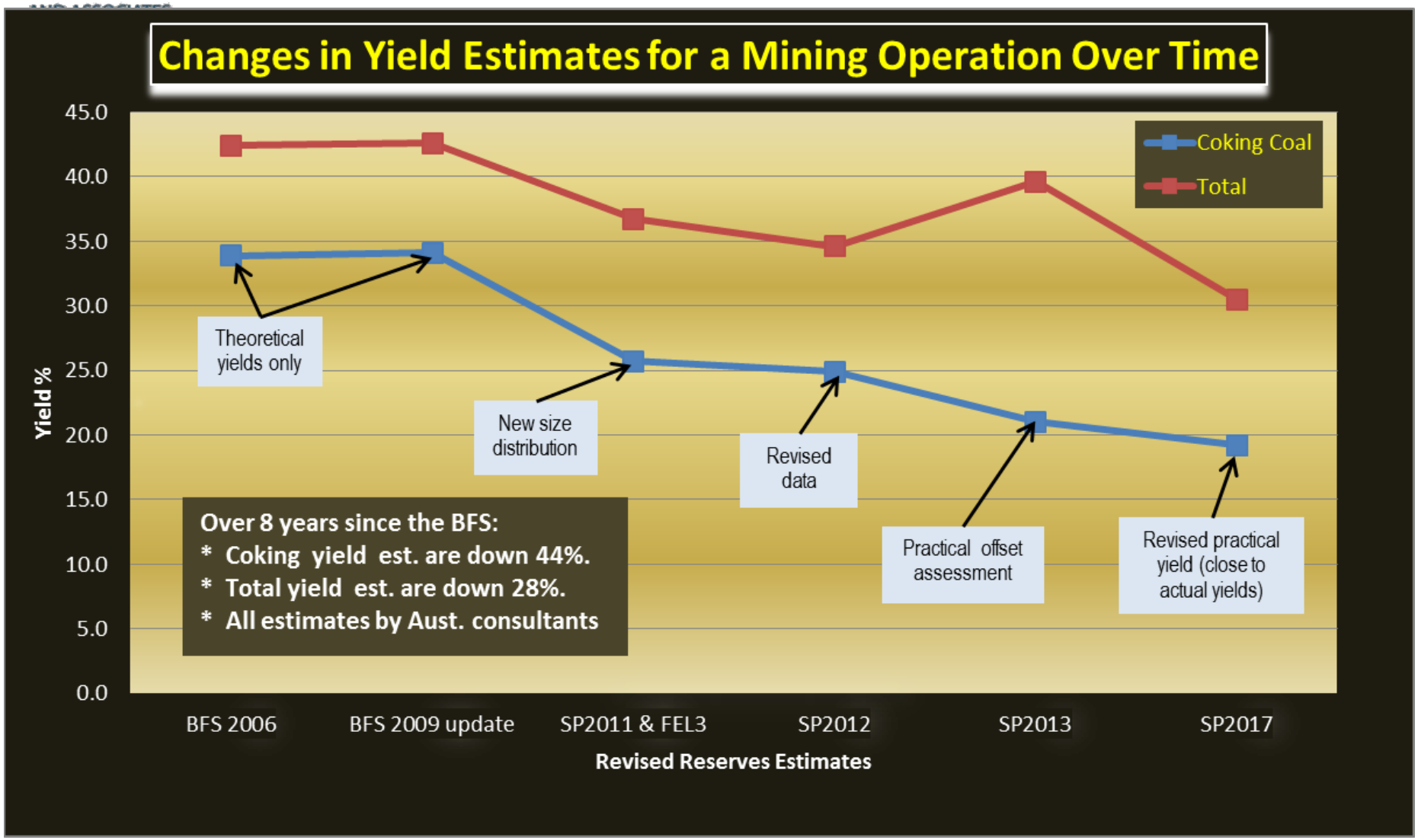
GPPH AND ASSOCIATES

A Case Study in Interpretation of Yield Data for Reserves Estimation

How could it possibly go wrong?

Importance of Quality

- Project economics is more sensitive to coal quality than any other factor.
  - Markets and pricing affect revenue.
  - Yields impact all on-site costs.
  - Quality errors are often systematic.
- Yet it is often given only cursory assessment.


