Objective

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

Determine the vertical and lateral isolation within the currently defined Hardy Wabiskaw-McMurray A Pool, using pressure data and integrated engineering techniques.

Pressure Data and Geology to Define Pressure Communication

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

Pressure

The Board's view (Decision 2004-045 for Hardy):

"The Board acknowledges that there are significant limitations to the use of pressure data in determining gas pooling in the areas under consideration. These limitations are due to:

1. both the quantity and quality of the pressure data, including the lack of historical pressure data,
2. commingling of production and pressure measurements from different stratigraphic intervals,
3. insufficient shut-in times and,
4. in some cases, the use of surface pressures.

The Board found very few cases where the pressure data were sufficiently definitive to base pooling decisions upon. In most cases, the Board relied more on geological data than on pressure data."

Geology

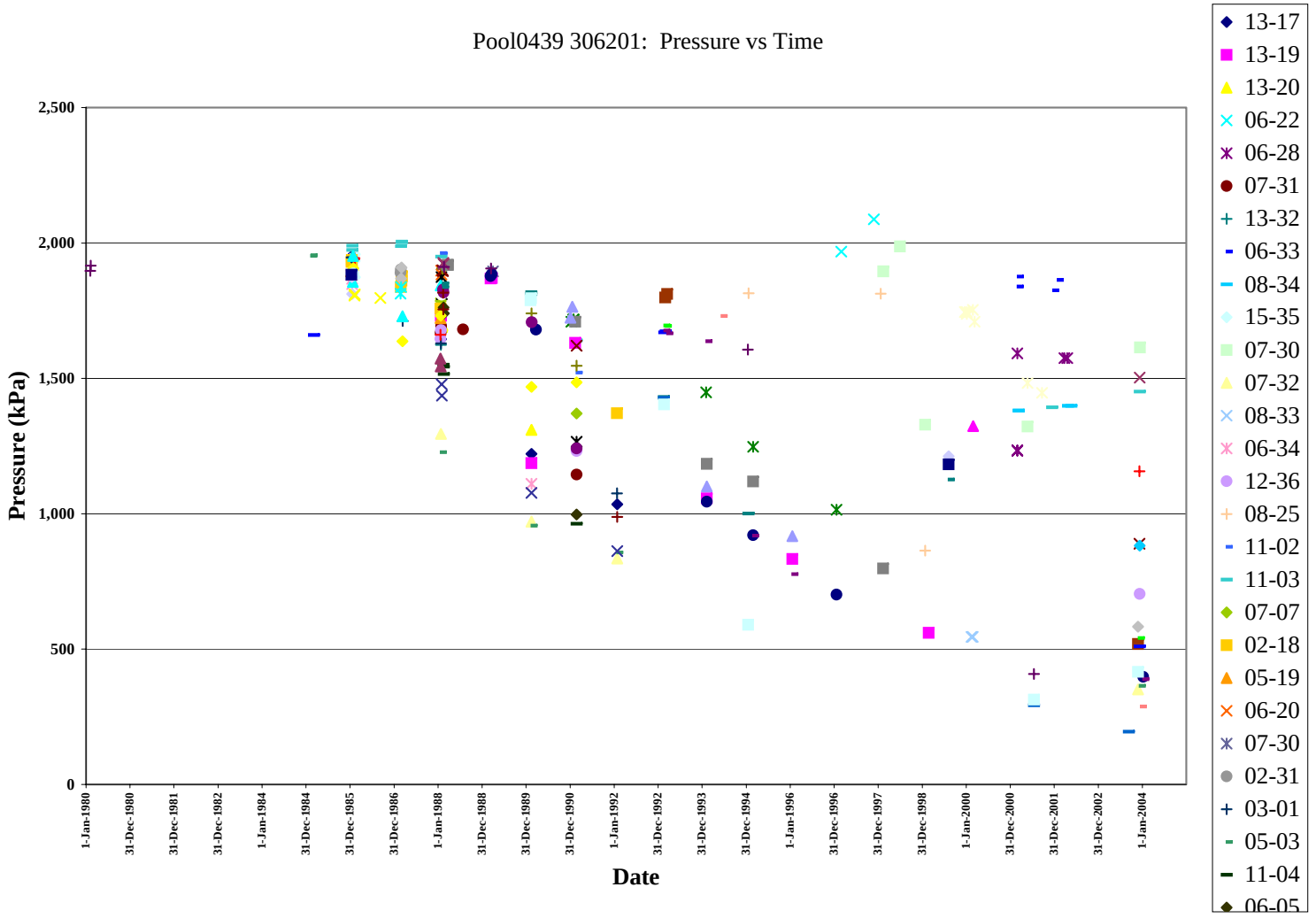
"However, I do not believe that the questions of pressure communication amongst lithologic units or between gas and bitumen zones can be answered definitively by stratigraphic analysis and mapping alone." (RGS '03)

Pressures for Wabiskaw-McMurray A Pool (SSG CD)

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray



PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

Methodology

Diagnostic Techniques to define ROI

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

- Pressure versus time - Examined long term reservoir pressure trends.
- Production Decline - Wells in pool should decline on same decline trend due to consistent pressure drop within high permeability pool. Pools with different pressure declines will decline at different rates.
- Gas–Oil or Gas-Water Contact Differences - Similar contact within pool implies continuity / differences imply discontinuity.
- Seismic bright spots - Indicate where gas is and is not areally. Used where seismic coverage and resolution was available.
- Material Balance (P/Z vs. Gp) - Estimate gas in place. Useful to compare to volumetrics and determine if boundaries reasonable.
- Stratigraphic correlation - Correlates lithological units between wells, however it does not define hydraulic communication.
- Structural mapping - Useful to define pool boundaries. Well control may be sparse

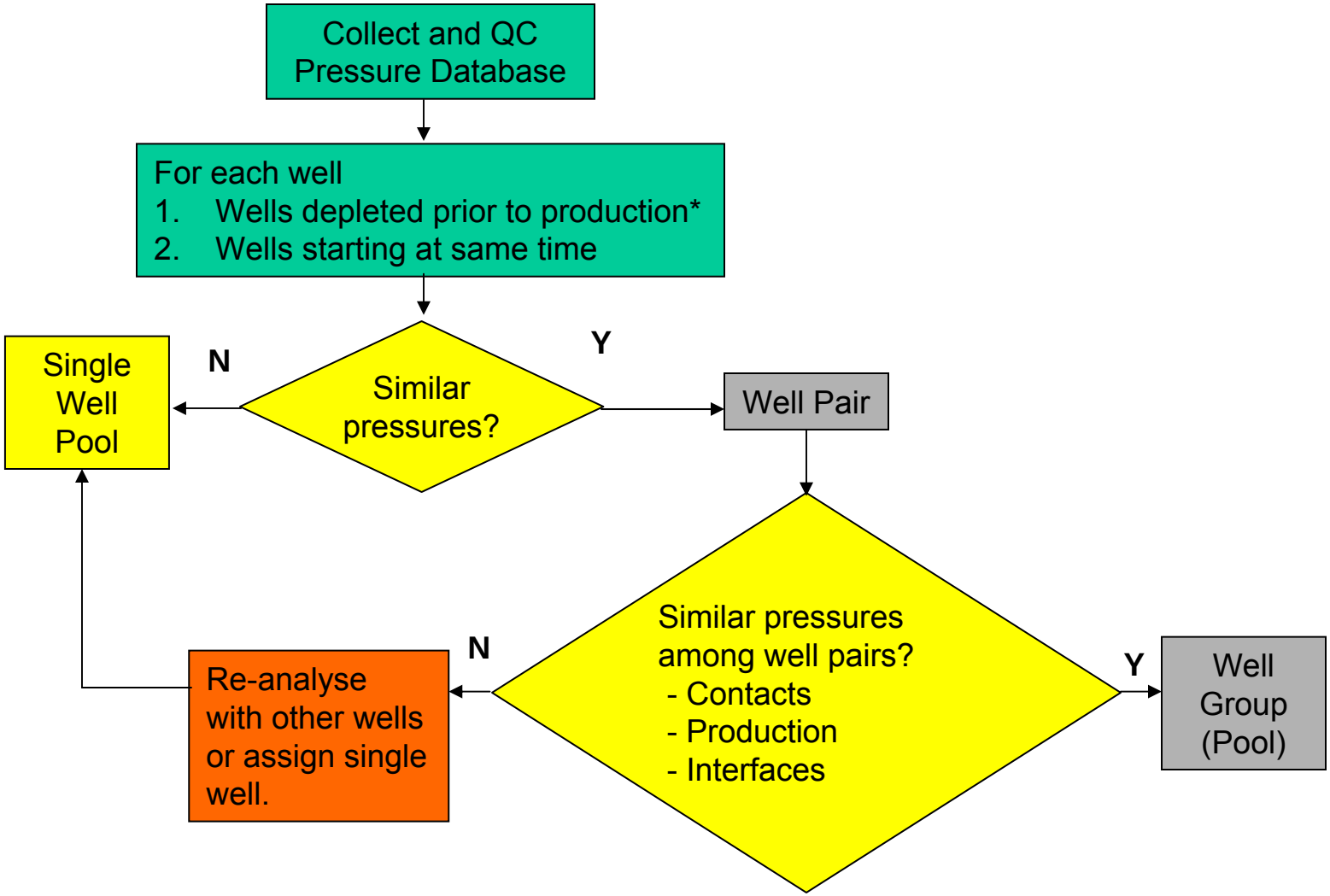
Determined 25 Areal Pools & 48 vertically and laterally isolated pools

