

**Plans Workshop July 18, 2017**

# **Worst Case Discharge (WCD)**

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**Definitions from FAQs**

**4 main problems w/ submissions**

**Scenarios of  
Revised and Supplemental Plans**

**Examples of Sidetracking**



10. Q. “You should determine the daily discharge rate as the cumulative discharge over the course of the day (i.e., 24 hour consecutive period) in which the **maximum flow rate is observed**, and the flow model should include the contributions from all producible reservoirs in contact with the open wellbore.”

13. Q. “You must supply the **assumptions and calculations** used to determine the volume (daily discharge rate) of the proposed well in your Plan or document that you expect will have the highest volume of liquid hydrocarbons.”

<https://www.boem.gov/NTL-2015-N01-FAQs/>



- **Operator responsibility** to determine WCD.
- Verification of operator submitted analogs, assumptions, and calculations through independent analysis.
- Verification of parameters assuming a best case exploration mode.
- Proprietary and non-proprietary data from BOEM corporate database used for verification.
- BOEM identifies **all** potentially producible hydrocarbon sands exposed to any open segment of the wellbore *during* drilling to determine the package of reservoirs that will discharge the maximum daily volume.



Q. What are the common problems that hinder the timely verification of the calculations and assumptions used in the determination of the Worst Case Discharge volume?

A. There are **4 main problems** that BOEM encounters in data submitted in support of the WCD volume determination:

- **Inconsistent data** in the Plan. For example, the depth of the top of the target sand or the bottom hole location of the WCD well is not consistent on forms or displays included with the submittal.
- **Insufficient data** submitted to verify the critical parameters needed to perform a reservoir simulation/nodal analysis.
- **Multiple analogs are listed but not linked to** specific reservoir parameters.
- **Borehole data was not submitted to BSEE** (TDM in GOMR) as required by BSEE 2016-N07.

<https://www.boem.gov/NTL-2015-N01-FAQs/>



BOEM-0137 provides tables for the operator to submit geologic and engineering parameters for the well with the highest worst case discharge volume.

**BOEM-0137** is not sufficient by itself to support the WCD scenario but allows BOEM to easily identify critical factors used in the calculation.

Worst Case Discharge (WCD) Well Information							
WCD Well Name	Surface Lease	Surface Area/Block	Bottom Lease	Bottom Area/Block	Product Type	MD	TVD

Analog Well(s)			
Area/Block	OCS Lease	Well No.	API No.



**Geologic Data for WCD includes:**

<b>Open Hole Interval for WCD</b>	
<b>Top (TVD in feet)</b>	<b>Base (TVD in feet)</b>

<b>Formation Data</b>	<b>Sand 1</b>	<b>Sand 2</b>	<b>Sand 3</b>	<b>Sand 4</b>	<b>Sand 5</b>
Sand Name					
Estimated Top TVD					
Estimated Base TVD					
Estimated Net Sand Height MD (Net Pay if hydrocarbon)					
Estimated Net Sand Height TVT (Net Pay if hydrocarbon)					
Fluid Type					
Used in WCD? (Yes/No)					

<b>Seismic Survey Used</b>
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# Engineering Data for BOEM-0137 includes:

WCD (STB/Day)				
WCD Calculated at	Mudline	y/n	Atmosphere	y/n
Flow Correlation				
Outlet Pressure (Psia)				
Gas Turbulence Factor				
Software Model Used				

Formation Data	Sand 1	Sand 2	Sand 3	Sand 4	Sand 5
Sand Name					
Permeability (mD)					
Initial Pressure (PSIA)					
Reservoir Temperature (F)					
Porosity					
Water Saturation					
Rock Compressibility (microsips)					
Water Salinity (ppm)					
Drive Mechanism					
Drainage Area (acres)					