Changes in Yield Estimates for a Mining Operation Over Time
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Yield %
Coking Coal
Total
Theoretical yields only
New size distribution
Revised data
Practical offset assessment
Revised practical yield (close to actual yields)
Over 8 years since the BFS:
* Coking yield est. are down 44%.
* Total yield est. are down 28%.
* All estimates by Aust. consultants
BFS 2006
BFS 2009 update
SP2011 & FEL3
SP2012
SP2013
SP2017
Revised Reserves Estimates

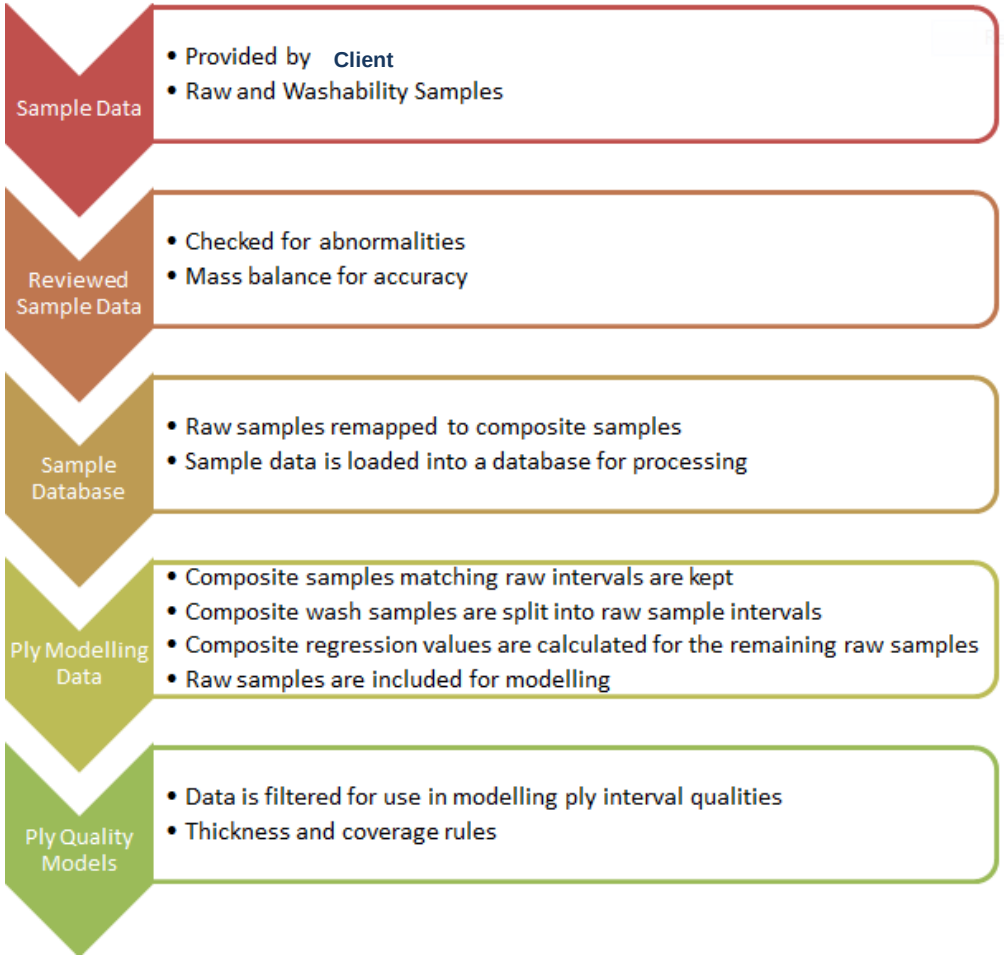
What went wrong?

- A BFS used slim core yields with a nominal loss.
- Poor liberation discovered after plant design.
- Plant simulation after production commenced.
- Testing does not match processing.
- New coal province – no pilot plant testing.
- No questions raised about process adequacy.