Determining Regions of Influence – Determining Well Groups

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray



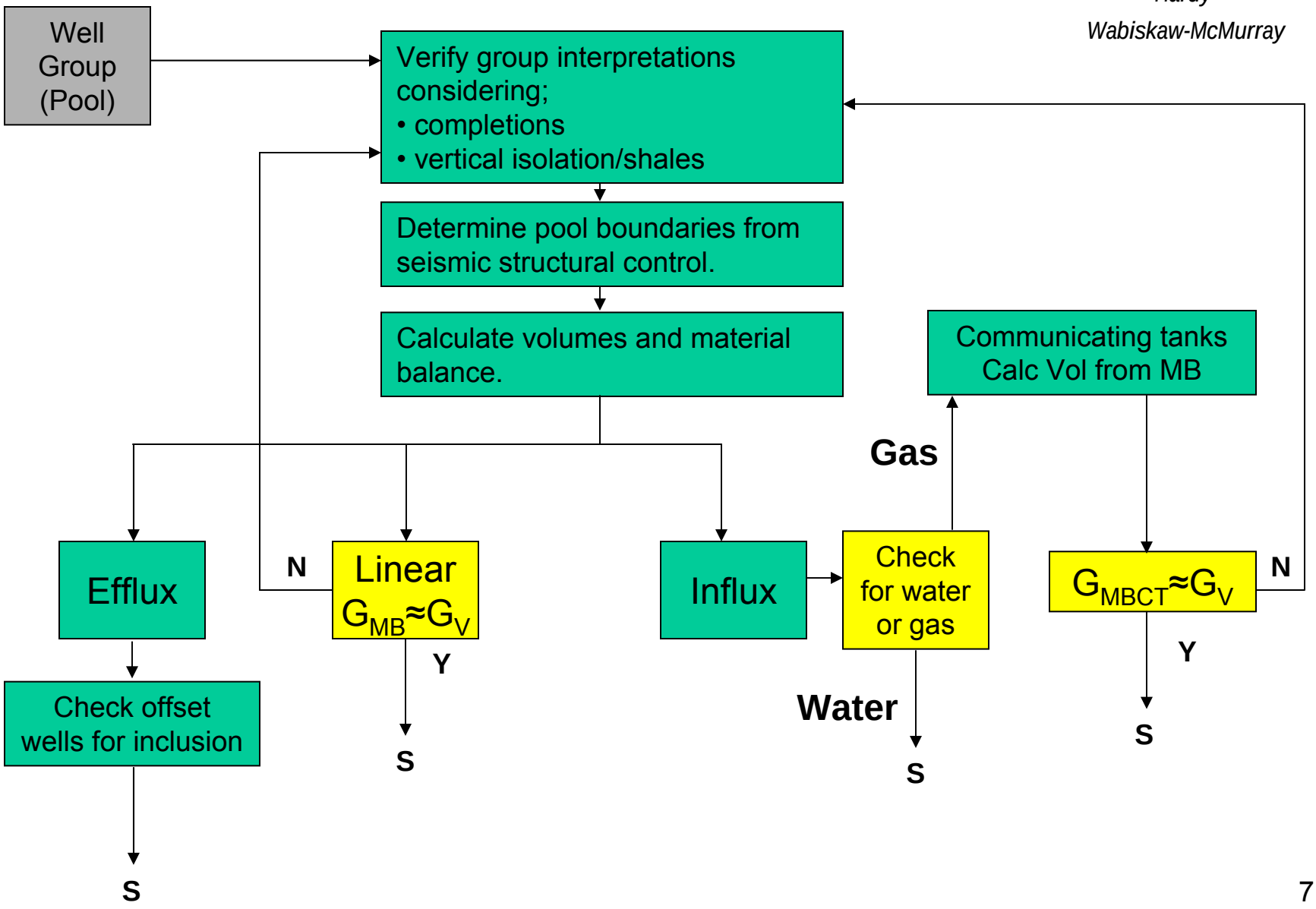
* Depleted wells must have pairs unless initial pressure incorrect

Determining Regions of Influence – Determining Pool Boundaries Size

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray



PARAMOUNT
ENERGY TRUST

Hardy

Wabiskaw-McMurray

Admissibility of Pressures

Interpretation, Data

Comments on Pressure

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

Review of 75 well tests

- The data quality is sufficient to accurately extrapolate the reservoir pressure and determine the reservoir flow characteristics. In most cases it is reasonable to expect a data accuracy within +/- 40 kPa.
- The accepted test procedure during field development was a 4 point test followed by a 12 hour flow and a 24 hour buildup. Later tests (1993 onwards) typically had 36 hour flow times and 10 days of buildup time.
- Pressure transient analysis shows the average permeability is in the order of 500 mD. The average skin effect ranges from +2 to +15. Higher skin values are due to turbulent flow (low pressure and high velocity).
- Initial reservoir pressures vary between 1800 and 2000 kPa. The low pressure promotes high gas compressibility.
- Due to the combination of high formation permeability, high gas compressibility and the relatively short flow times, the pressure transients are characterized by radial flow. An accurate extrapolation of a semilog (Horner Plot) is possible to obtain the reservoir pressure.

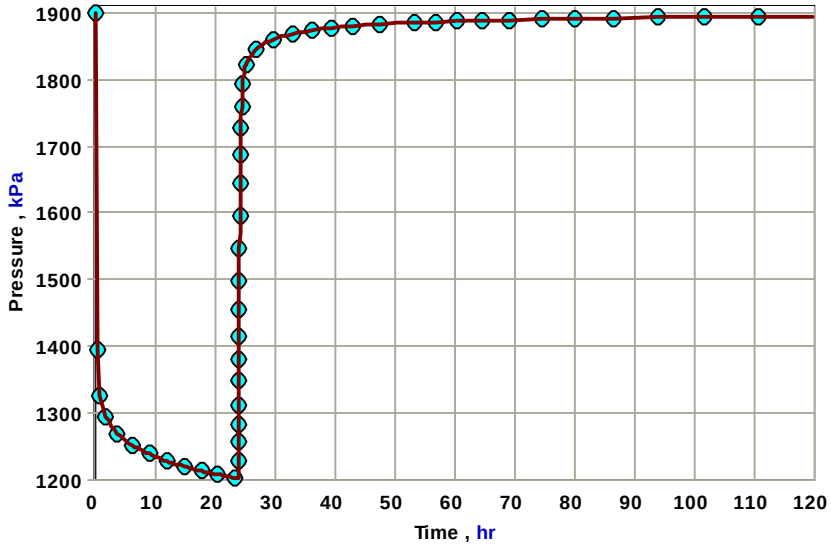
- 20 Years of data
- Over 300 points
- Good quality data (little surface data)

Synthetic Buildup Response

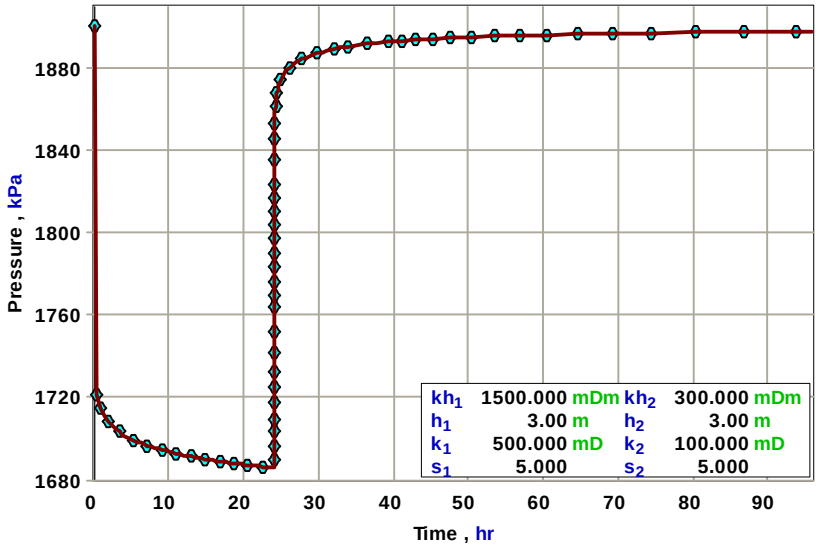
PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray



Single layer (100 md)



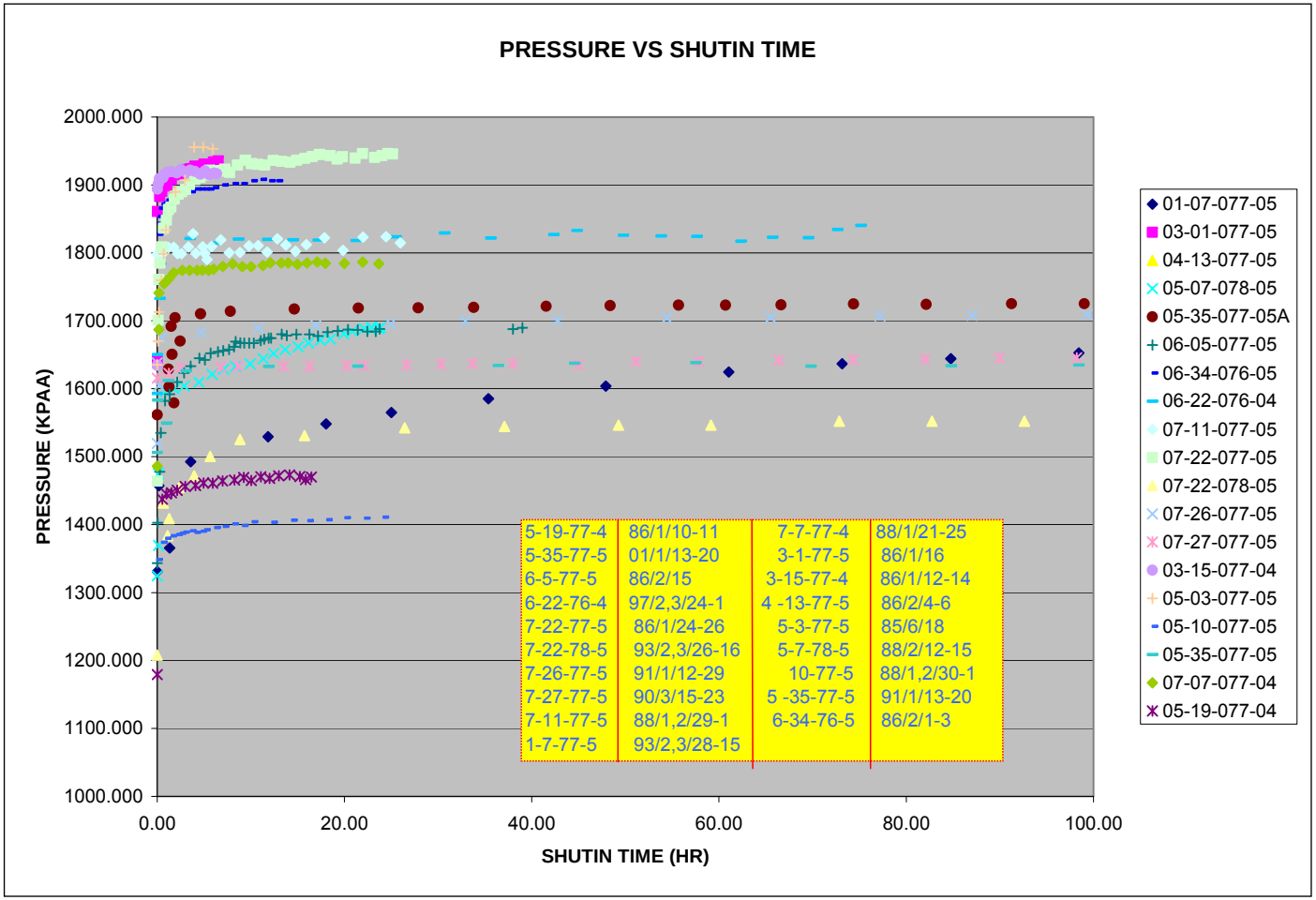
Dual Layer (100/500 md)