# Oil/Gas Reservoir Data for BOEM-0137 includes:

<b>Oil Reservoir Data</b>	<b>Sand 1</b>	<b>Sand 2</b>	<b>Sand 3</b>	<b>Sand 4</b>	<b>Sand 5</b>
Bubble Point Pressure (PSIA)					
Initial Bo (RB/STB)					
Bo (RB/STB) @ Bubble Point					
Rsi (SCF/STB)					
Initial Oil Viscosity (Cp)					
Oil Viscosity (CP) @ Bubble Point					
Oil Compressibility (1/PSIA)					
Oil API Gravity (API)					
Specific Gas Gravity (0.00)					
<b>Gas Reservoir Data</b>	<b>Sand 1</b>	<b>Sand 2</b>	<b>Sand 3</b>	<b>Sand 4</b>	<b>Sand 5</b>
Condensate API Gravity (API)					
Specific Gas Gravity (0.00)					
Yield (STB/MMCF)					



# Permeability Data for BOEM-0137 includes:

Source of Permeability Used			
Permeability from MDT			
Permeability from Core Analysis	Percussion core	Rotary sidewall core	Conventional core
Pressure Transient Analysis			
Permeability from CMR or NMR log analysis			
Permeability from other source			

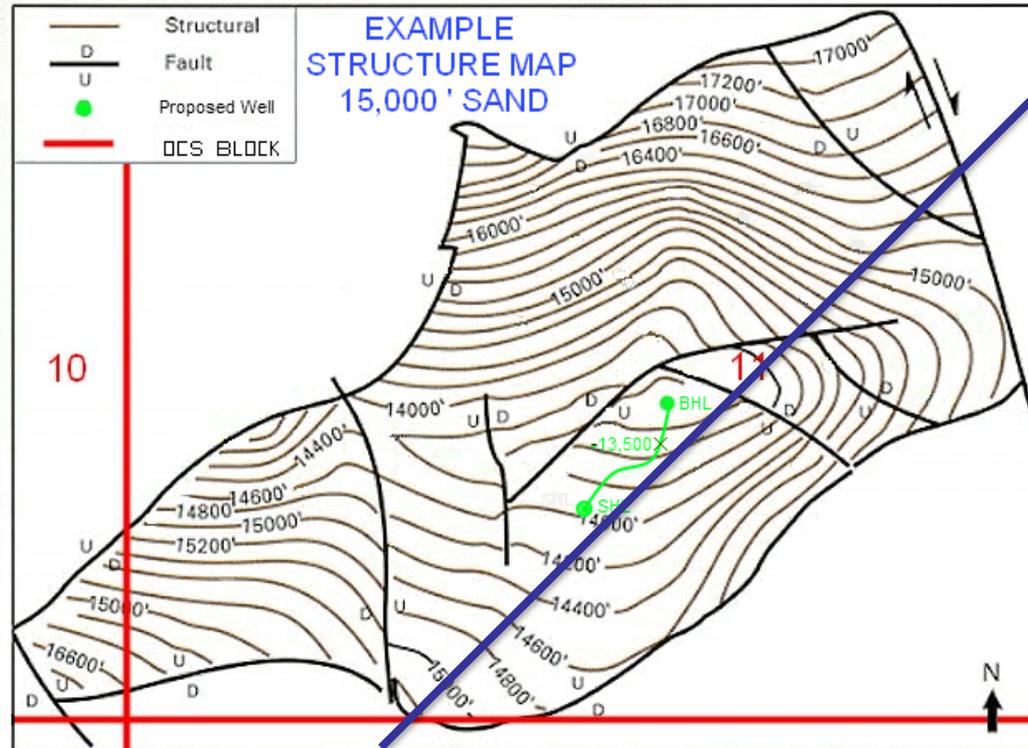
Provide Model Input Values for Relative Permeability:	
Residual Oil to Gas fraction (=1-S <sub>lc</sub> -S <sub>wc</sub> )	
Residual Oil to Water fraction (=S <sub>oc</sub> )	
Critical Gas fraction (S <sub>gc</sub> , Gas/Oil-Water Systems)	
Residual Gas to Water fraction (S <sub>gc</sub> , Gas/Gas-Water Systems)	
K <sub>ro</sub> Oil Curve Endpoint (fraction of absolute permeability)	
K <sub>rg</sub> Gas Curve Endpoint (fraction of absolute permeability)	
K <sub>rw</sub> Water Curve Endpoint (fraction of absolute permeability)	