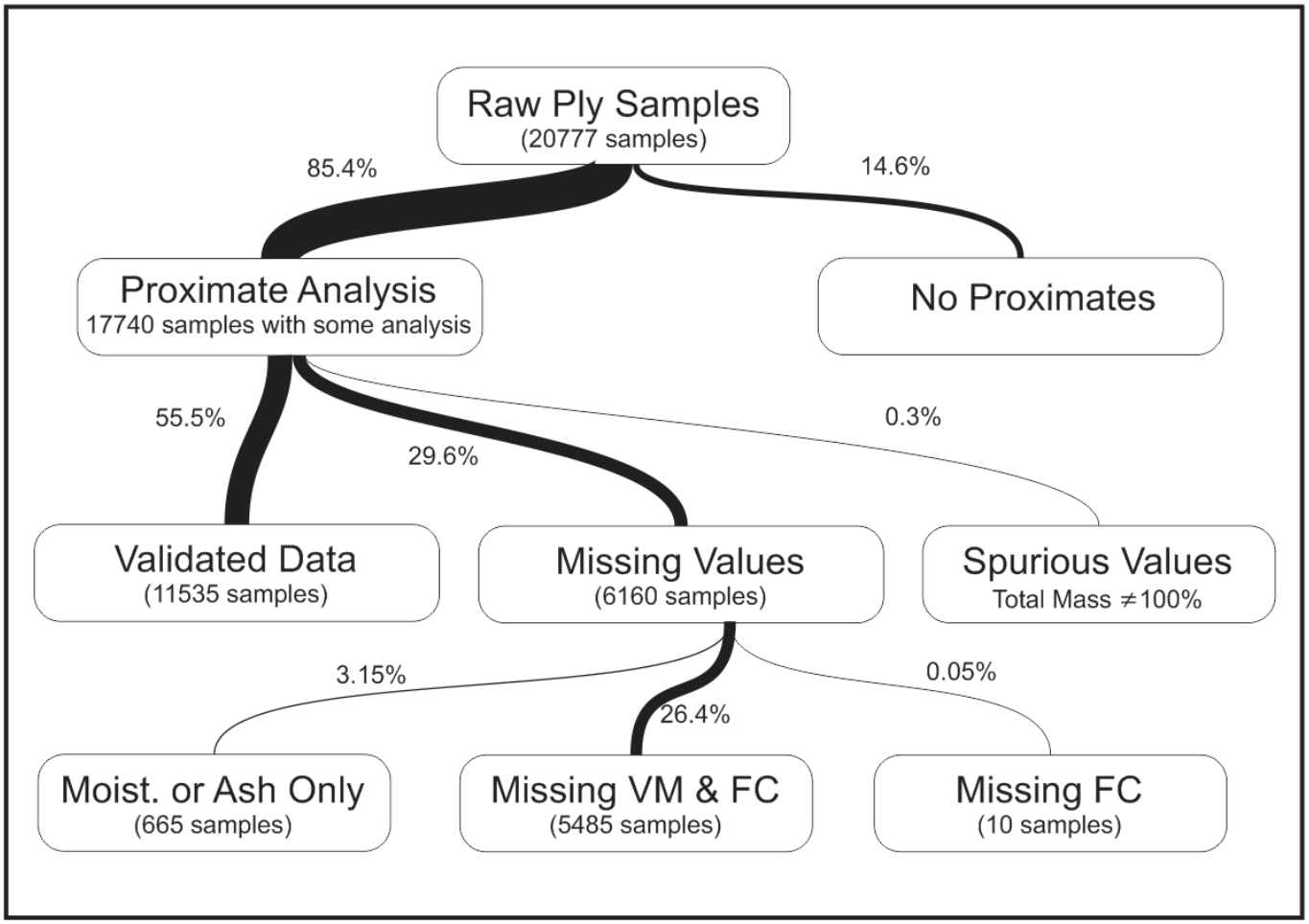
Case Study 2 – Hunter Valley

- Multi-seam deposit with:
  - 15 seam groups
  - 158 coal plies
  - 411 working section combinations
- Exploration in multiple programmes since 1970's.
- Modelling on a ply basis.