Actual Field Buildup Response

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

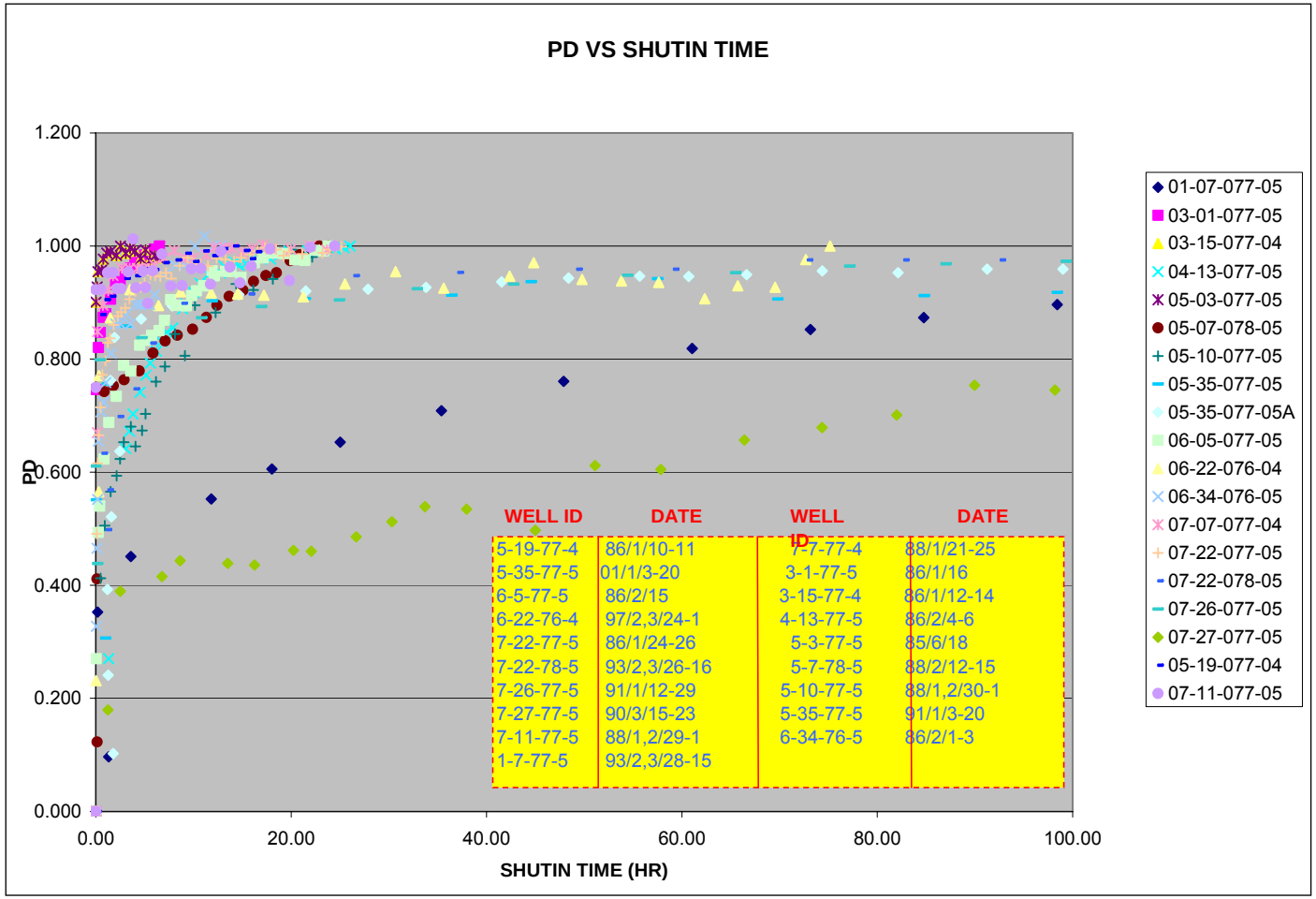


Actual Field Buildup Response - Dimensionalized

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray



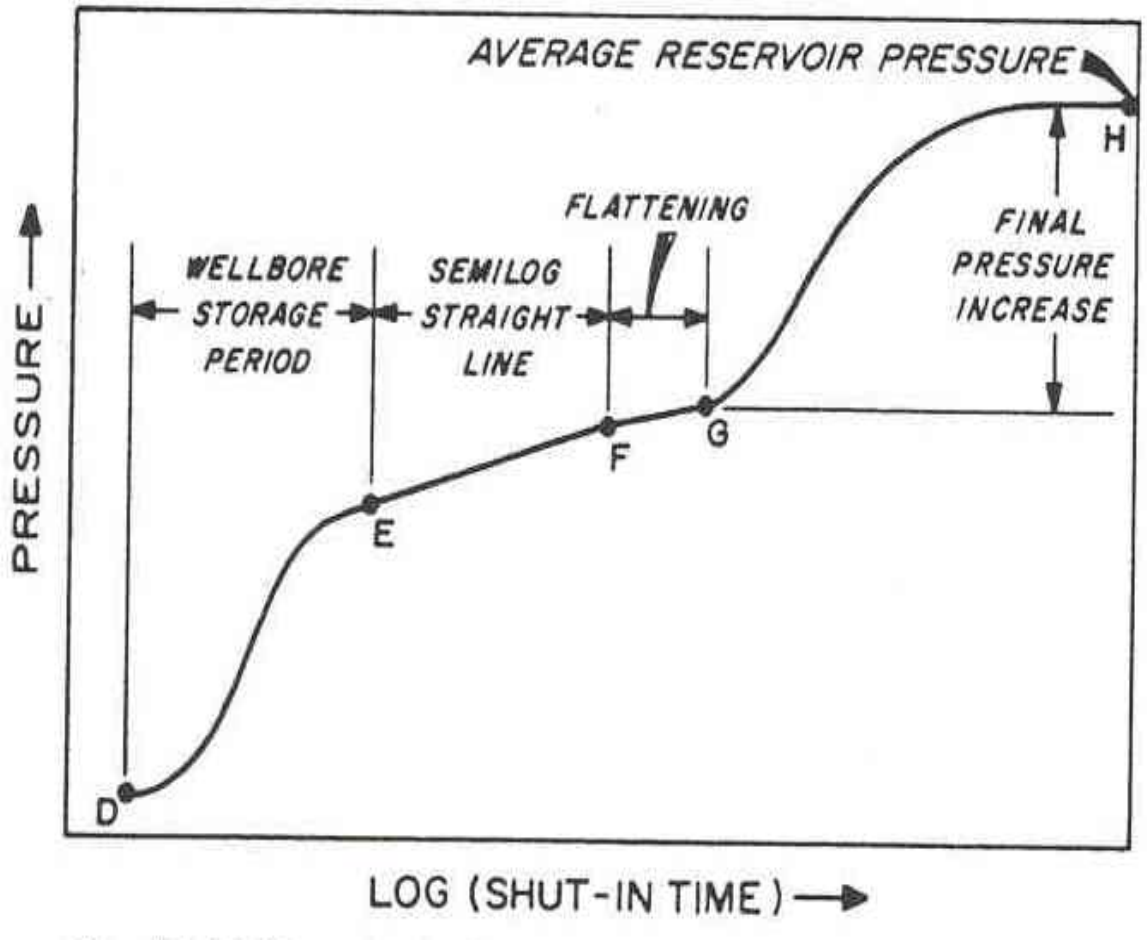
$$P_d = \frac{P - P_{\min}}{P_{\max} - P_{\min}}$$

Pressure Build-Up Response for Single Well, Dual Layer Bounded Reservoir

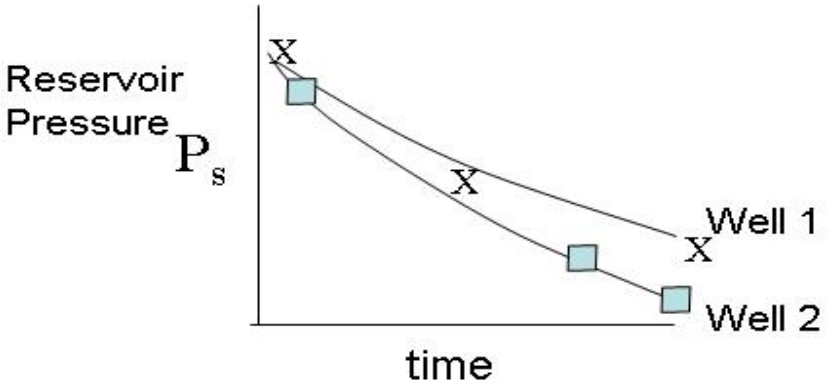
PARAMOUNT ENERGY TRUST

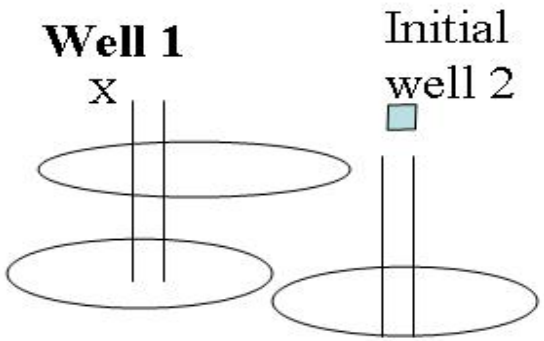
Hardy

Wabiskaw-McMurray



Pressure behavior of Laterally Isolated Reservoirs





Cross Sectional view

Divergent Behavior

Pressure difference as measured by wells show differences in pressure

drain two pools

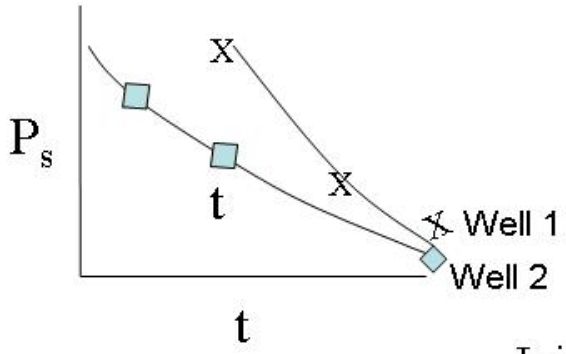
(Well 1and well 2 drain separate compartments)