**Structure Maps** for each producible sand to be encountered in the open hole.

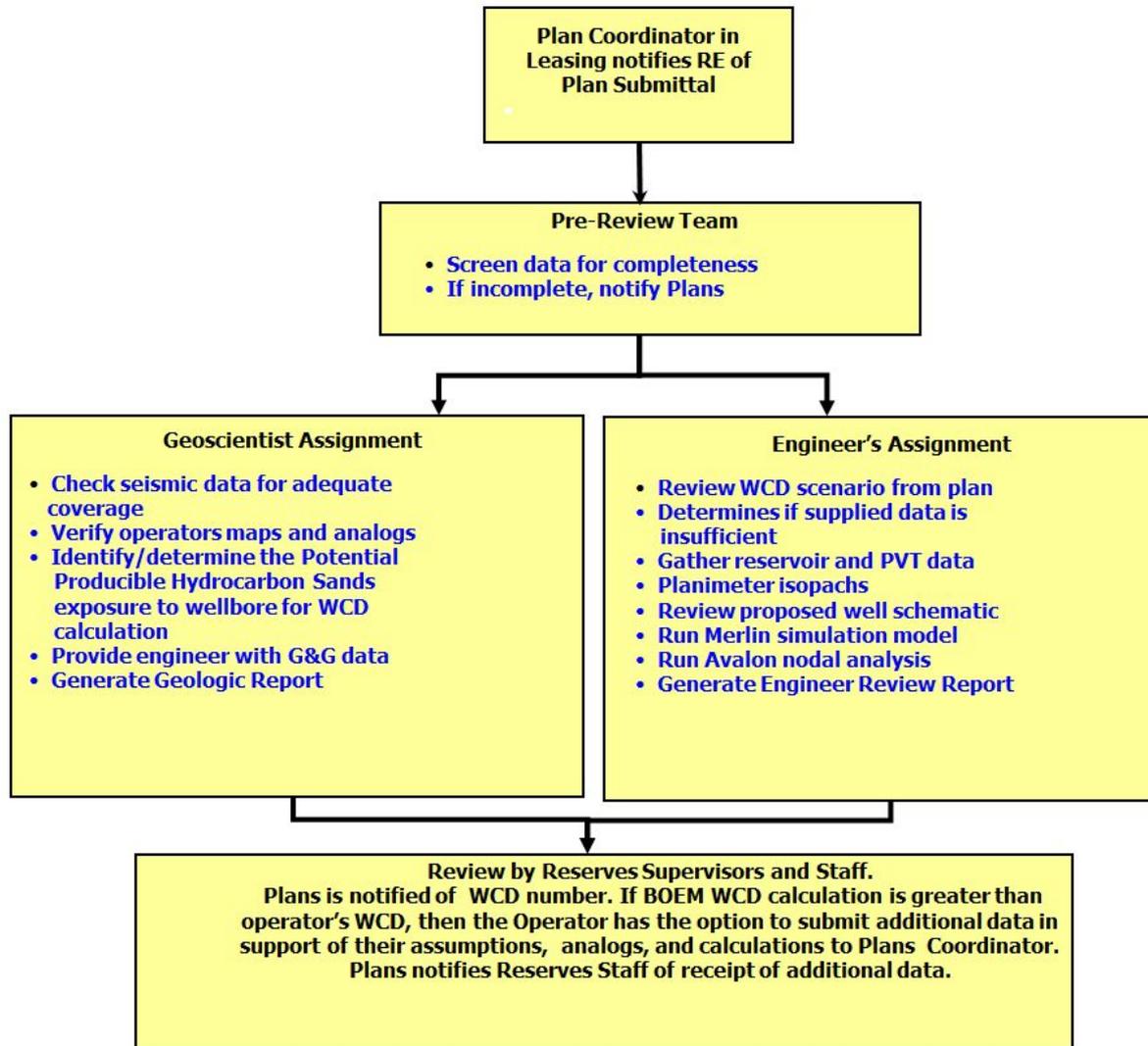
**Cross-section** depicting all anticipated hydrocarbons bearing zones.