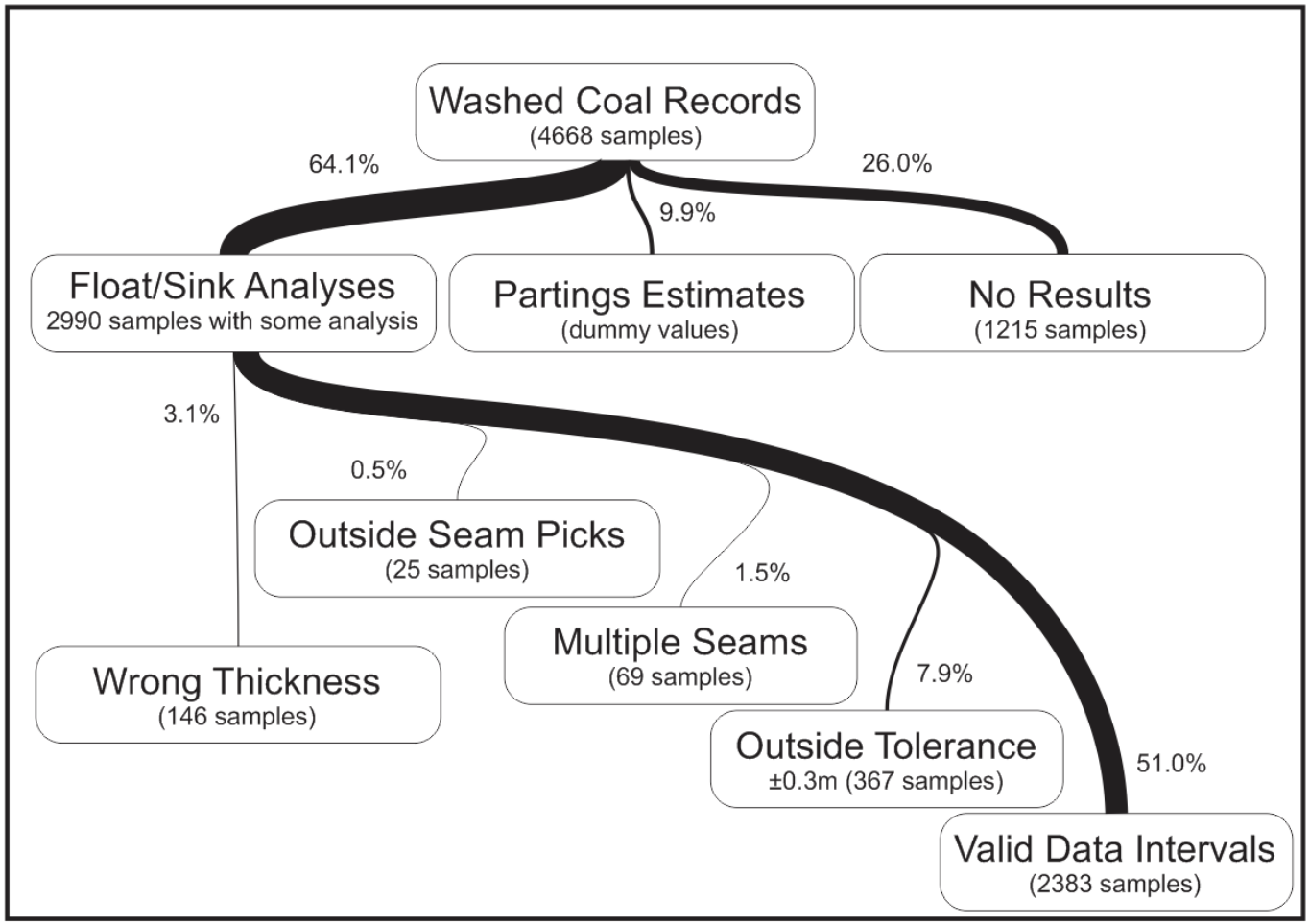
Data Checking, Validation, Analysis and Modelling Procedure



