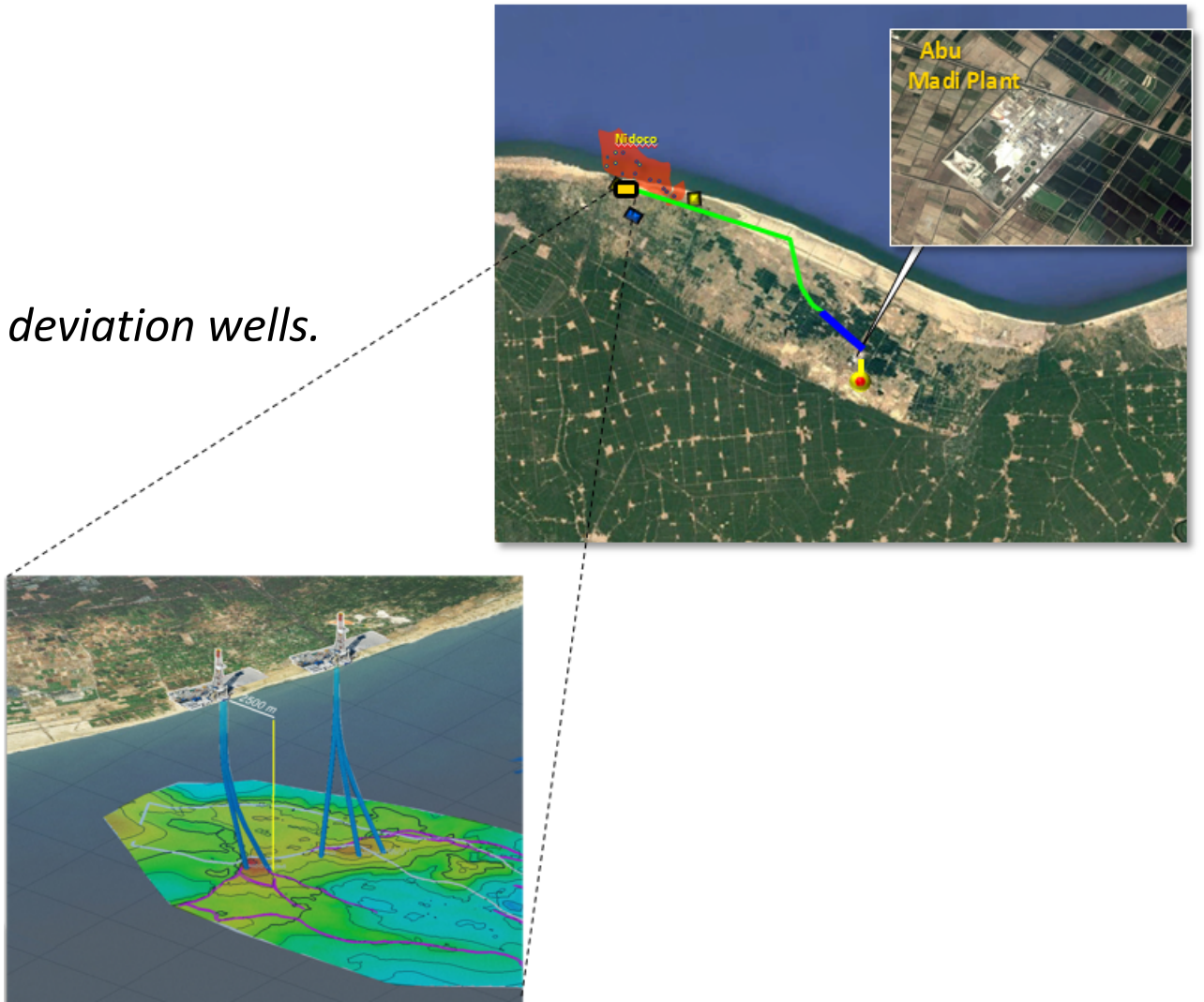
Study the impact of improper choke design on gas production profile

Sep-2019

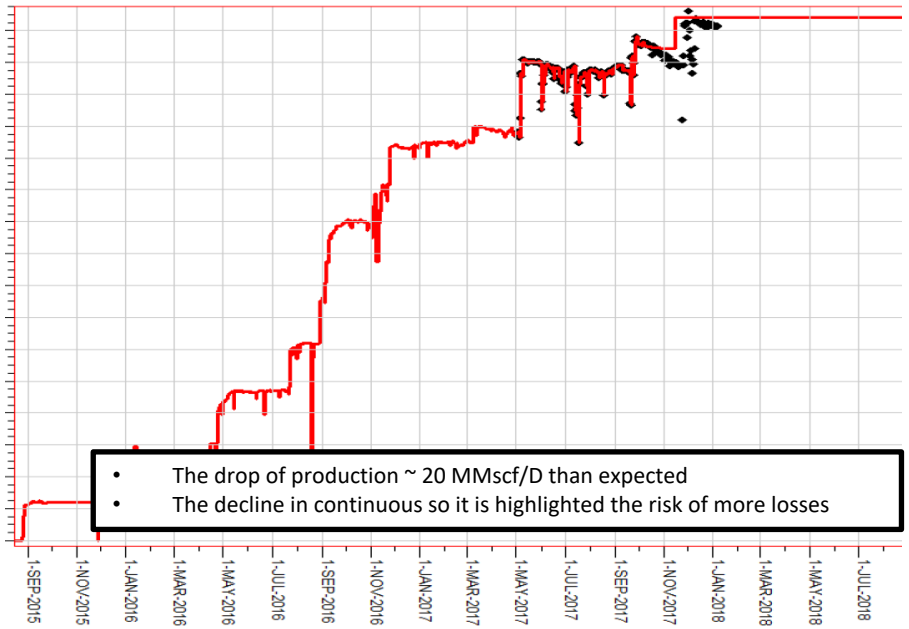
Field General Overview

- *Nidoco Offshore gas filed discovered and operated by ENI Egypt,*
  - *Gas Discovered at Jul-2015*
  - *Production start up Aug-2015*
  - *Reach Max plateau Nov-2017 (1150 MMSCF/D)*
  - *Offshore field drilled from onshore location with deviation wells.*
  - *Total Number of wells 14 wells*
  - *Production process at Abu madi plant & EPF*
  - *Maximum plants capacity ~ 1200 MMscf/D*



Case study

- *Normal workflow*
  - *Nidoco Offshore field drilled from onshore location with deviation wells up to ~ 4000 Mt depth*
  - *The production profiles were generated initially using 3D model approach with generic constrains such as ;*
    - Plant capacity.
    - Arrival pressures.
    - Well deliverability and max draw down.
    - VLP of well completions.
    - Initial erosion rate as max production rate for each well
- *The issue;*
  - *After drilling 10 wells the plateau declined early than expected,*
  - *The main concerns of the decline "which is not implemented in normal work flow";*
    1. *Choke size.*
    2. *Orifice restriction.*



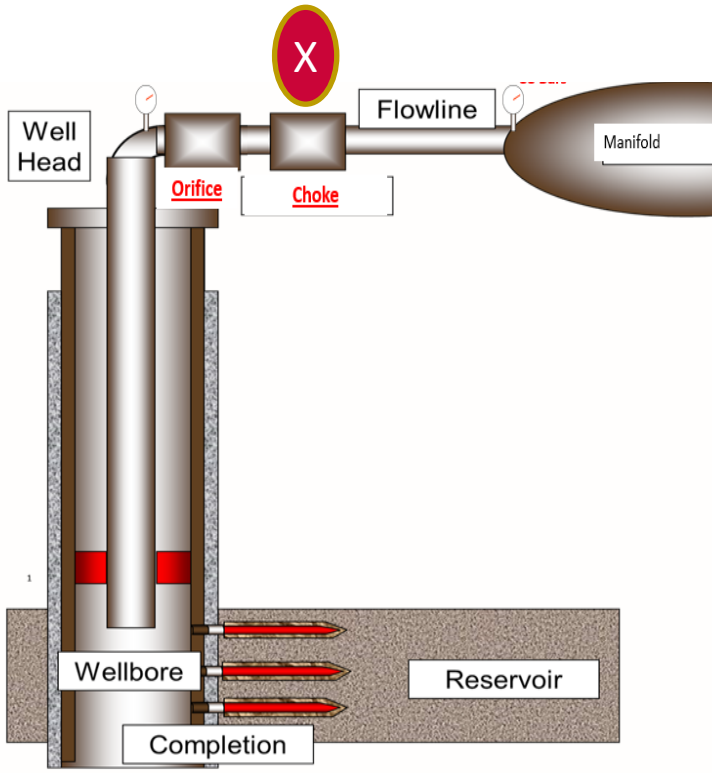
- *The challenges;*
  1. *Capture the above mentioned issues and re-generate a forecast profile to capturing the effect of further constrains*
  2. *Provide an optimization and improving actions to recover the production*