Pressure Behavior of Commingled Reservoirs

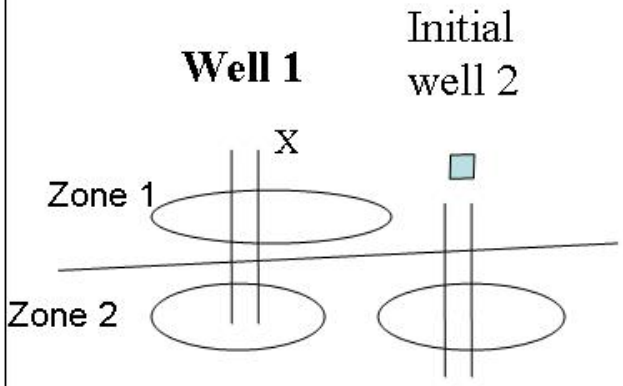
PARAMOUNT ENERGY TRUST

Hardy

McMurray



Convergent behavior



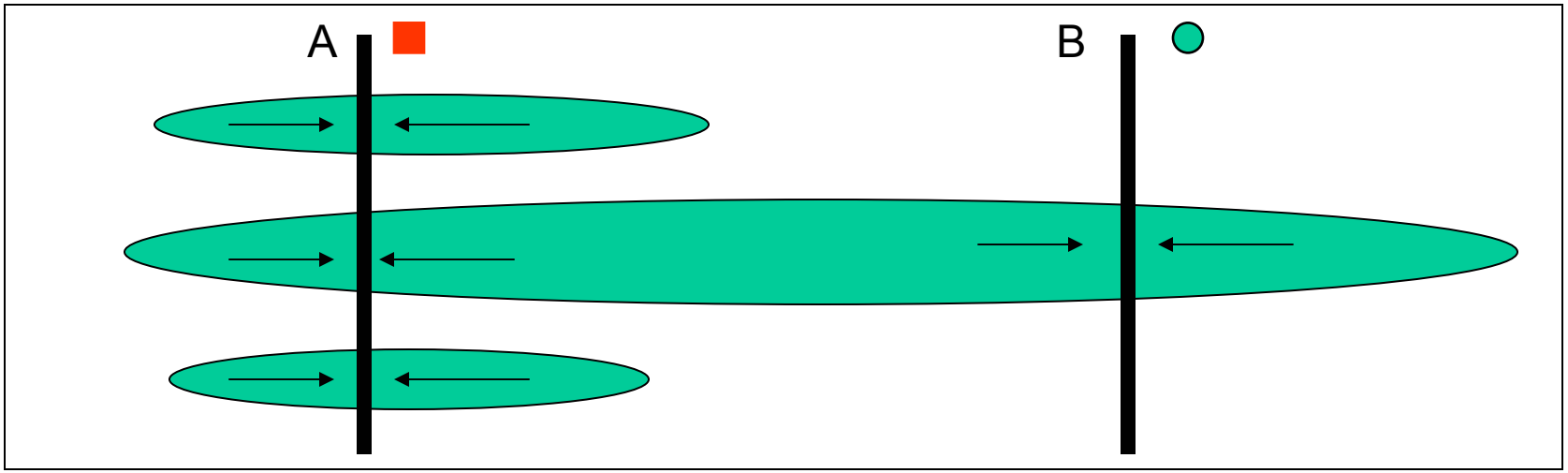
Initial measured pressure is different in later drilled wells because one zone is vertical hydraulically isolated from the other zone; Zone 1, has higher initial pressure than the current pressure in Zone 2, the more continuous zone. However, with crossflow and production measured pressure in both zones will eventually be the same.

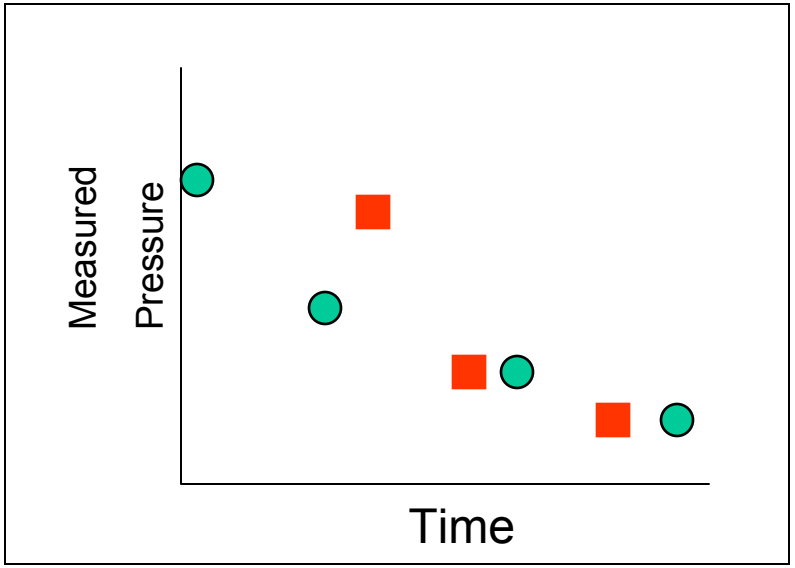
Explaining Pressures in Hardy Field

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray





- Permeability of formation is very high K~500 md (average PTA)
- Large Δp contrast not expected layer equalize (kh Δ p)1, (khΔp)2
- Even though multiple completions often one zone dominant

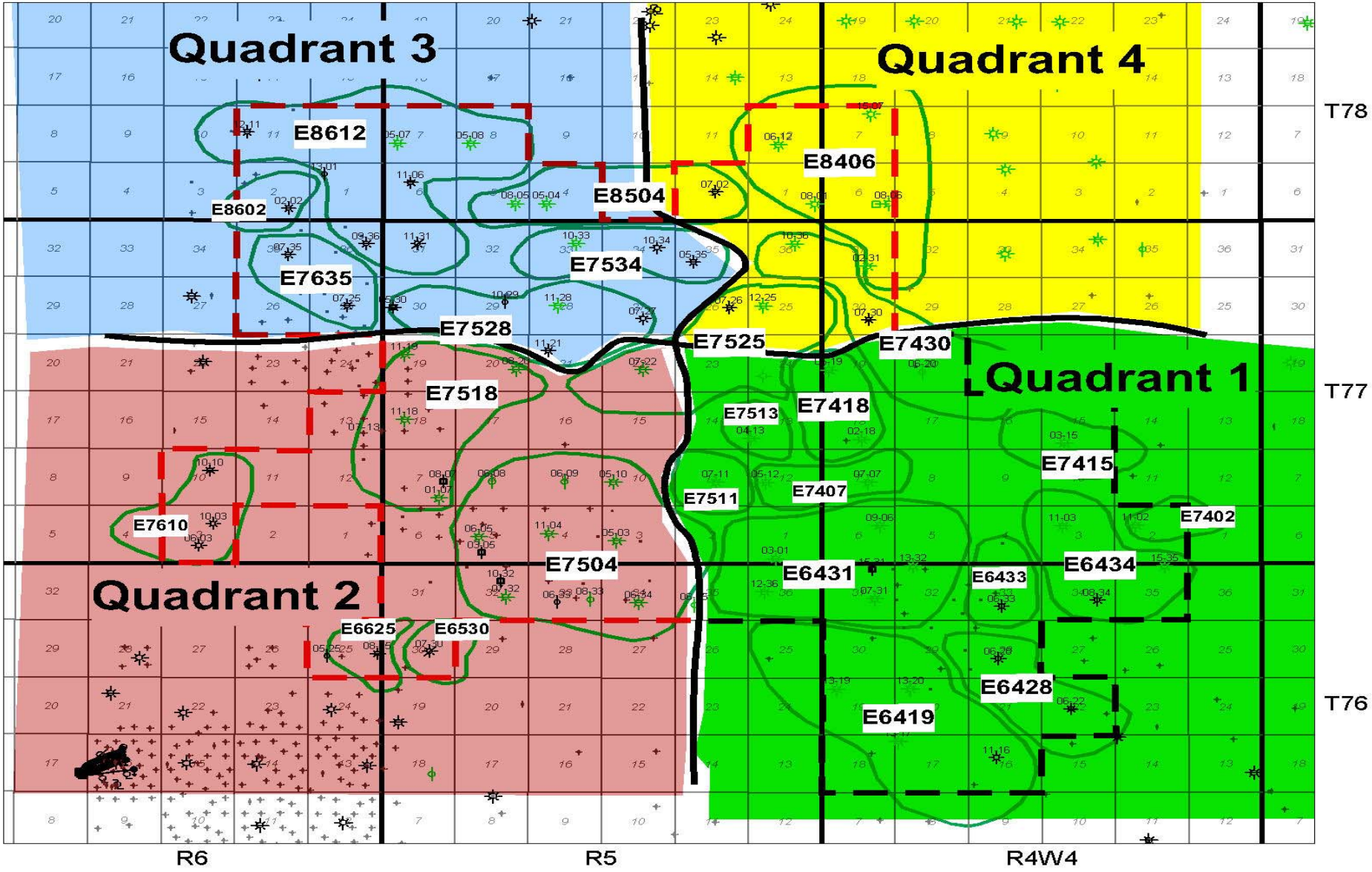
PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