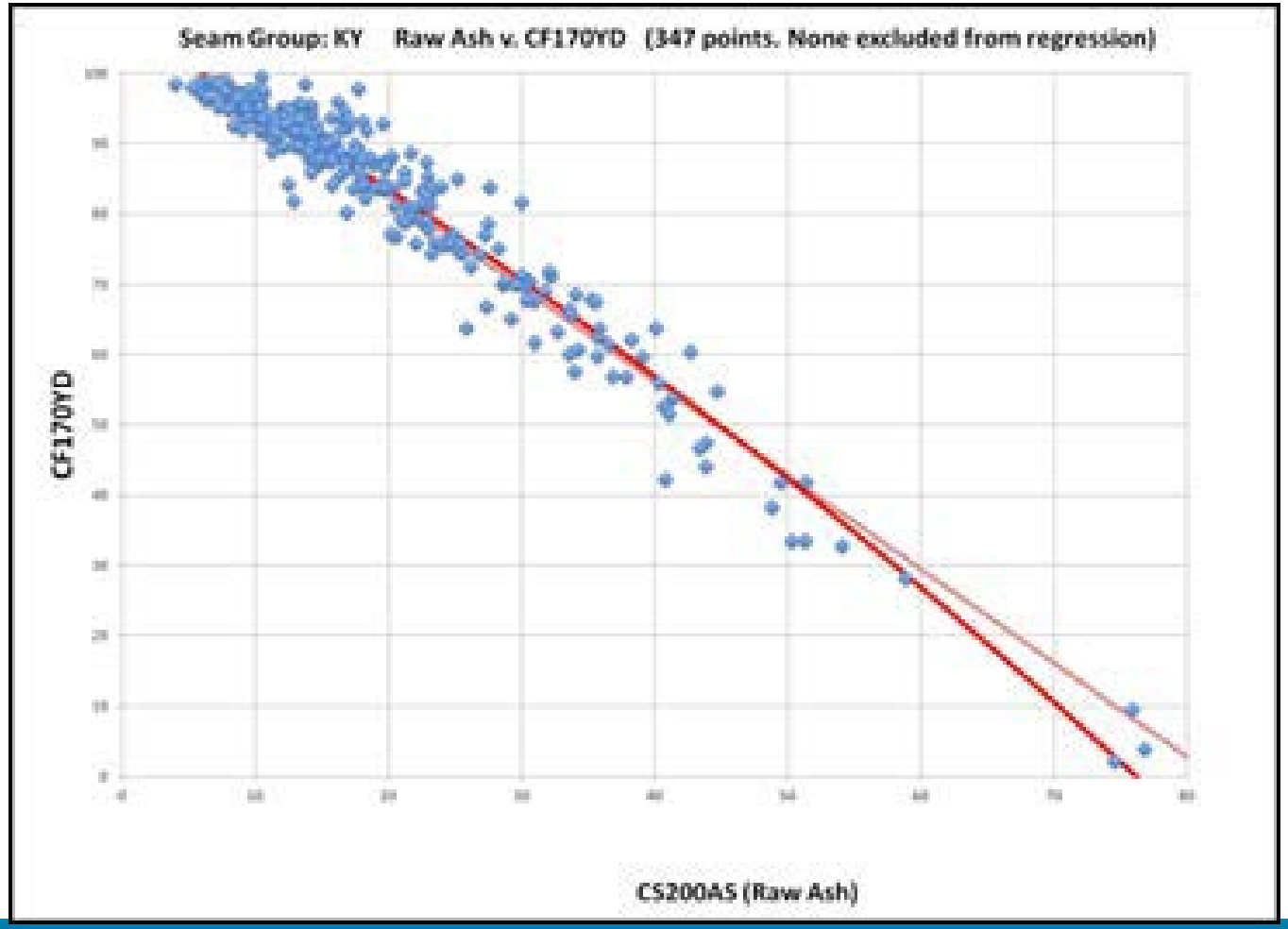
Raw Ply Sampling Results



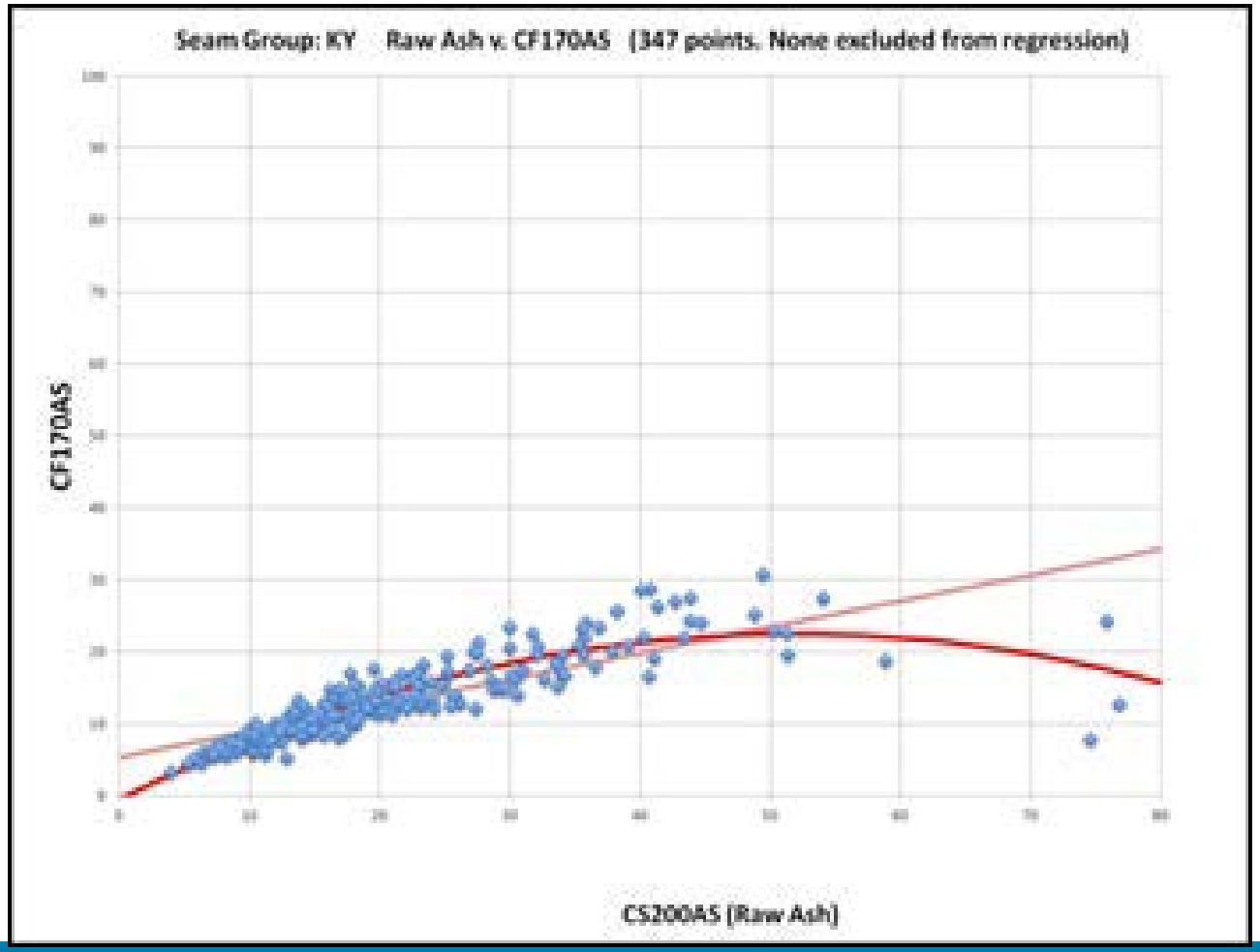
Coal Washability Correlation Results



Regression of Yield on Raw Ash

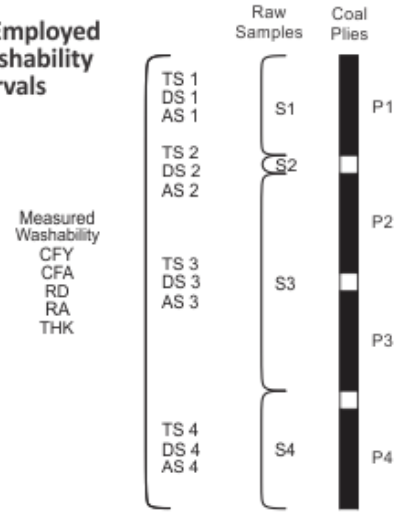


Regression of Washed Ash on Raw Ash



- Composite washability was split into plies.
- Raw ash regressions were used to weight the yield/ash split between plies.
- Gave a very significant increase in useable data.
- Raw ash regressions give lower confidence infill data points.

Figure 5.1 - Methodology Employed in Splitting Composite Washability into Raw Sample Intervals



Raw Samples do not necessarily correlate with individual plies or partings, but form the smallest unit possible for reporting of washability results. Raw samples each have a thickness (TSN), density (DSn) and raw ash (ASn). Measured washability is commonly determined for a composite working section. As well as sample interval thickness (THK), composite sample density (RD) and composite raw ash (RA), the composite sample will have a cumulative floats yield (CFY) and a cumulative floats ash (CFA) for each density fraction. The raw sample qualities are related to the composite washability qualities by,

$$THK = \sum_{n=1}^{i} (TSn),$$

$$RD = \frac{\sum_{n=1}^{i} (TSn.DSn)}{THK}, and$$

$$RA = \frac{\sum_{n=1}^{i} (TSn.DSn.ASn)}{THK.RD}$$

$$For\ i\ raw\ samples$$

These relations can also be used to estimate missing raw sample data. Floats yield and ash can be estimated for each raw sample using the linear regression formulae developed for each seam group,

$$FYSn = a_0 + a_1 ASn, and$$
$$FASn = b_0 + b_1 ASn$$
$$where\ a_0, a_1, b_0, b_1\ are\ the\ regression\ coefficients$$