Objective

- *Study the impact of improper designed elements on the production forecast,*

1. *Surface elements (Orifice & Choke) ?*
   - *The production profiles forecast assumed that there is no pressure drop in the X-Tree valves.*
   - *The pressure drop across the any surface elements is a function of gas rate, so it can't be consider a constant pressure drop*

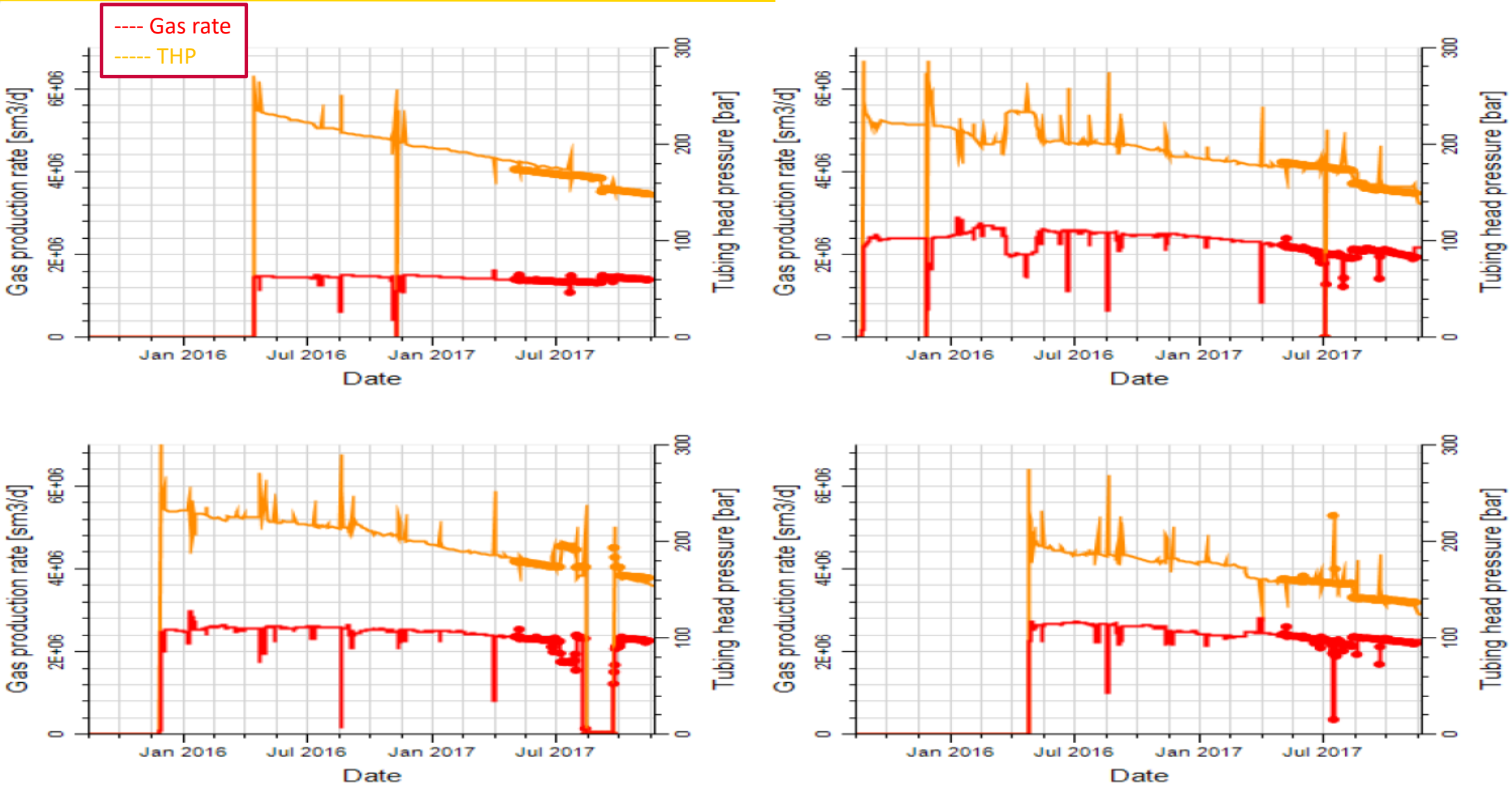
1. *Differentiate between the impact of each Surface element.*
   - *For operational actions it is important to quantify the impact of each surface element individually.*



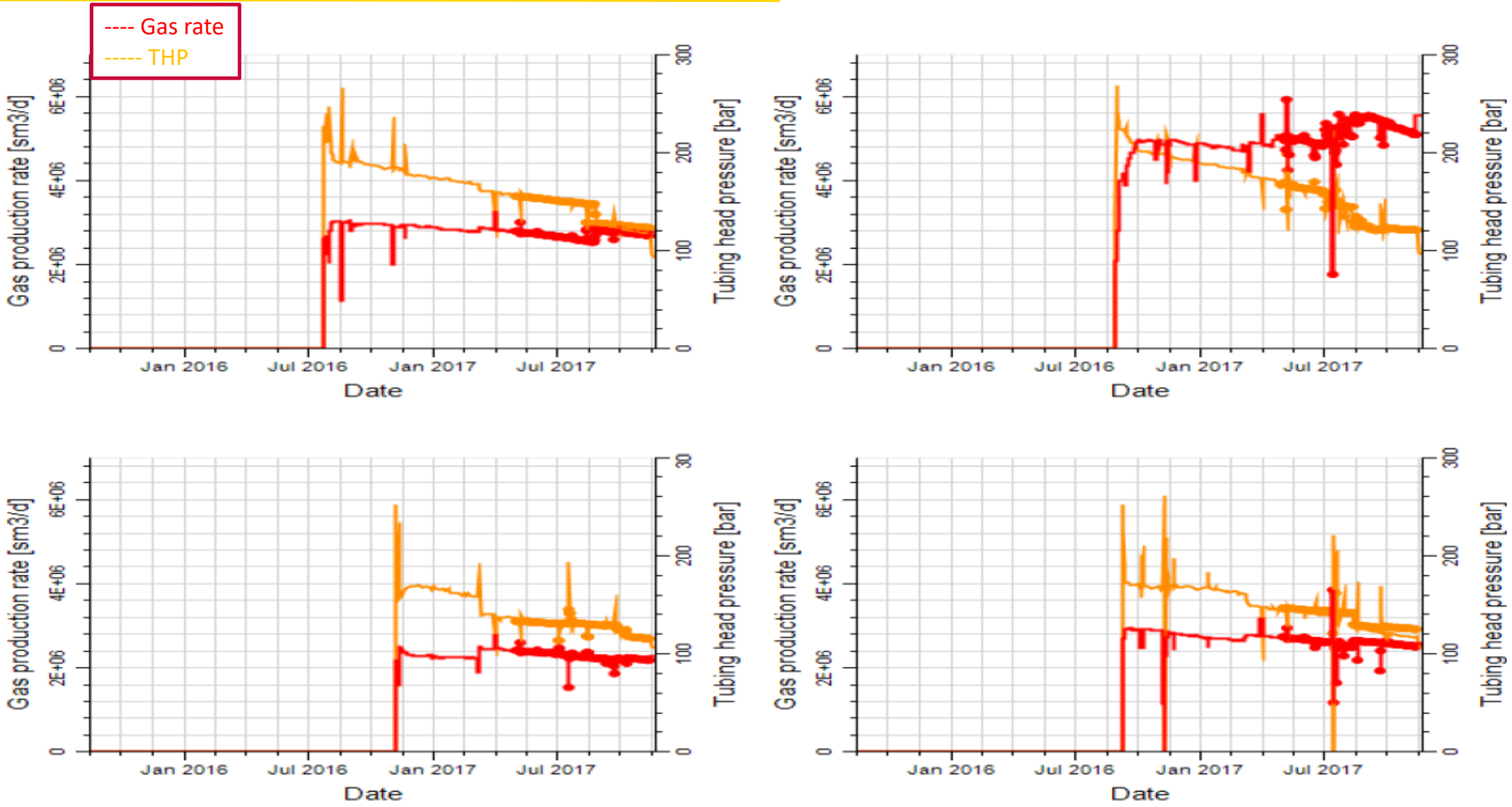
Updated Workflow

Action	Tool
1- Update the history match and generate production forecast using generic constrain with current wells rate as control	Eclipse
2- Model the impact of surface elements (orifice & choke)	Pipesim
3- Include the impact of surface elements (choke & orifice) in eclipse (Network option)	Eclipse/Network Model
4- Study the impact of the current choke size only by removing the orifice from the network.	Eclipse