**Annotated seismic section** through well site location using the most recent seismic data available. A section that ties the WCD well to the analog well is beneficial.



seismic section





Plans **before** Macondo  
have **Limited** WCD information

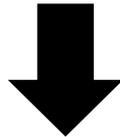
Plans **after** Macondo  
have **Detailed** WCD Analysis



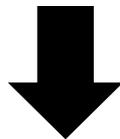
**pre 2010**

Initial Exploration Plan or  
Initial Development Operations Coordination Document (DOCD)

**No Detailed WCD information was submitted**



Company **must submit Revised or Supplemental Plan  
with WCD information  
If plan has drilling activity**



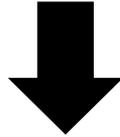
**Submit Form BOEM-0137 with pages 3&4**



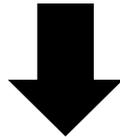
**post 2010**

Initial Exploration Plan or  
Initial Development Operations Coordination Document (DOCD)

**Detailed WCD information was submitted**



Company wants to **Revise or Supplement** the Plan  
with drilling activity



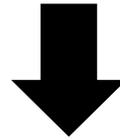
**Was a well drilled on the Initial Plan?**



post 2010 Initial Plan

**NO well** was drilled on the Initial Plan

Company wants to **Revise or Supplement** the Plan with drilling activity



Options:

**Keep WCD rate**

(refer back to WCD info of original plan)

or

**Submit new WCD rate**

**Form BOEM-0137 with pages 3&4**



post 2010 Initial Plan  
**NO well was drilled on the Initial Plan**



## **Submit new WCD rate**

Change in analogue,  
another well was drilled nearby

Different casing plan

Different targets, well depths

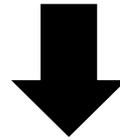
## **Keep WCD rate**

Same targets &  
well locations in similar reservoirs

Same casing plan



post 2010 Initial Plan  
**A well was drilled on the Initial Plan**



Outcomes:

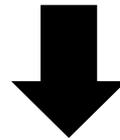
Results of Well **less** than expected – Option to **keep** WCD rate  
or submit **lower** WCD rate

Results of Well **similar** to expected – **Keep** WCD rate

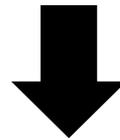
Results of Well **greater** than expected – Must submit **higher** WCD rate



post 2010 Initial Plan  
**A well was drilled on the Initial Plan**



**Other hydrocarbon potential on block**  
submitting Revised or Supplemental plan with drilling



Options:

**Keep WCD rate**  
(refer back to WCD info of original plan)

**Submit new WCD rate**  
(change in target sands and hydrocarbons)



post 2010 Initial Plan  
**A well was drilled on the Initial Plan**



## **Submit new WCD rate**

Change in analogue,  
new well was drilled on the Initial Plan

Different casing plan

Different targets, well depths

## **Keep WCD rate**

Same targets & depths  
different wells

Same casing plan



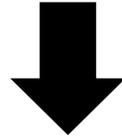
Big Oil has lease

**A well was drilled on the Initial EP**

**BOEM Approved WCD = 100,000 BOPD**

**OSRP = 300,000 BOPD**

**The drilled well found uneconomical hydrocarbons**



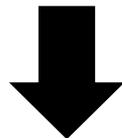
**Big Oil assigns lease to another operator**