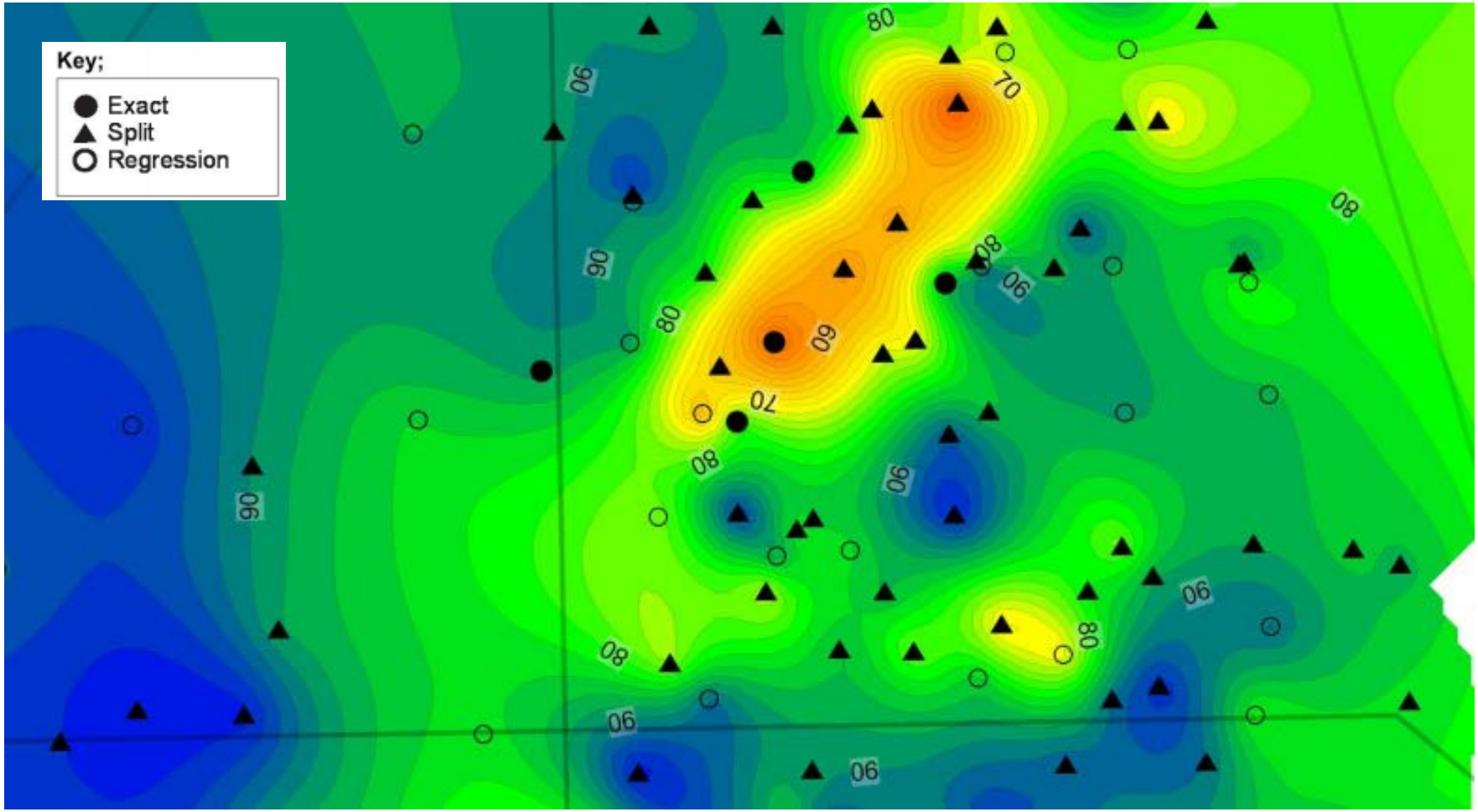
These estimates need to be adjusted to ensure that the measured composite washability qualities are honoured.