Actual Field Pressure vs Time

Pool Pressure Trend Quadrants

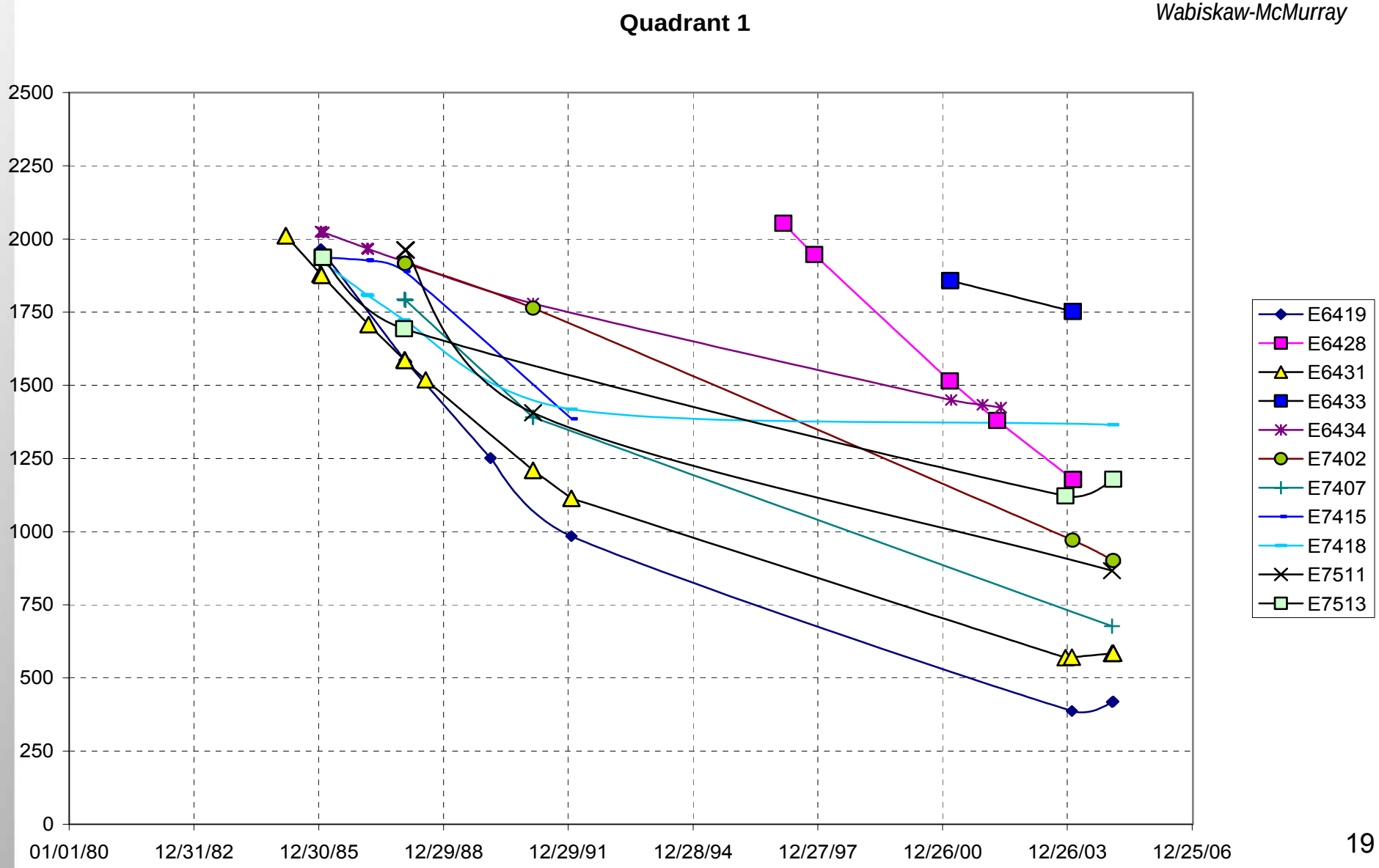


Quadrant 1

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

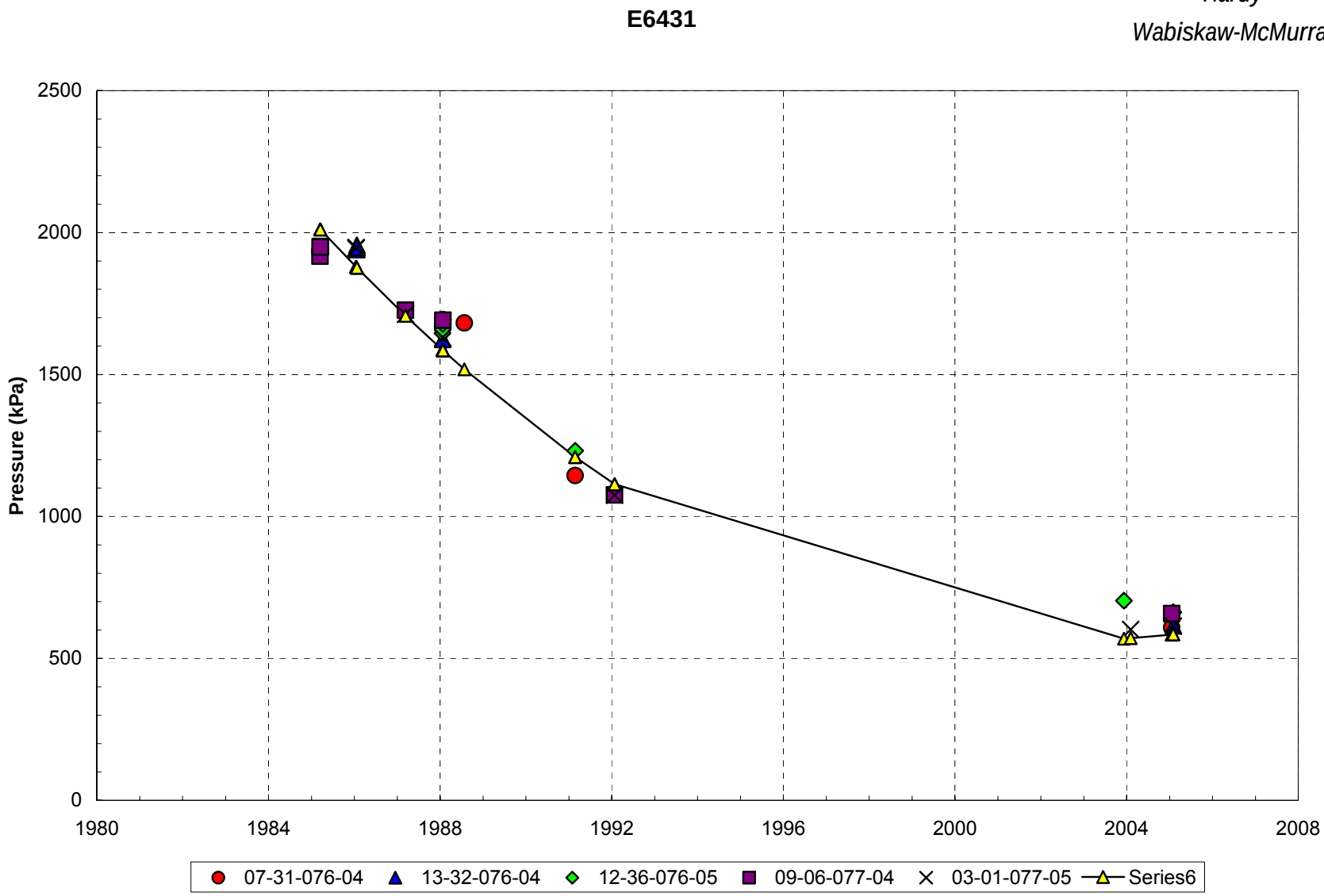


An Example of Trendlines Plotted - E6431

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

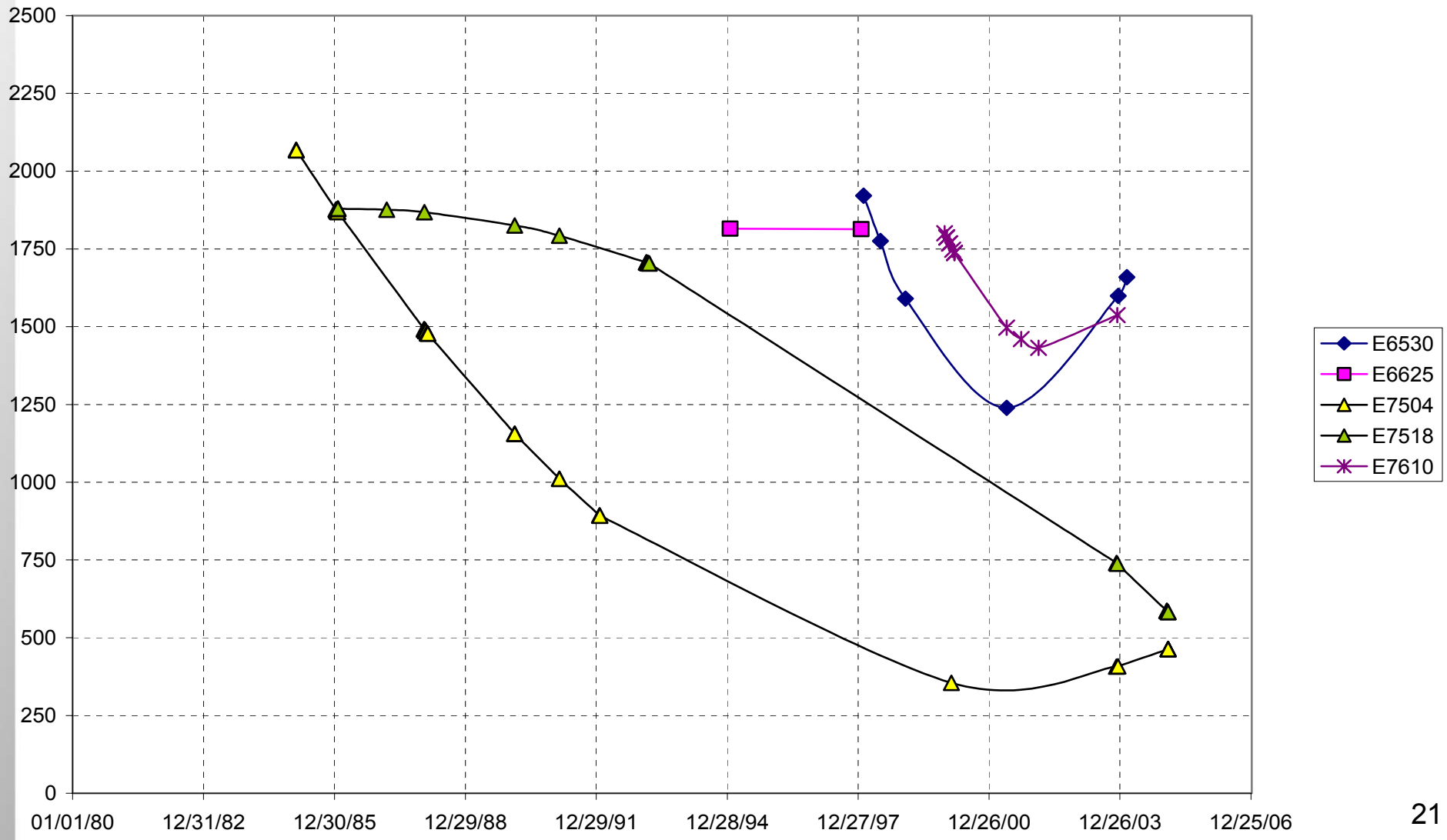


Quadrant 2

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