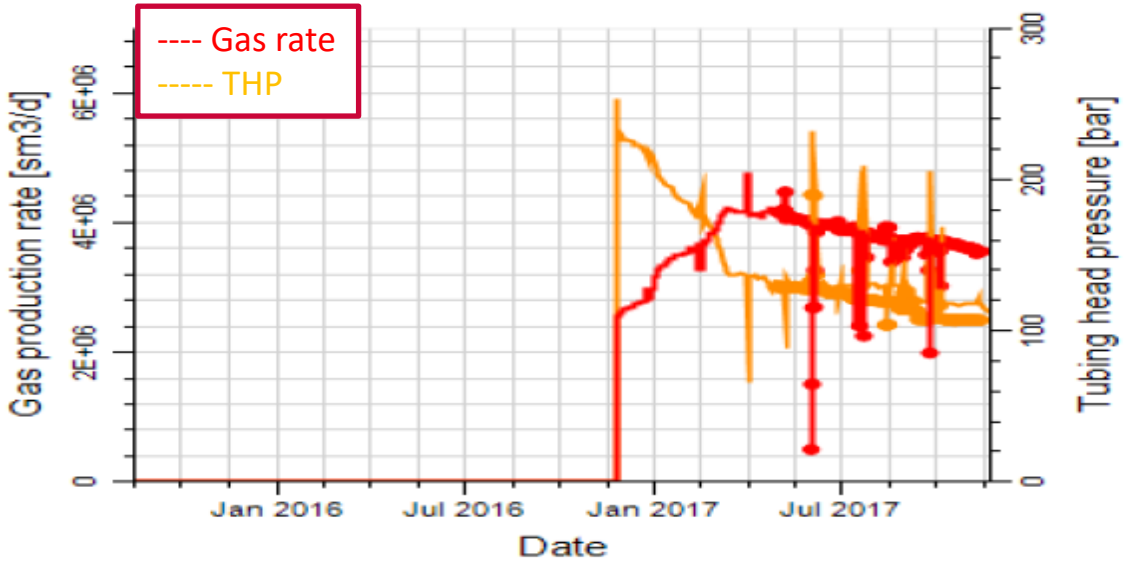
History Match

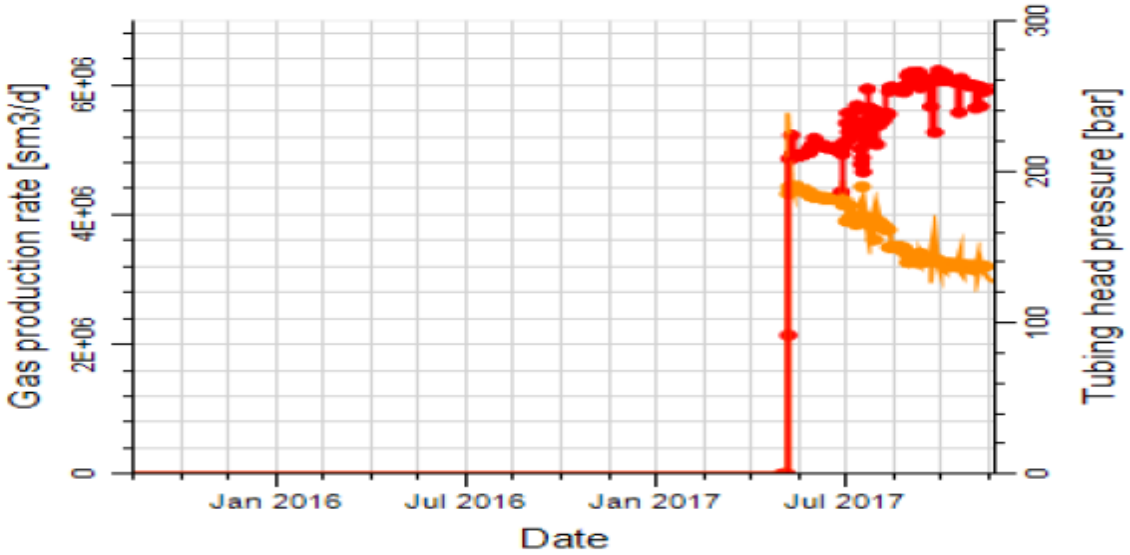


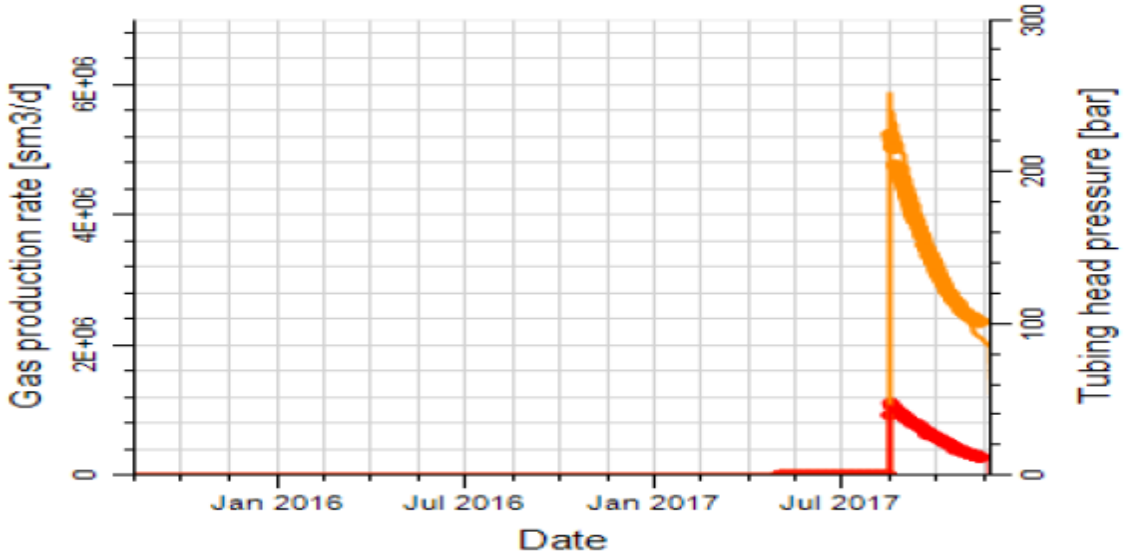
History Match



History Match







Forecast Profile using generic Constrains

1150 MMSCF/D plateau, Current gas rate of wells for production control

- Applying normal workflow the failed can sustain the plateau of 1150 MMSCFD for one year

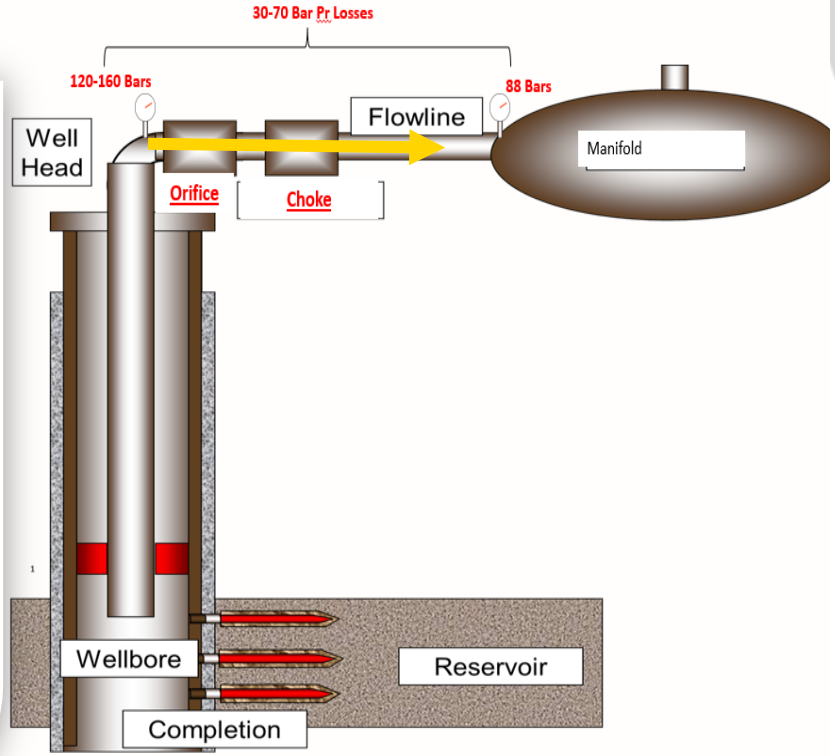
Surface restrictions (Choke & Orifice)