The new operator wants to drill **shallower targets** nearby existing production

**Submits a Revised or Supplemental EP with drilling**

**Operators WCD = 29,000 BOPD**

**Operators OSRP = 34,000 BOPD**

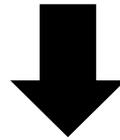


**BOEM will re-evaluate WCD**

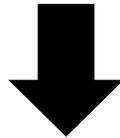


# Examples

Shelf Oil has lease  
Shelf Oil submits Initial DOCD  
**BOEM Approved WCD = 20,000 BOPD**  
**OSRP = 30,000 BOPD**



Shelf Oil submits a Revised or Supplemental Plan for 4 new wells on the lease  
Revised or Supplemental Plan 1 Well D calculated WCD = 18,000 BOPD  
Revised or Supplemental Plan 2 Well E calculated WCD = 15,000 BOPD  
Revised or Supplemental Plan 3 Well F calculated WCD = 16,000 BOPD  
Revised or Supplemental Plan 4 Well G calculated WCD = 14,000 BOPD



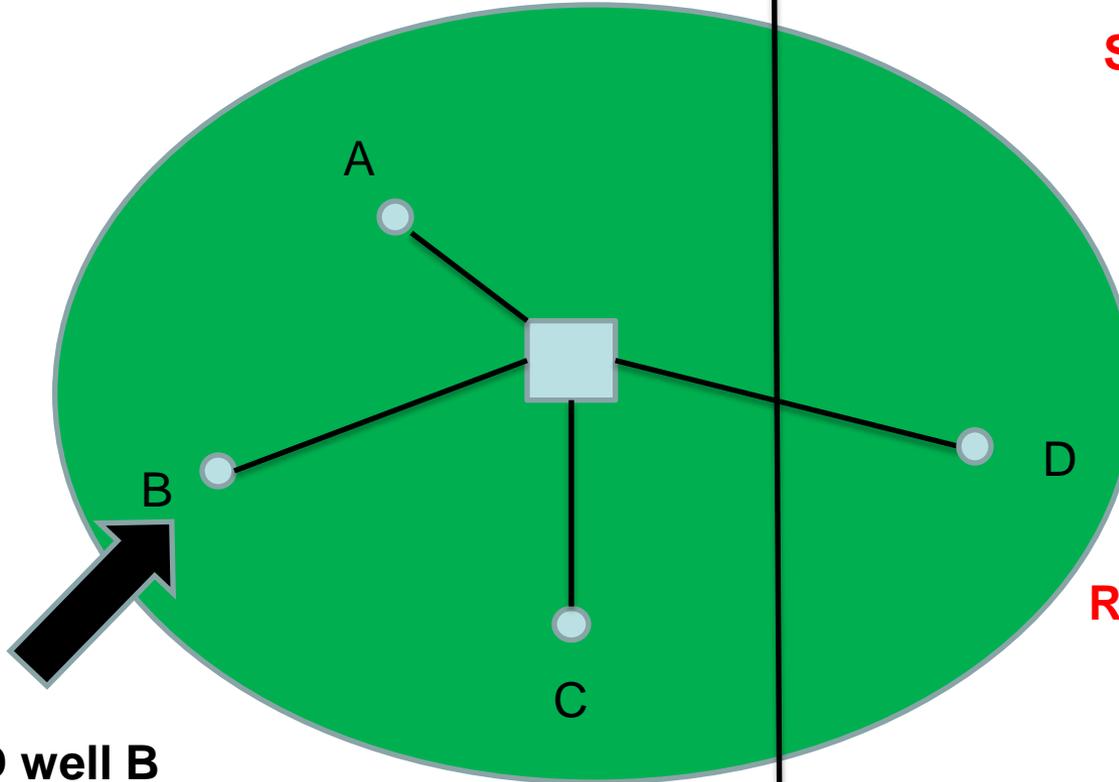
**BOEM Approved WCD = 20,000 BOPD**



# Sidetrack onto another lease

LEASE 100

LEASE 101



**Submit or Reference  
WCD information**

**Options:**

**Rerun WCD for well D**

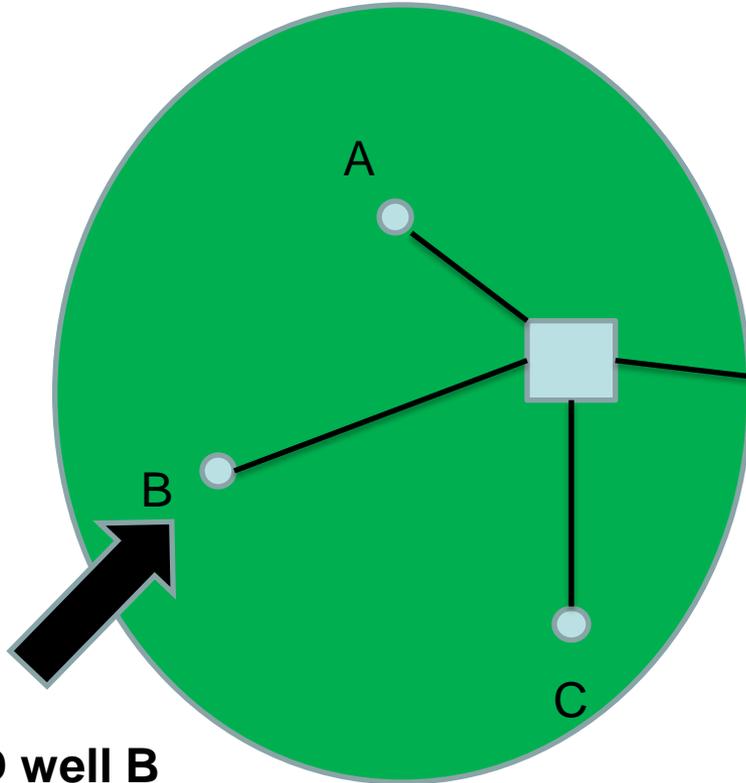
**Reference or  
Submit WCD info  
from well B**