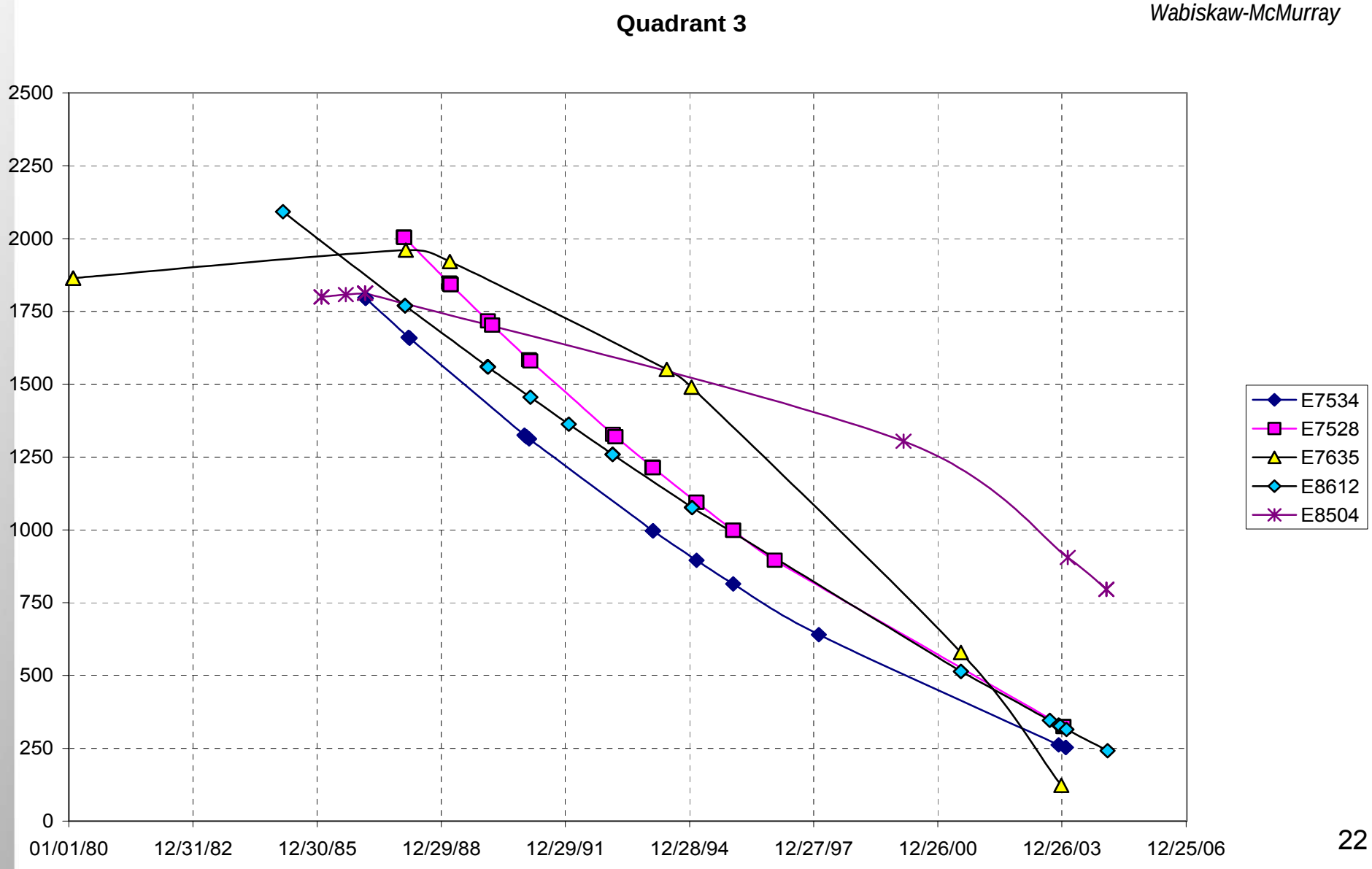


Quadrant 3

PARAMOUNT ENERGY TRUST

Hardy

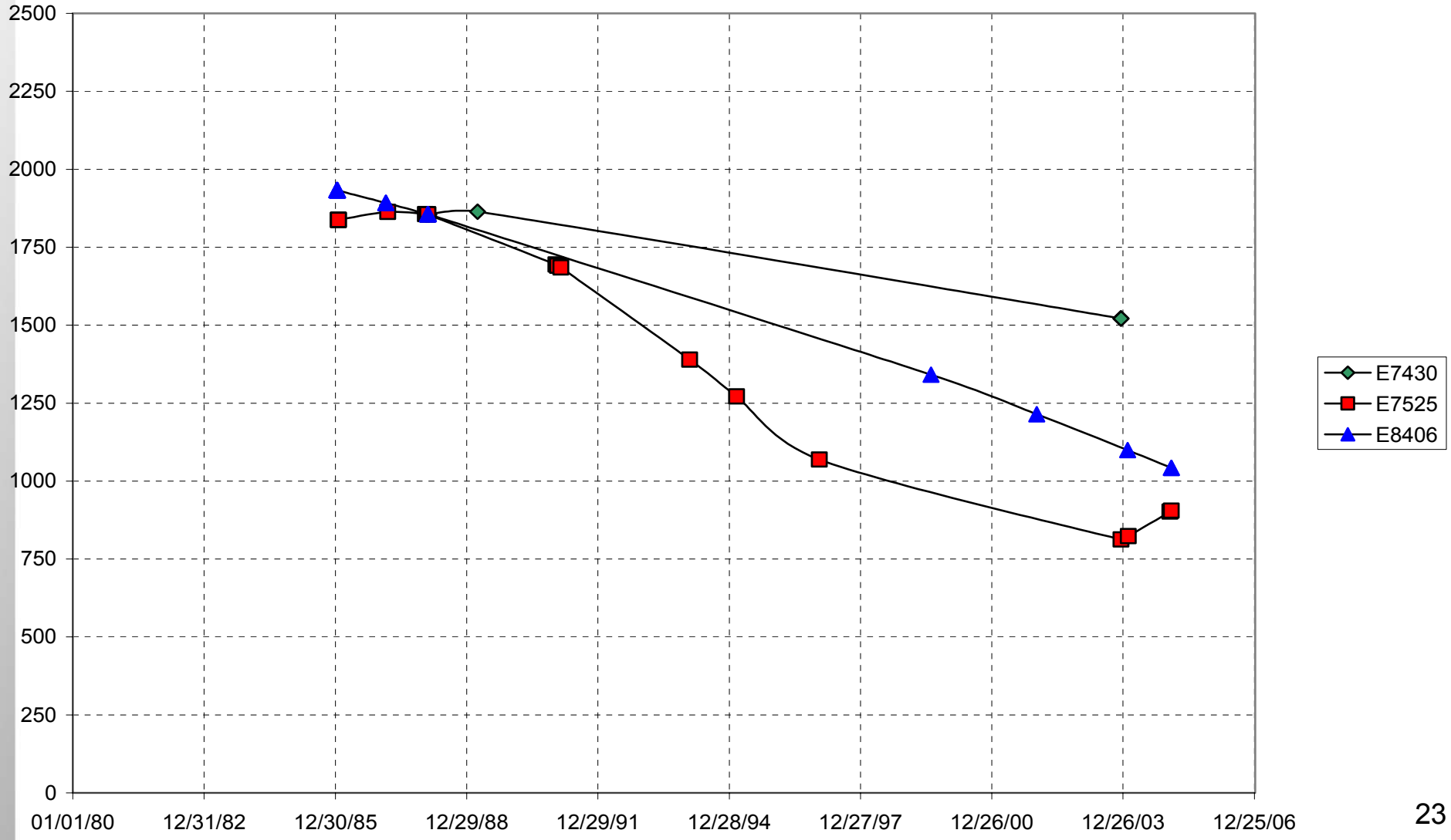
Wabiskaw-McMurray



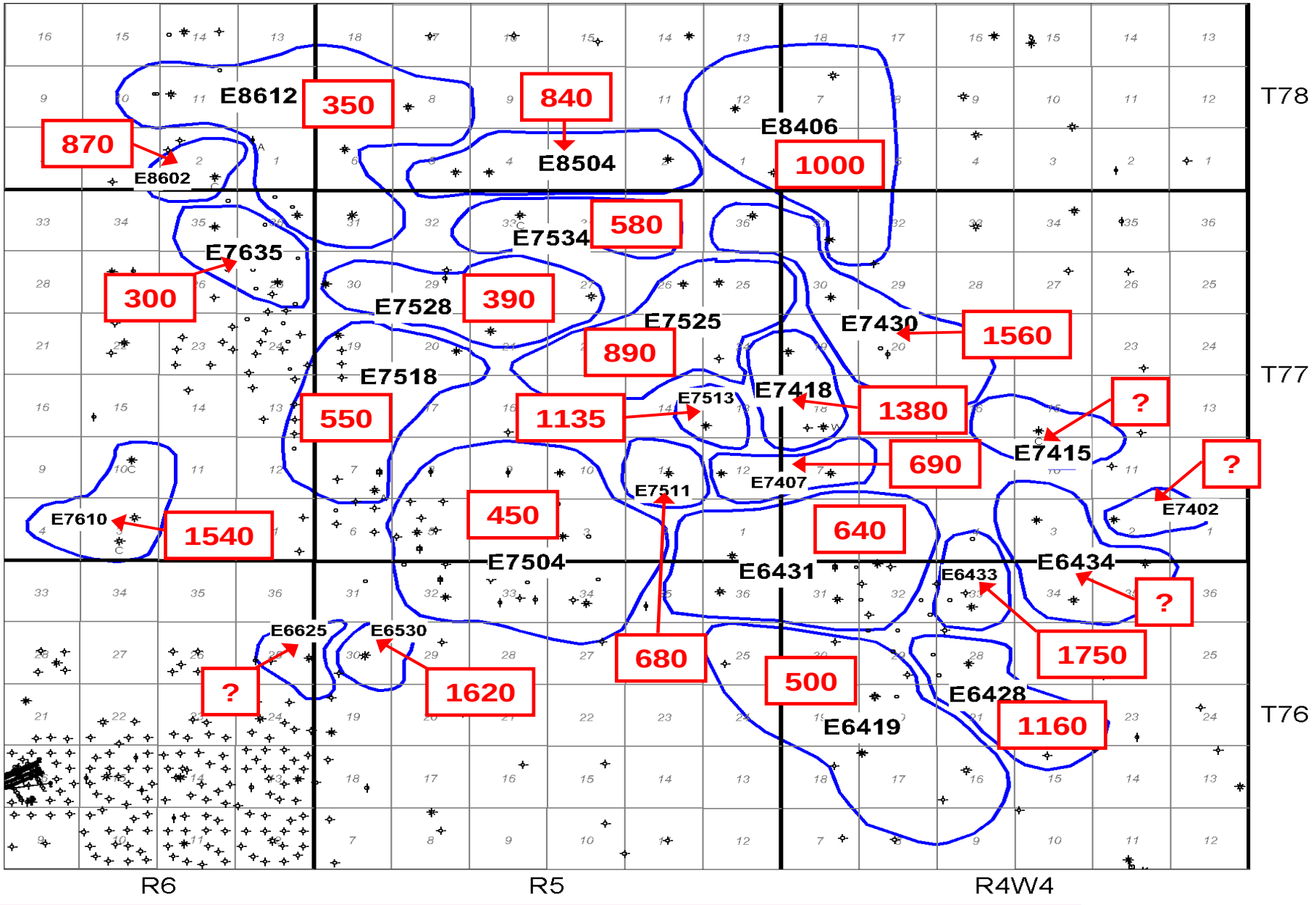
Quadrant 4

Hardy

Wabiskaw-McMurray



Current 2004/2005 Pool Pressures



PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

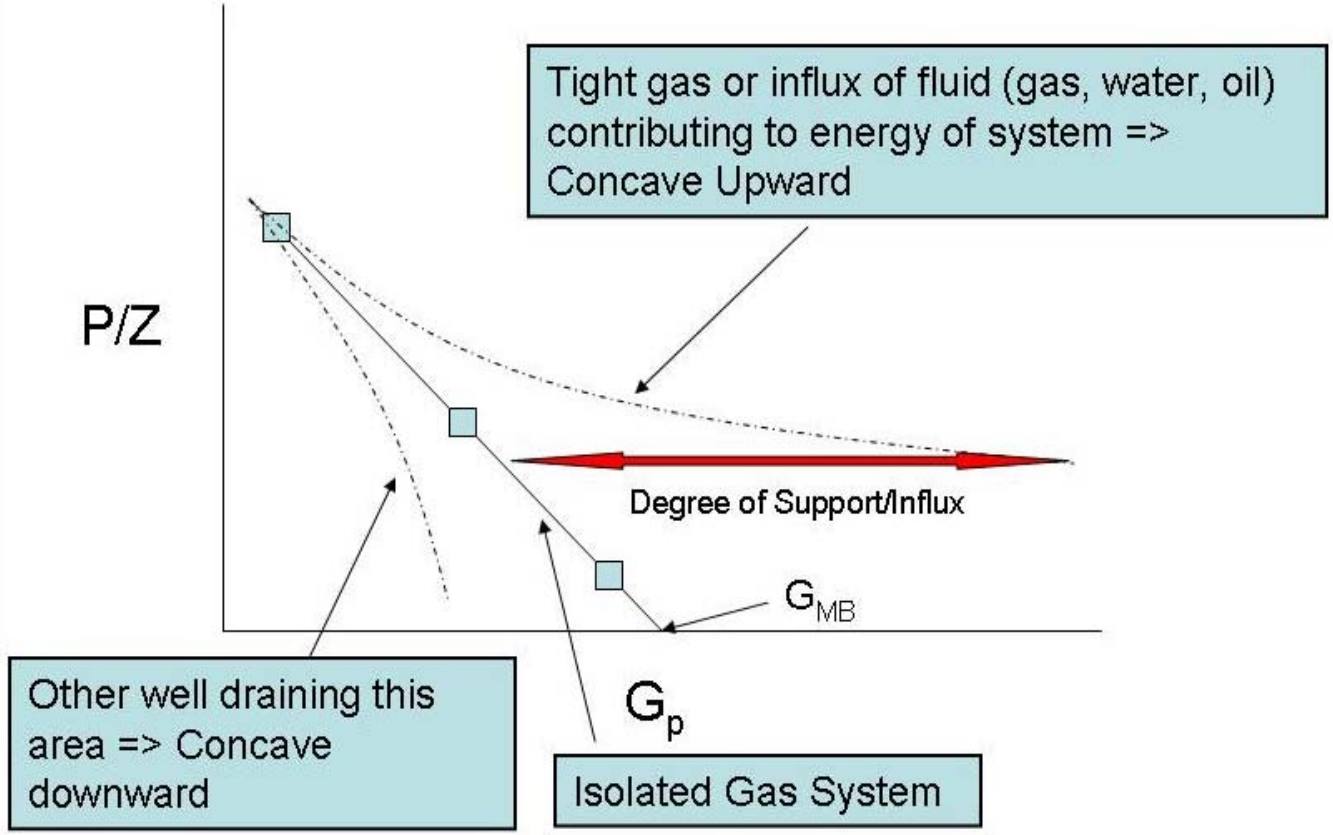
Pressure/Z vs Gas