Overview

The gas phase pressure drop is given by Bernouilli's equation:

$$\Delta p_G = \frac{\rho_n}{2 \cdot c}\left(\frac{v}{c_{vG} \cdot Z_G}\right)^2 \qquad \text{[Eq. 1089.4]}$$

$v = \frac{q}{A_{bean} \cdot \rho_n}$	is the mixture velocity through the choke	ft/s	m/s
q	is the mass flow rate	lb/s	kg/s
$A_{bean} = \frac{\pi \cdot d_{bean}^2}{4}$	is the choke area at the constriction	ft^2	m^2
$\rho_n = \lambda_L \cdot \rho_L + \lambda_G \cdot \rho_G$	is the no-slip density	lb/ft^3	kg/m^3
λ_L and λ_G	are the liquid and gas phase flowing fractions		
ρ_L and ρ_G	are the liquid and gas phase densities	lb/ft^3	kg/m^3
$Z_L = 1$ and $Z_G = 1 - \frac{0.41 + 0.35\,\delta^4}{\gamma} \cdot \frac{\Delta P}{P_{up}}$	are the liquid and gas compressibilities		
c	is a conversion factor for engineering units	$c = 144 \cdot g\ lb/(ft \cdot s^2)/psi$	$c = 1$



$$\Delta P_G \propto \frac{1}{\rho_n}\left(\frac{Q_G}{A_{beam}}\right)^2$$

Surface restrictions (Choke & Orifice)

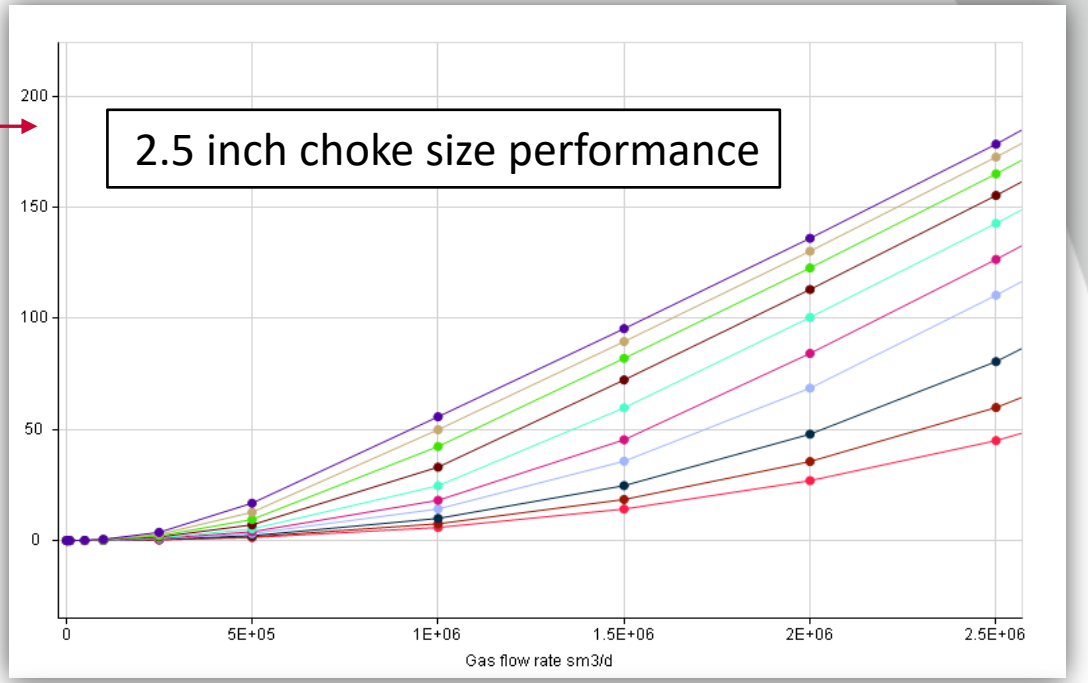
Pressure drop match & pressure drop relations generations

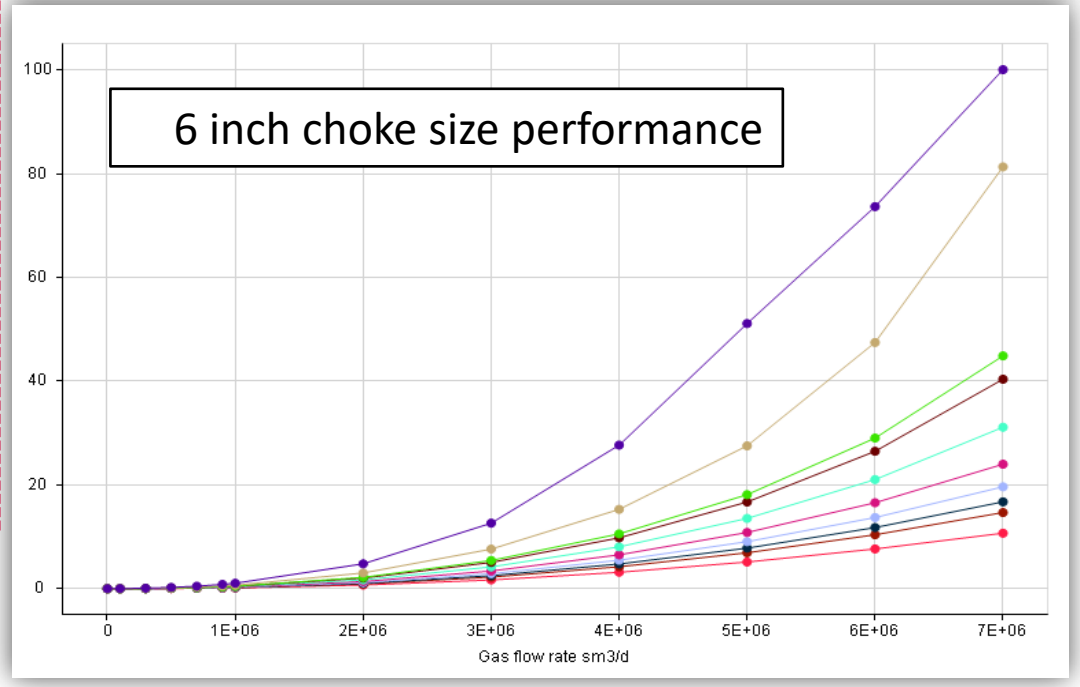
Well	Upstream Bars	Mid stream Bars	Downstream Bars	Gas rate MSmc/D
1	149.2	109.8	85.6	1.4
2	123.8	88.7	85.4	2.68
3	115.9		85.3	2.18
4	149.9	95.8	88.3	1.95
5	162.7	119.4	87.6	2.26
6	137.4	127.6	87.8	2.20
7	125.9	98.8	87.4	2.50
8	107.3		87.8	3.56
9	121.7		87.8	5.10
10	137.7	110.6	88.1	5.90

Model the choke & orifice performance Using Nodal analysis;

- For each well generate the model of the choke and orifice.
- Match the pressure drop across each surface element per well.
- Generate VLP curve " Vertical lift performance" for each surface element with expected range of gas rates and pressures

Pressure drop Across Choke & Orifice (Bars)