$$FYSn' = FYSn. \frac{(THK.RD.CFY)}{\sum_{n=1}^{i} (TSn.DSn.FYSn)}, and$$

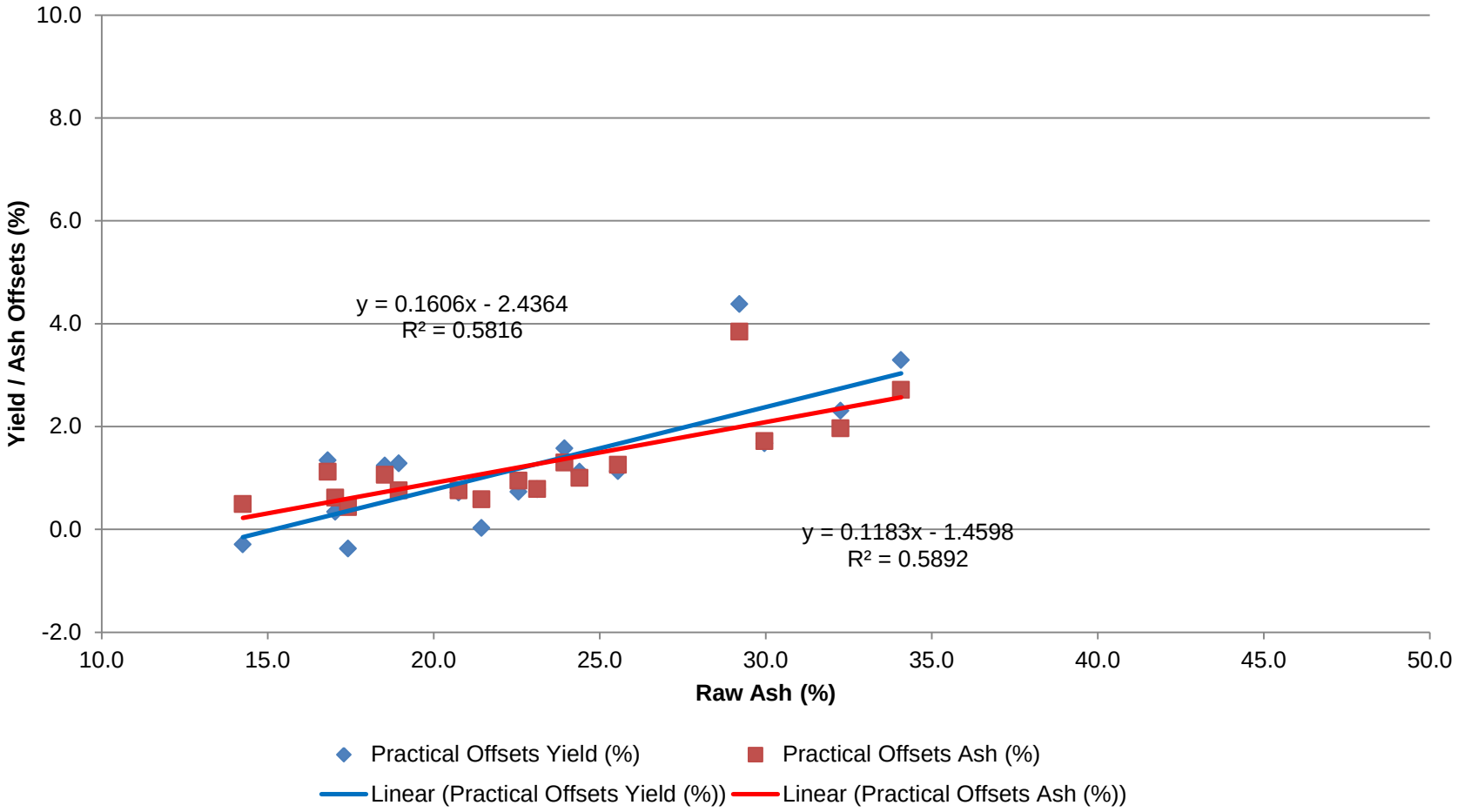
$$FASn' = FASn. \frac{(THK.RD.CFY.CFA)}{\sum_{n=1}^{i} (TSn.DSn.FYSn.FASn)}$$

Additional checks and adjustments need to be made to ensure that the raw sample floats yield (*FYSn'*) and floats ash (*FASn'*) estimates lie within practical and acceptable limits. These raw samples estimate can then be used for modelling.

F1.60 Yield Model for a Ply



Practical Offsets at F1.60



Conclusions

- Coal quality is of paramount importance.
- Validate the data.
- Manipulation of data can improve information for modelling reserves.
- Use existing deposit knowledge.
- In a new coal province use bulk samples and pilot plant testing.

Questions

- Are our competent persons really competent?
- Should a higher standard be required for sensitive reserve estimates?
- Should an independent review be mandatory?

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Thank You