Material Balance P/Z vs. Gp Scenario Schematic

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

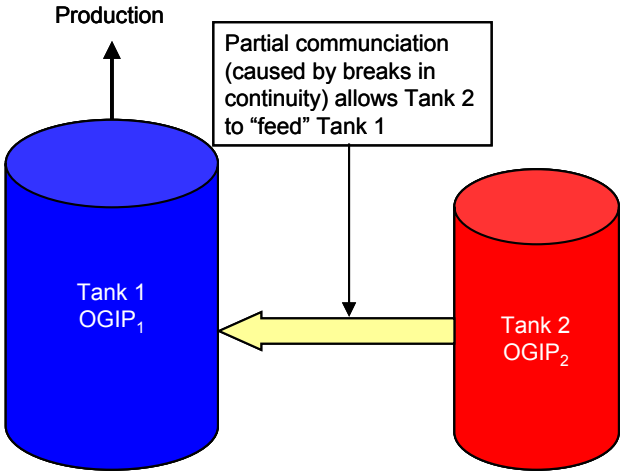


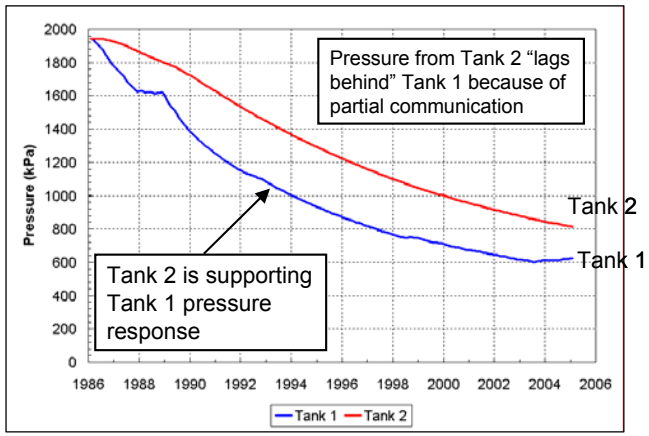
Communicating Tanks Model

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray





Used in 4 of 25 pools

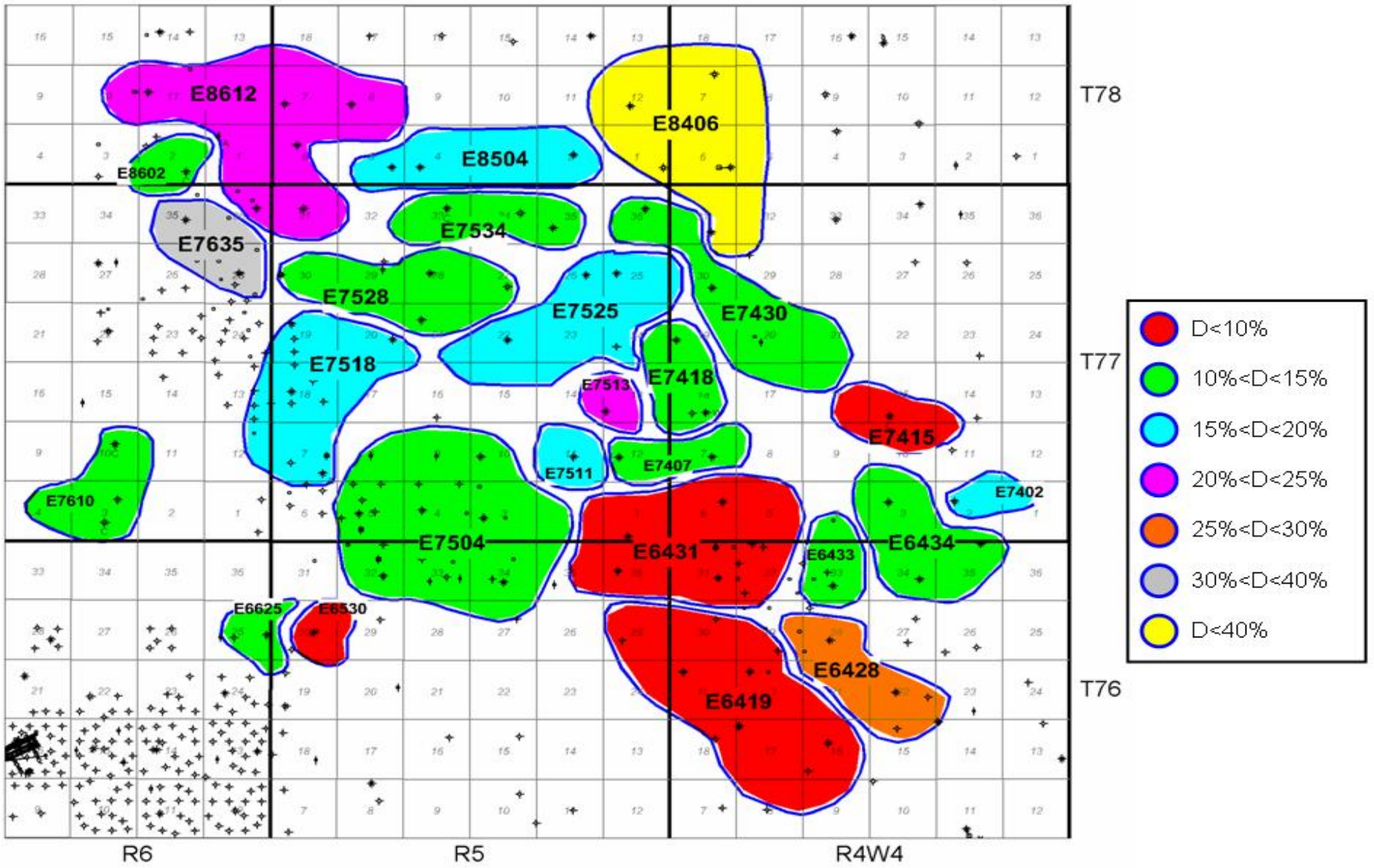
PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