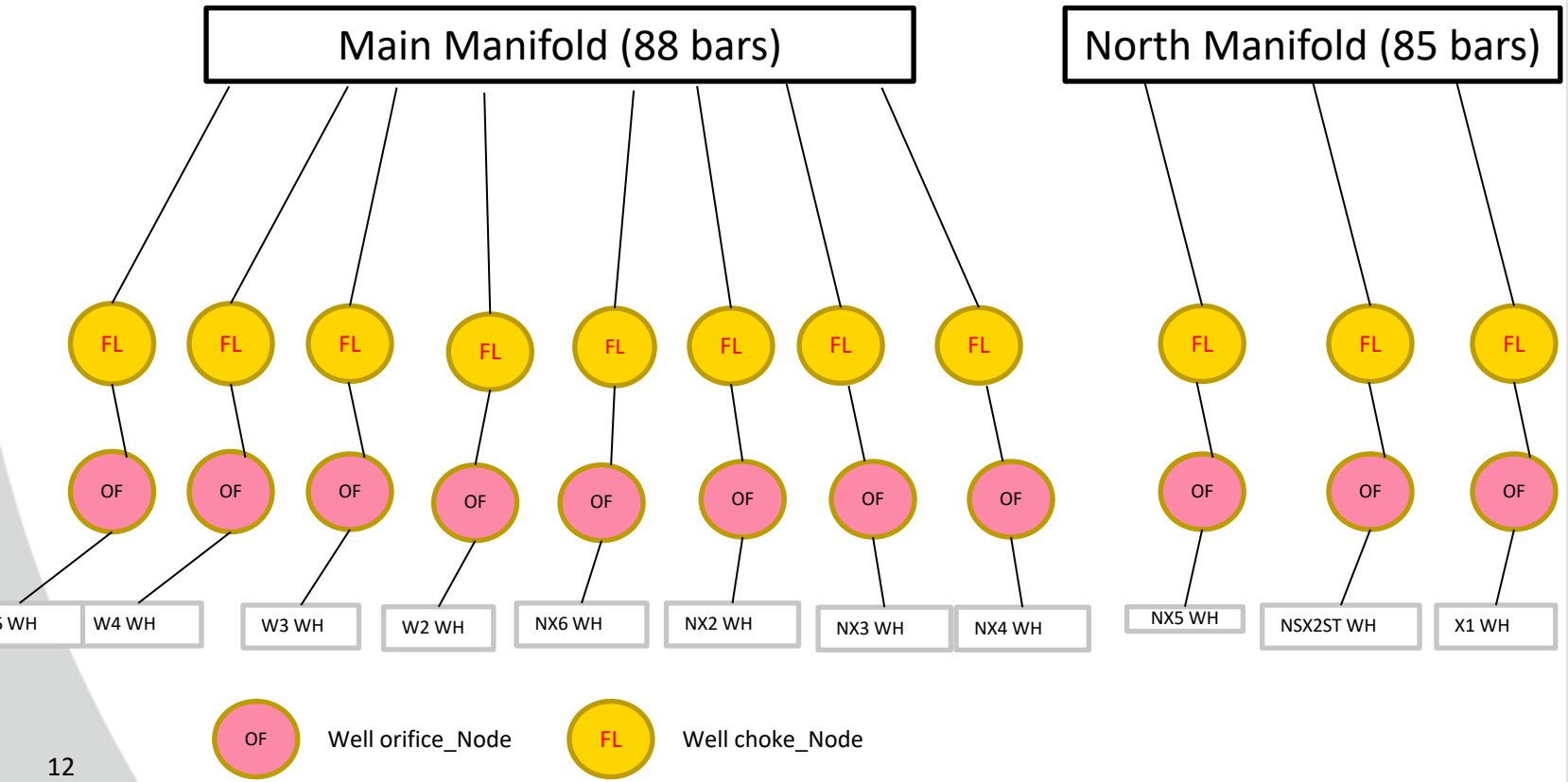




Surface restrictions (Choke & Orifice)

Implement the surface elements to 3D model

- *Generate VLP curves for each element in the surface components*
- *Build network model as descried below to integrate the VLP with the 3D model results*



Eclipse keywords

GRUPTREE

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PLANT FIELD /
M_MASTER PLANT /
NX2_FL M_MASTER /
NX2_OF NX2_FL /
NX2_WH NX2_OF /
NX3_FL M_MASTER /
NX3_OF NX3_FL /
NX3_WH NX3_OF /
NX4_FL M_MASTER /
NX4_OF NX4_FL /
NX4_WH NX4_OF /
NX6_FL M_MASTER /
NX6_OF NX6_FL /
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W2_WH W2_OF /
W3_FL M_MASTER /
W3_OF W3_FL /
W3_WH W3_OF /
W4_FL M_MASTER /
Ect ..

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BRANPROP

PLANT	FIELD	9999	/
M_MASTER	PLANT	9999	/
NX2_FL	M_MASTER	9999	/
NX2_OF	NX2_FL	23	/
NX2_WH	NX2_OF	22	/
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NX3_WH	NX3_OF	24	/
NX4_FL	M_MASTER	9999	/
NX4_OF	NX4_FL	27	/
NX4_WH	NX4_OF	26	/
NX6_FL	M_MASTER	9999	/
NX6_OF	NX6_FL	30	/
NX6_WH	NX6_OF	9999	/
W2_FL	M_MASTER	9999	/
W2_OF	W2_FL	32	/
W2_WH	W2_OF	31	/
W3_FL	M_MASTER	9999	/