**WCD well B  
WCD = 20,000 BOPD**



# Sidetrack onto another lease

LEASE 100

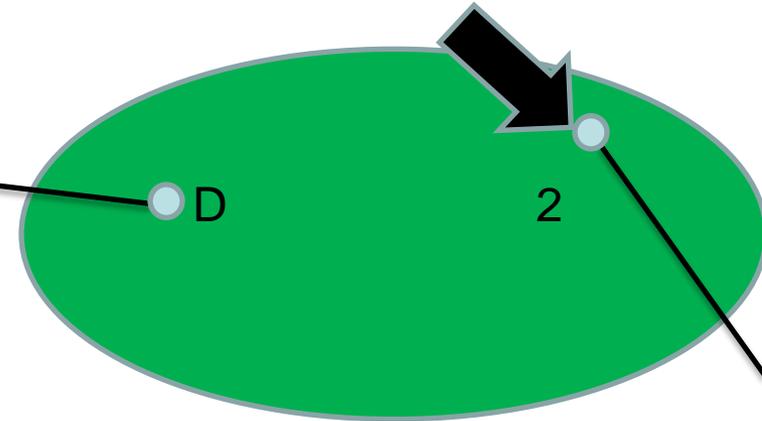


**WCD well B**  
**WCD = 20,000 BOPD**

LEASE 101

**Submit or Reference  
WCD information**

**WCD well 2**  
**WCD = 12,500 BOPD**



**Options:**

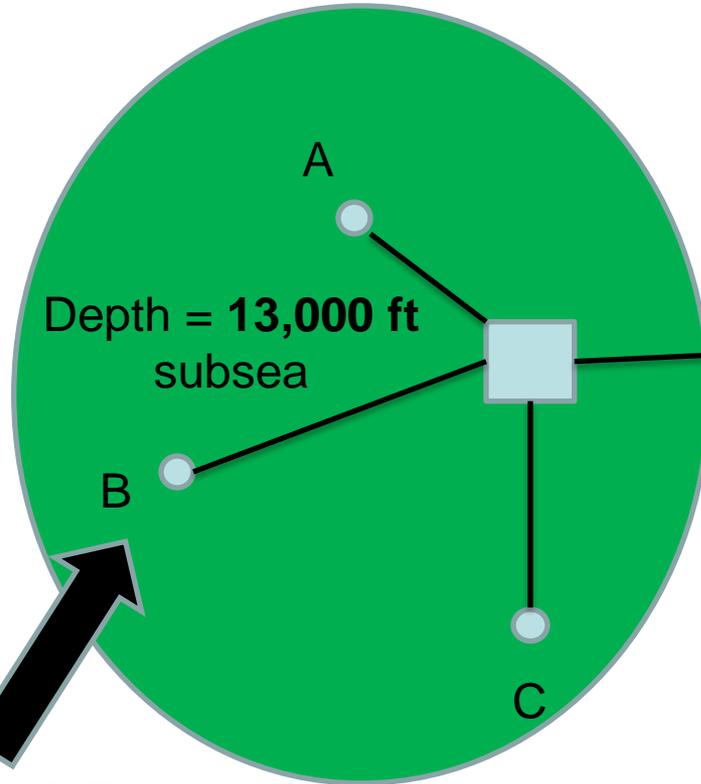
**Rerun WCD for well D**

**Reference or  
Submit WCD info  
from well B  
or from well 2**



# Sidetrack onto another lease

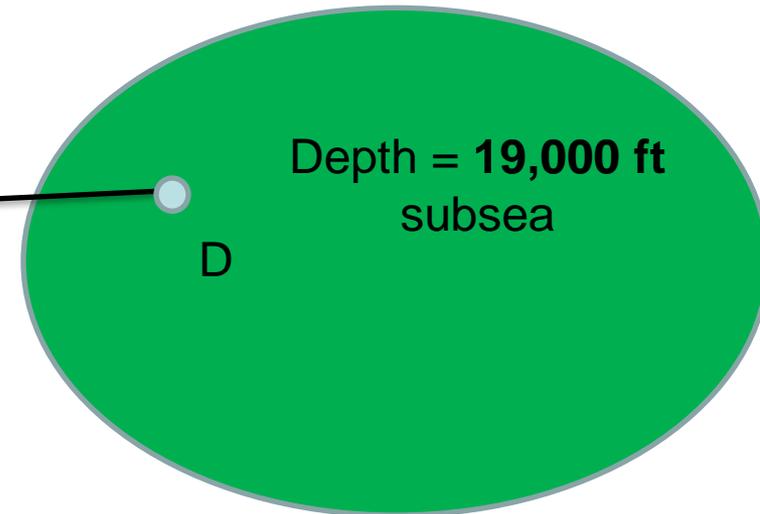
LEASE 100



**WCD well B**  
**WCD = 20,000 BOPD**

LEASE 101

**Submit WCD information**



**depths and target sands**  
**cause an increase in WCD**  
**Rerun WCD for well D**



**Operator should have  
one WCD number per plan**

**WCD Submissions  
need to be complete  
without contradictions**



**The Plan WCD for  
Revised and Supplemental Plans  
may reference  
Initial Plan WCD calculations**



**The operator may raise or lower WCD rates, but operator must submit the WCD information on pages 3 and 4 of Form BOEM-0137**



**Sidetracks across lease lines  
may reference  
WCD calculations  
on adjacent block**



**If the depths and target sands are different causing an increase in WCD, operator needs to rerun the WCD calculations and submit the WCD information on pages 3 and 4 of Form BOEM-0137**



## Questions?

Have you met to review WCD with  
BOEM staff?



## Grant Burgess Reserves Section Chief

Contact: [Grant.Burgess@boem.gov](mailto:Grant.Burgess@boem.gov)