Production Decline

Areal View of Pool Decline Rates



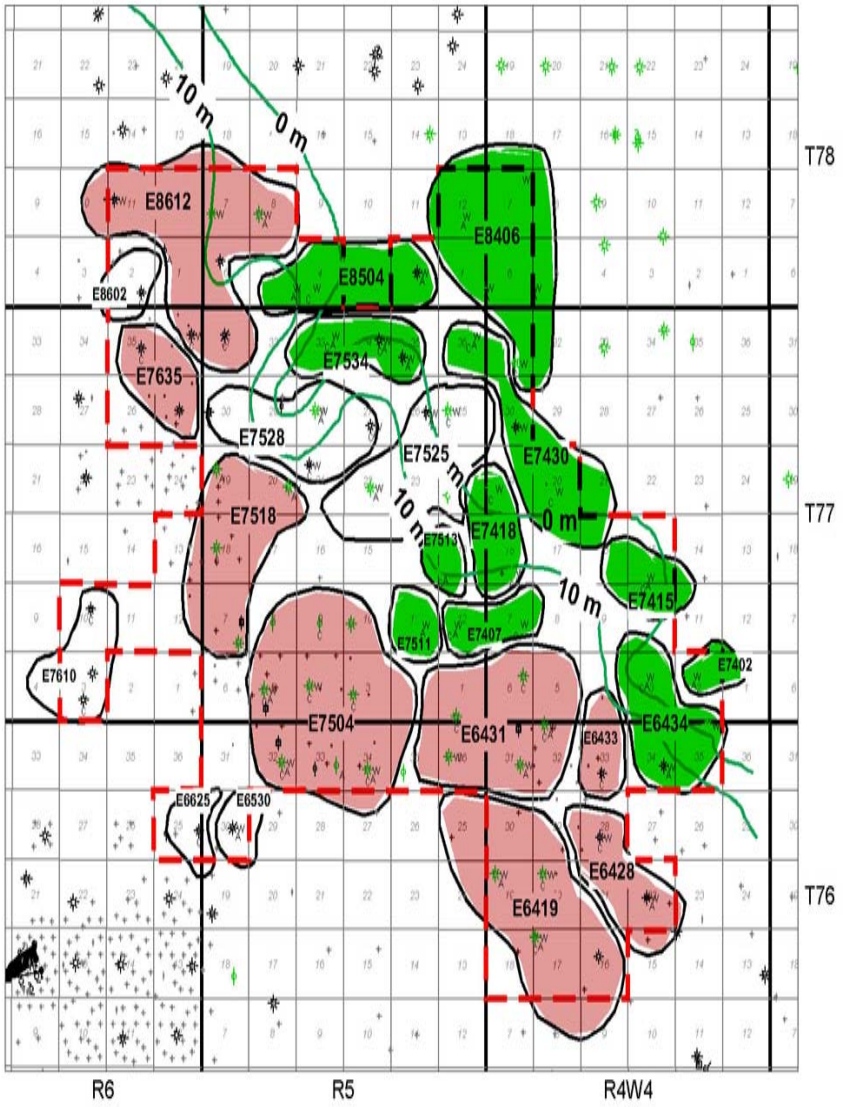
PARAMOUNT ENERGY TRUST

Hardy

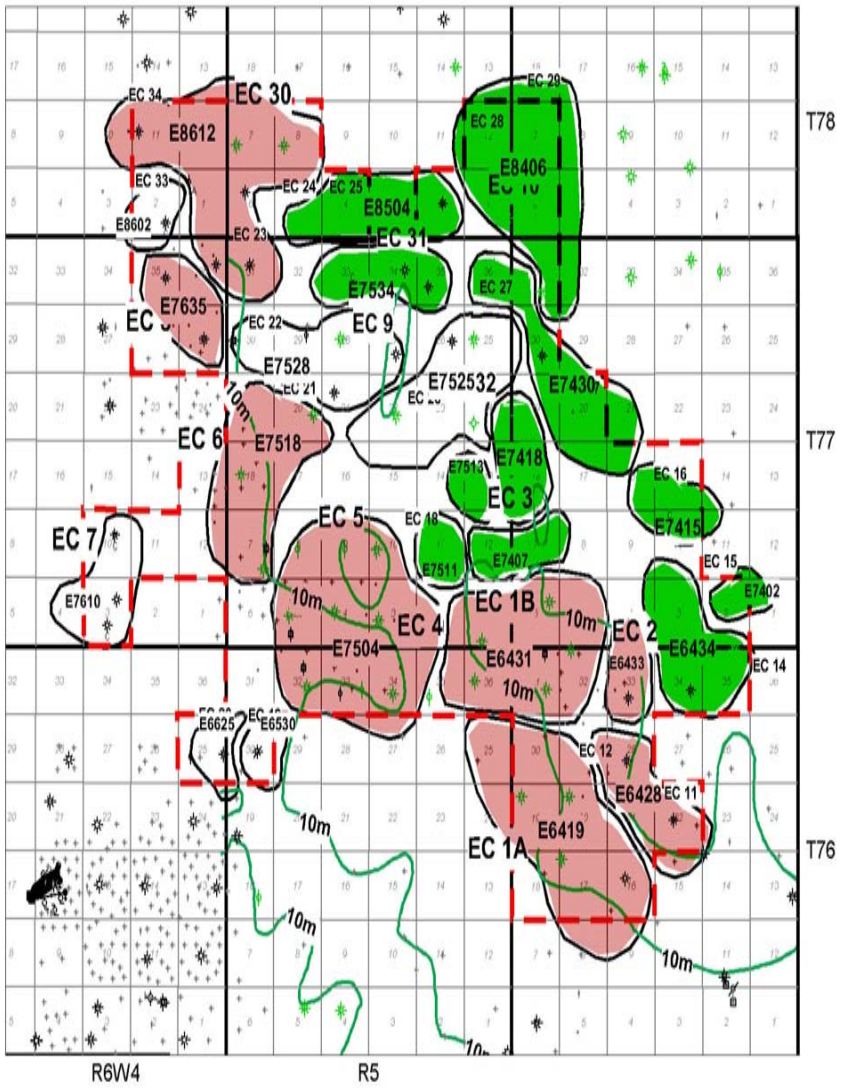
Wabiskaw-McMurray

Suitability for Thermal Development

Potentially Recoverable Bitumen



RGS



Petrel Robertson

SUMMARY

PARAMOUNT ENERGY TRUST

Hardy

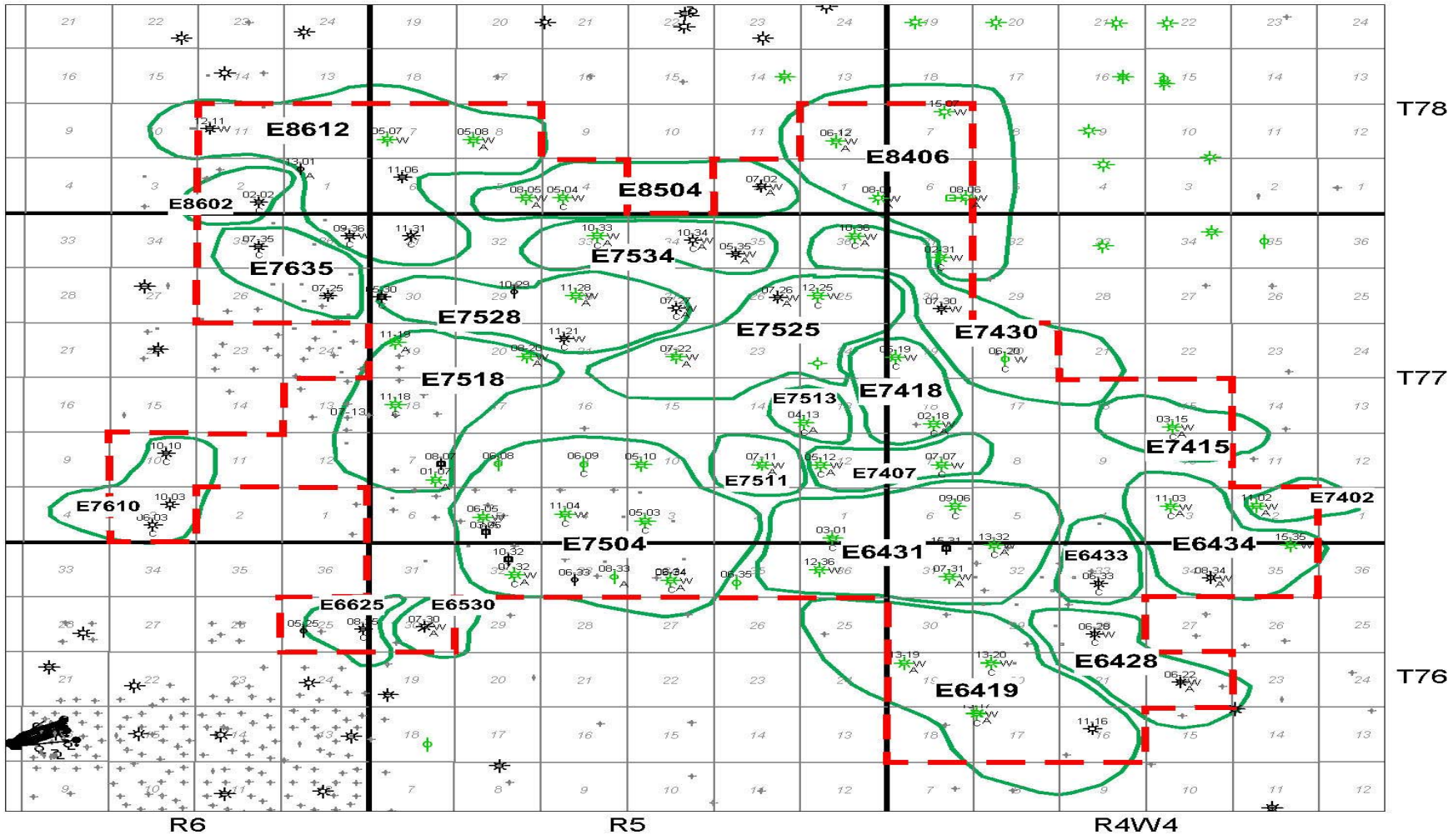
Wabiskaw-McMurray

- There is sufficient usable pressure data to make pooling decisions
- The pressure behavior within each smaller pool shows little difference within the pool, but distinct differences between other smaller pools;
- Analysis is based on an integration of pressure, production, geological and geophysical data;
- Disconnects (compartmentalization) in pool continuity supported by pressure and production decline differences, contact differences and seismic breaks;
- Smaller pools can be defined in the current Hardy Wabiskaw-McMurray A Pool resulting in revised ROI's

Gas Pools in Hardy as determined by EPIC Consulting Services Ltd.

PARAMOUNT ENERGY TRUST

Hardy



SCENARIOS

PARAMOUNT ENERGY TRUST

Hardy

Wabiskaw-McMurray

- Case 1 – Non-associated gas - Wabiskaw C where the Wabiskaw D is present and sealing, or McMurray gas where there is no underlying McMurray bitumen (produce).
- Case 2 – Associated gas - McMurray where there is insufficient bitumen (<10m), or Wabiskaw C gas where the regional Wabiskaw D shale is missing (produce).
- Case 3 – Associated gas (McMurray or Wabiskaw C gas where the regional Wabiskaw d shale is missing) where there is sufficient bitumen (>10m) but is not viable according to the GIAG Thermal Sub-Committee recommendations (produce)
- Case 4 – Associated gas (McMurray or Wabiskaw C gas where the regional Wabiskaw d shale is missing) where there is sufficient bitumen (>10m) to be viable according to the GIAG Thermal Sub-Committee recommendations. PEOC's modelling work shows that SAGD recovery is insensitive to top gas pressure, and therefore these wells should also be allowed to produce.