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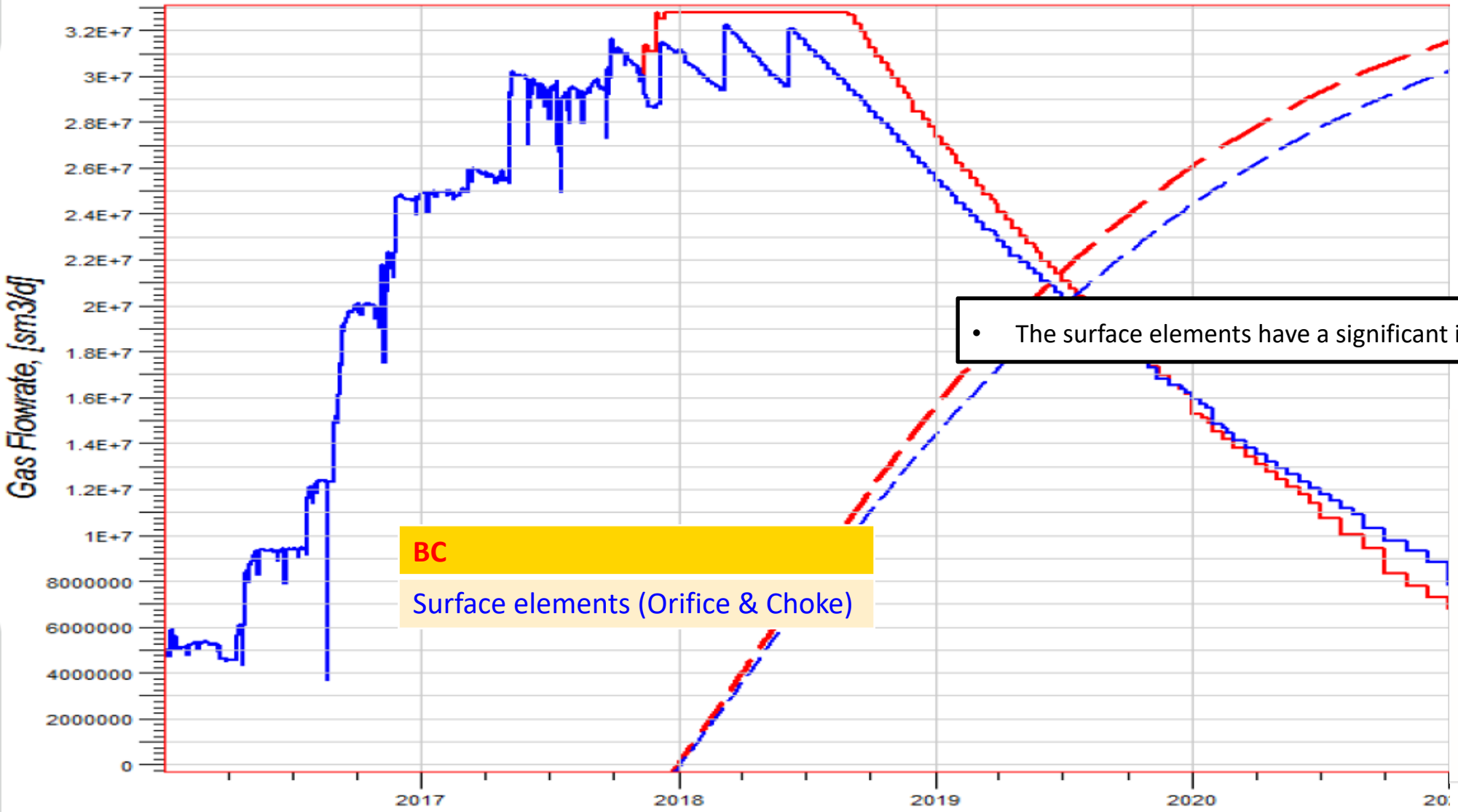
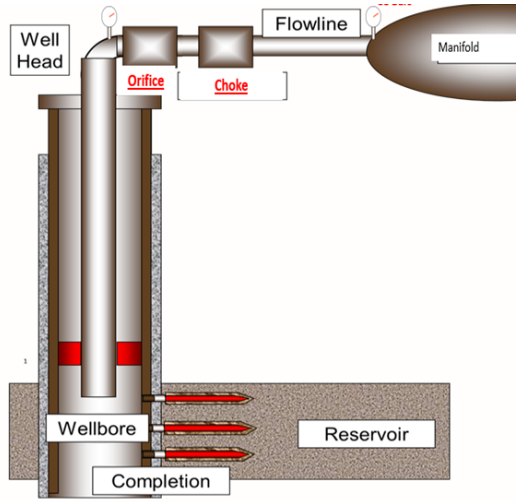
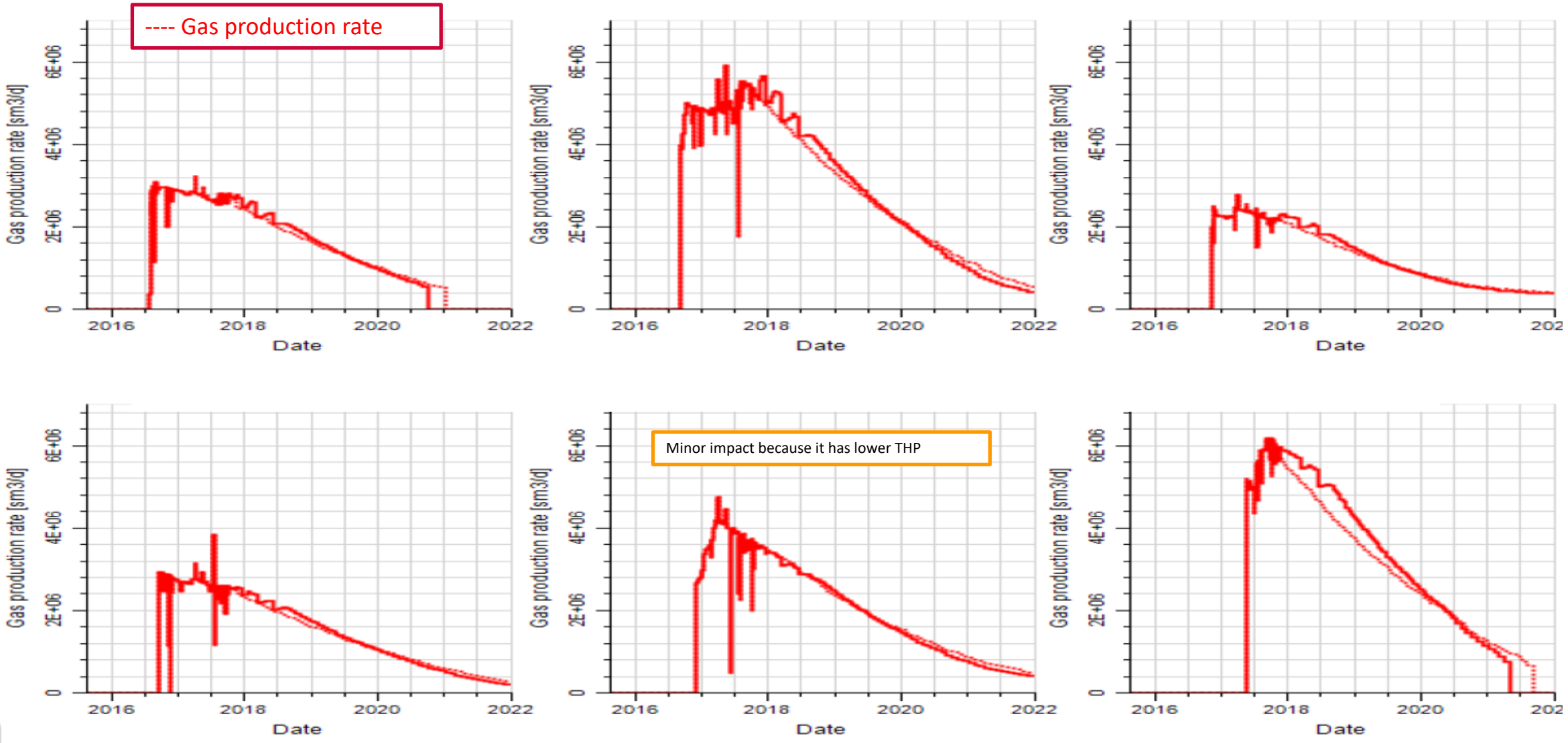
Impact of surface elements on Nidoco profile



- The surface elements have a significant impact on the production drop

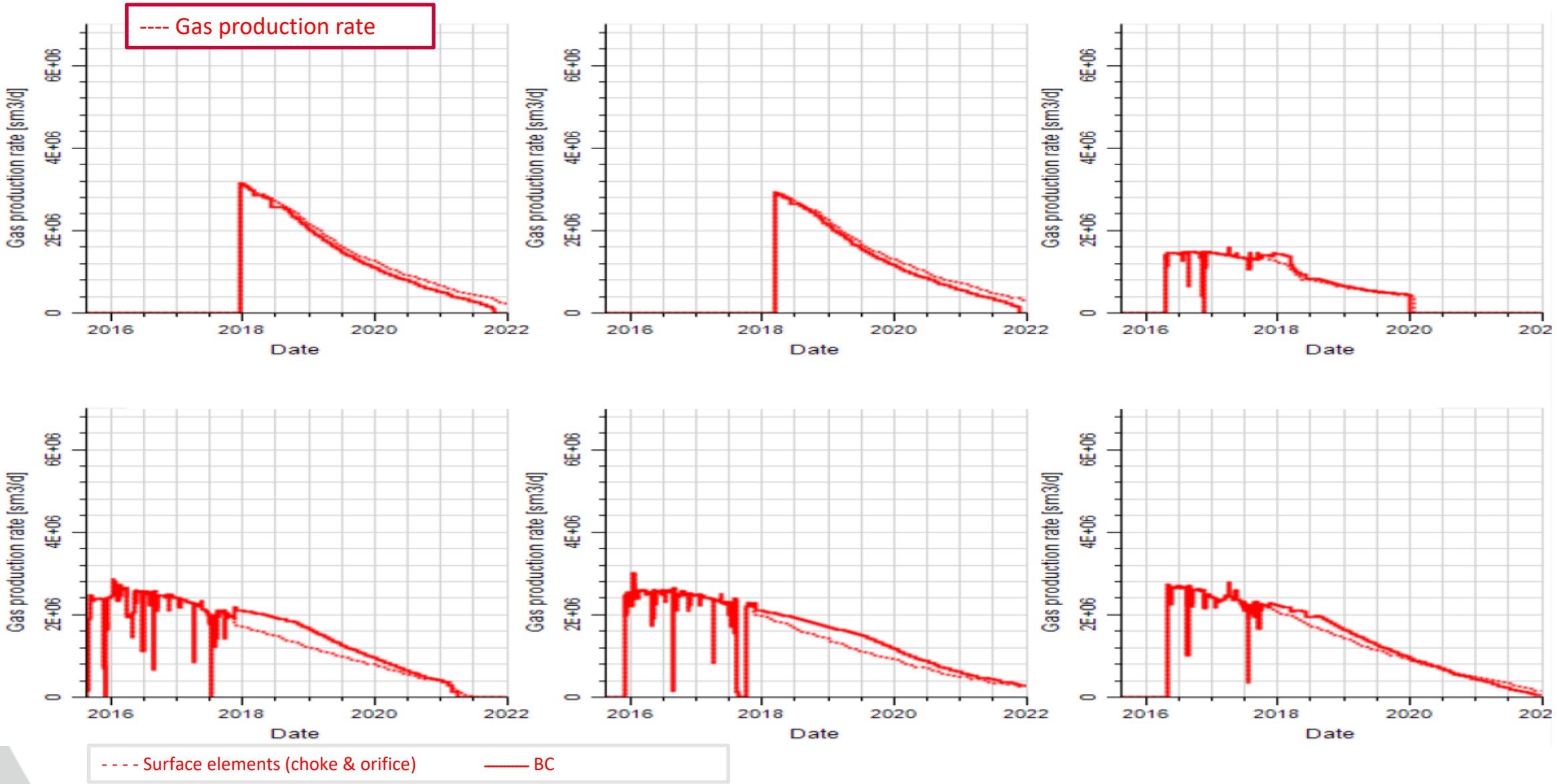


Impact of surface elements (Choke & Orifice) well by well



Impact of surface elements (Choke & Orifice) well by well

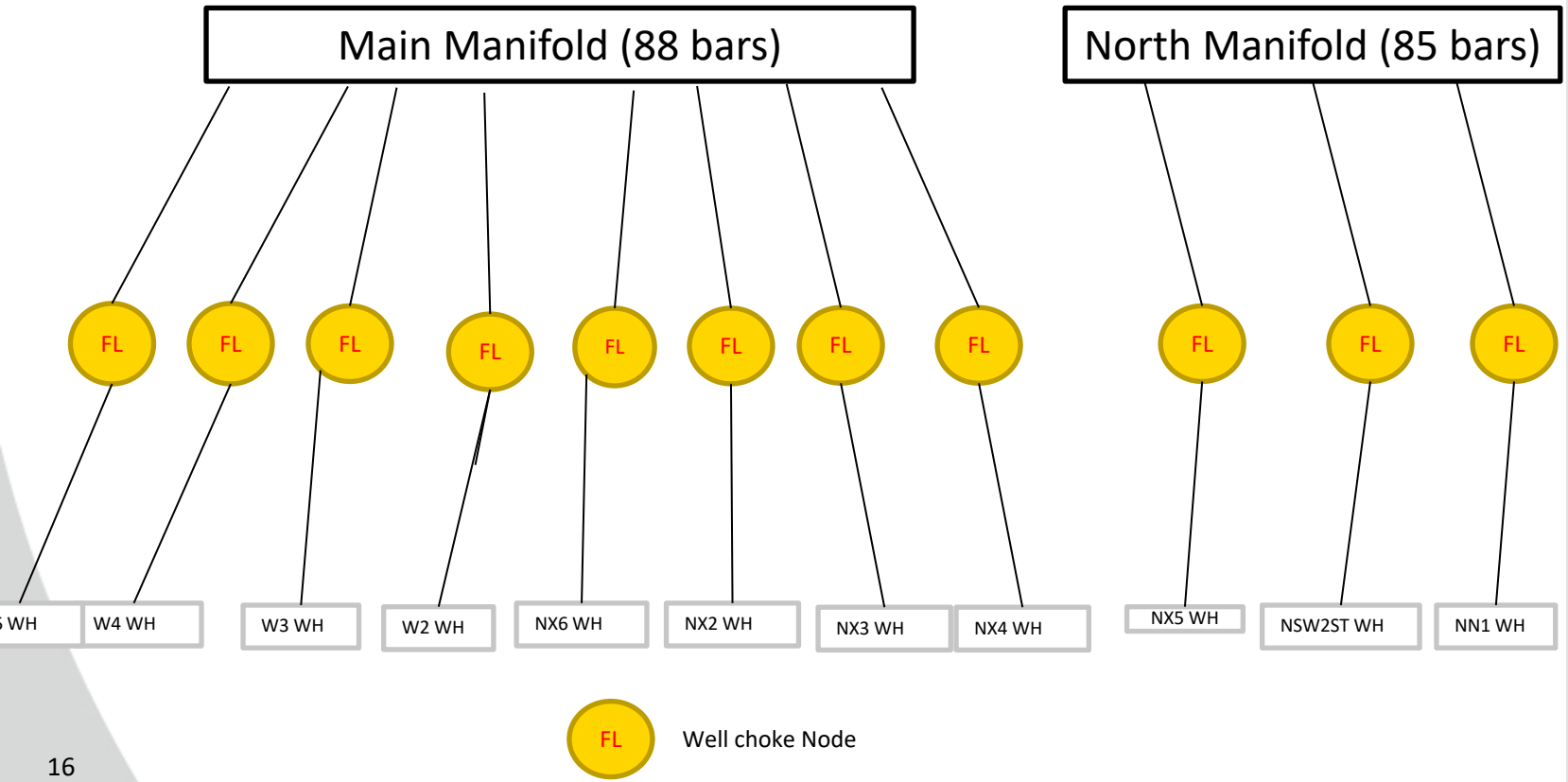
Cont.



Surface restrictions (Choke only)

Implement the surface elements to 3D model

- *Study the impact of **choke** if the orifice is removed.*
  - *Remove the orifice from the system*
  - *Build network model as descried below*



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W2_WH W2_OF /
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W3_OF W3_FL /
W3_WH W3_OF /
W4_FL M_MASTER /

Ect ..

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NX2_OF	NX2_FL	23	/
NX2_WH	NX2_OF	9999	/
NX3_FL	M_MASTER	9999	/
NX3_OF	NX3_FL	25	/
NX3_WH	NX3_OF	9999	/
NX4_FL	M_MASTER	9999	/
NX4_OF	NX4_FL	27	/
NX4_WH	NX4_OF	9999	/
NX6_FL	M_MASTER	9999	/
NX6_OF	NX6_FL	30	/
NX6_WH	NX6_OF	9999	/
W2_FL	M_MASTER	9999	/
W2_OF	W2_FL	32	/
W2_WH	W2_OF	9999	/
W3_FL	M_MASTER	9999	/
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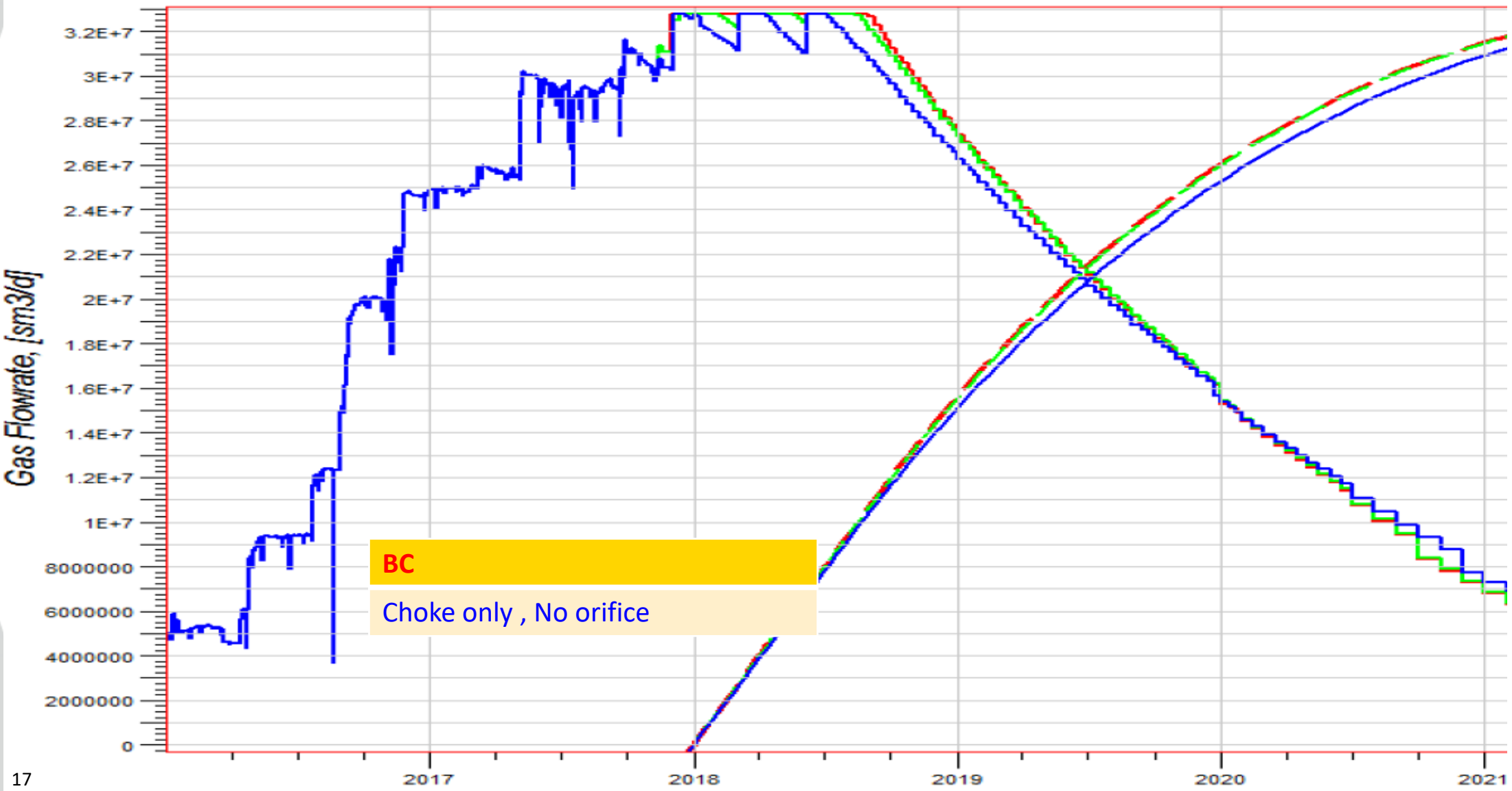
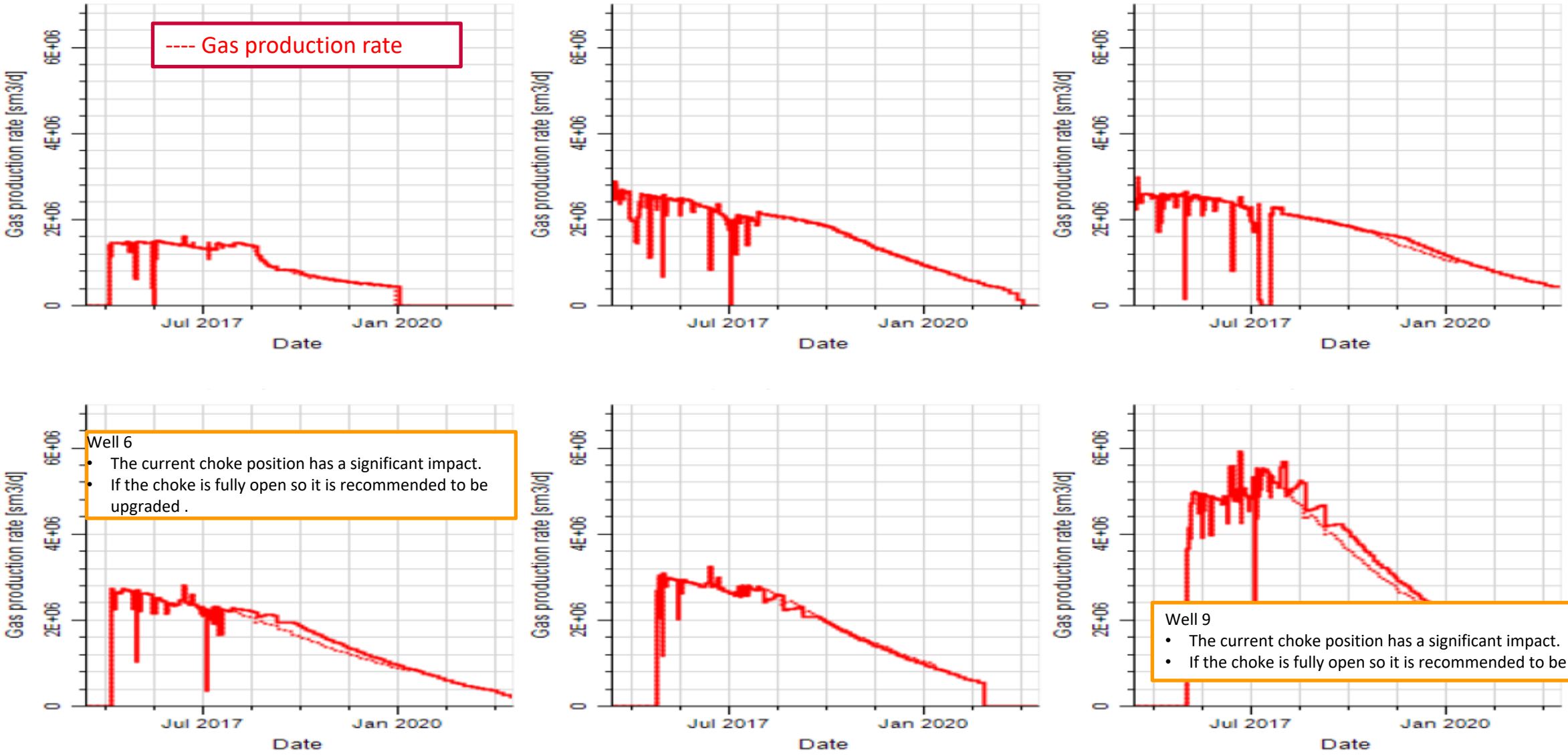
Impact of current choke opening only on Field profile



Impact of current choke position only

Remove the orifice from the system

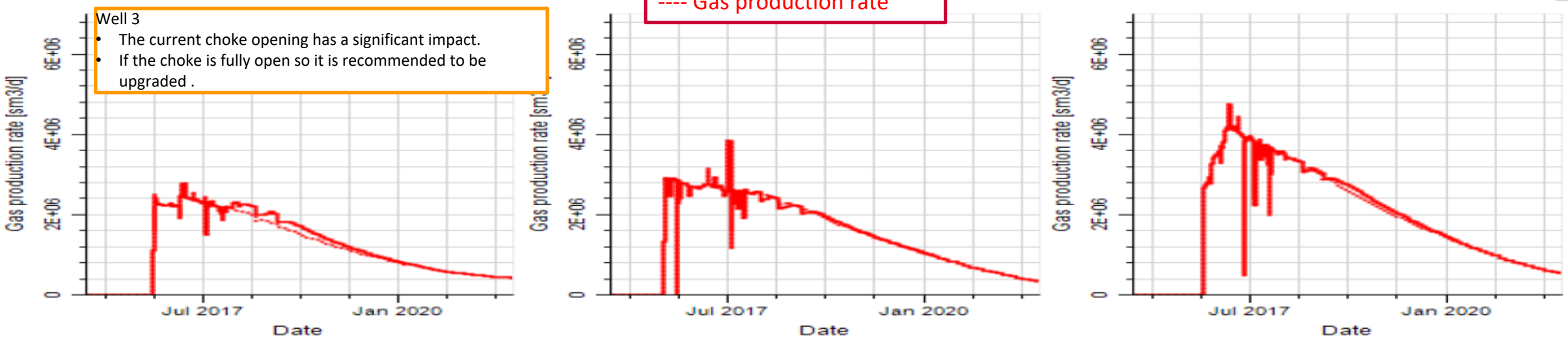


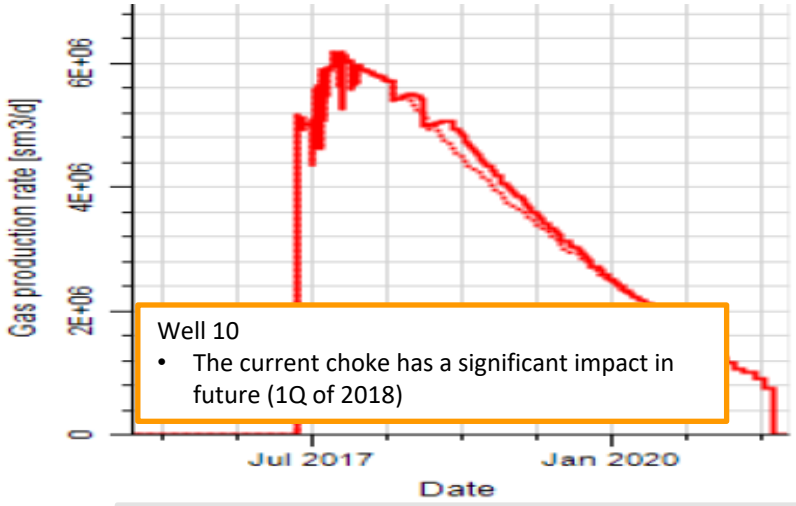
Impact of current choke position only

Remove the orifice from the system

Well 3
- The current choke opening has a significant impact.
- If the choke is fully open so it is recommended to be upgraded .

---- Gas production rate





Well 10
- The current choke has a significant impact in future (1Q of 2018)

Choke actions

1. Wells 3,6,9, and 10 current choke position will affect on the production profile and need to be upgraded and revised

- - - - choke impact ——— BC

Conclusion

- *All orifice elements have a significant impact on Field profile.*
- *4 wells (3,6,9, and 10 current choke position will affect the production profile and need to be upgraded and revised)*