

# PETROCEDENO



*October, 2012*

# Contents

- Conformation of Petrocedeno
- General Location of Petrocedeno
- Mission and Vision
- Chain Value
- Petrocedeno's Business Plan
  - Production
  - Upgrader
  - Marketing

# The “Mixed Company”

Under Venezuelan Oil Industry Nationalization,  
Petrocedeno is incepted on May 1st, 2007



**Venezuela**  
60%



**France**  
30,3%

**StatoilHydro**

**Norway**  
9,7%

# Extra Heavy Oil, Orinoco Basin



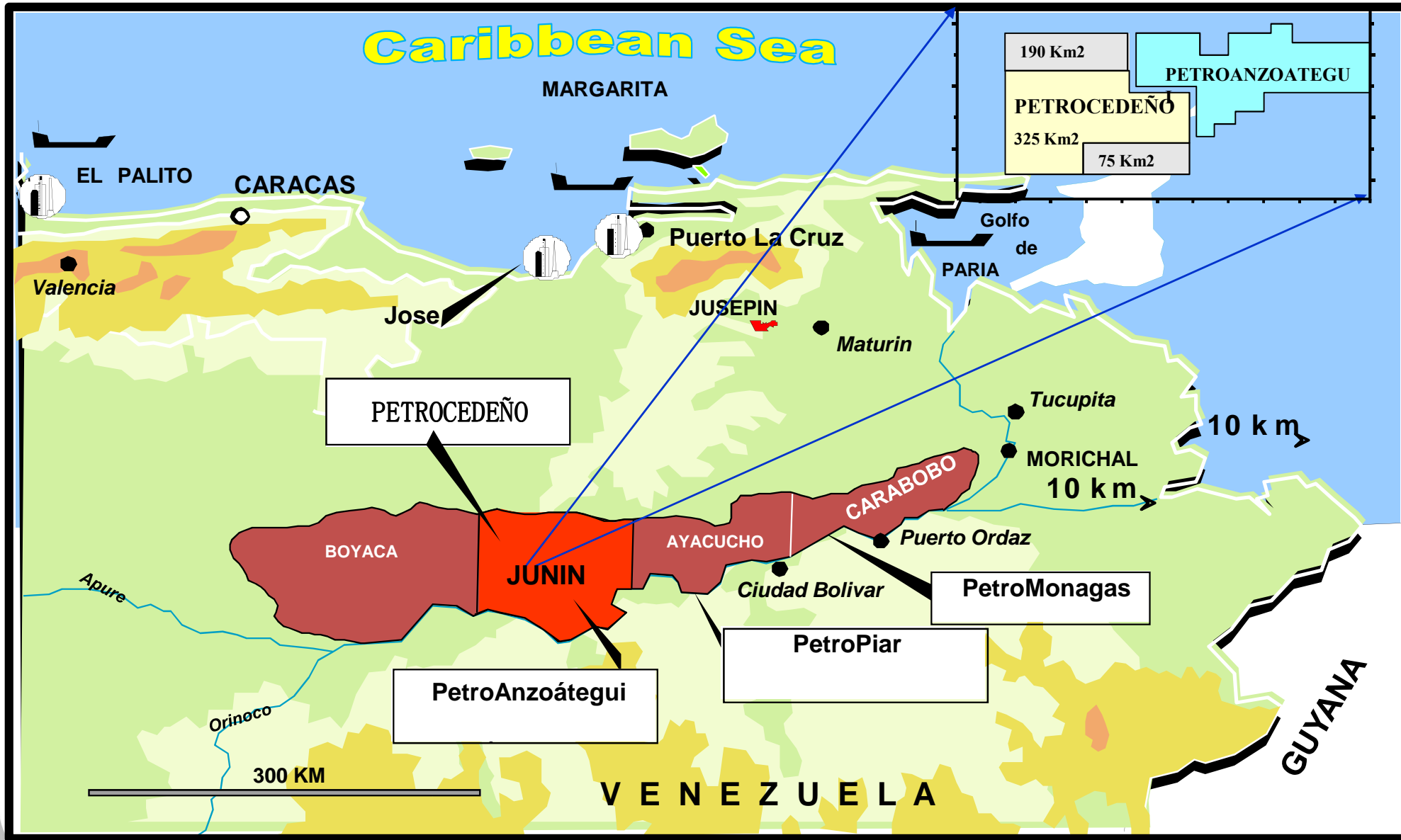
 PETROCEDENO

## Orinoco Belt Facts

- ◆ Size: 54,000 km<sup>2</sup>
- ◆ Proven Reserves, 295 Billion Barrels (Certified by Ryder Scott)
- ◆ Extra heavy oil (8 - 10<sup>o</sup> API) with high sulfur content (4.2 wt %)



# General Location



# Mission

Through its participation in the development of the Orinoco Basin, Petrocedeno mission is to maximize shareholder value through continuous improvement in the performance of their operations, while generating benefits for Venezuela and enhances the development of the local communities where Petrocedeno is present.

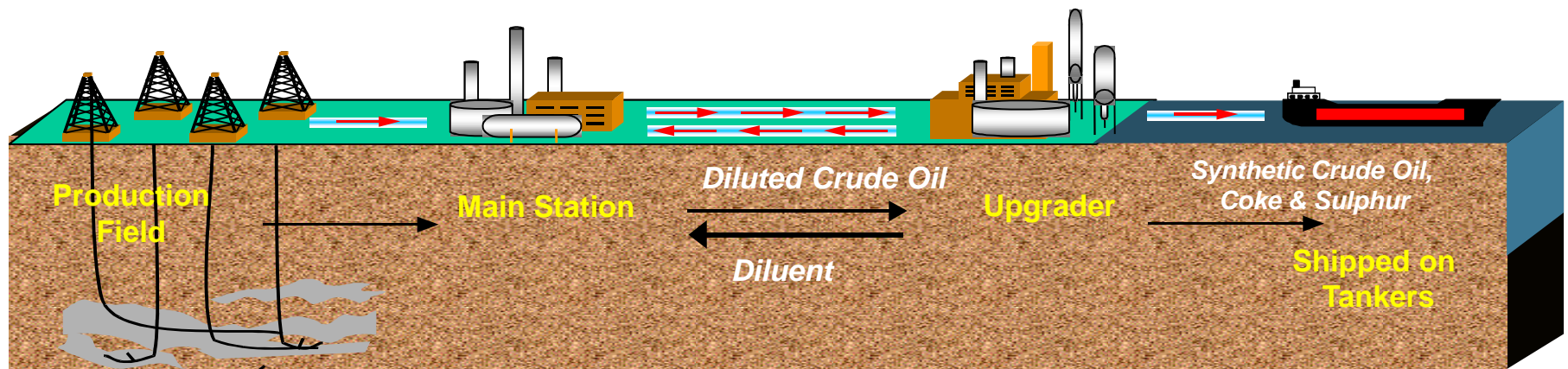
Petrocedeno PDVSA is an oil operator which seamlessly manages the production, upgrading and marketing of heavy oil from the Orinoco Oil Basin. Mixed Company is a subsidiary of PDVSA (60% stake), Total (French company, with 30.3%) and StatoilHydro (Norwegian company, with 9.7%).

# Vision

- Petrocedeno will be recognized as the leader in the production and upgrading of heavy oil, and will outperform other companies (and associations) heavy oil comparable indicators.
- Petrocedeno will have an efficient business-oriented organization, which will be able to maximize value for its shareholders and society.
- Petrocedeno will be a continuous improvement company, which will provide its employees with a challenging environment and within a learning organization.
- Petrocedeno will develop its activities with a great sense of responsibility for the environment and safety.
- Petrocedeno will promote high ethical.
- Petrocedeno will be committed to the development of all employees.
- All employees will be committed to fulfilling the vision of Petrocedeno.

# Value Chain

## Production Upgrader Marketing



210 MBPD of Extra Heavy Oil (8.5° API)  
280 MBPD of Diluted Crude Oil (17° API)

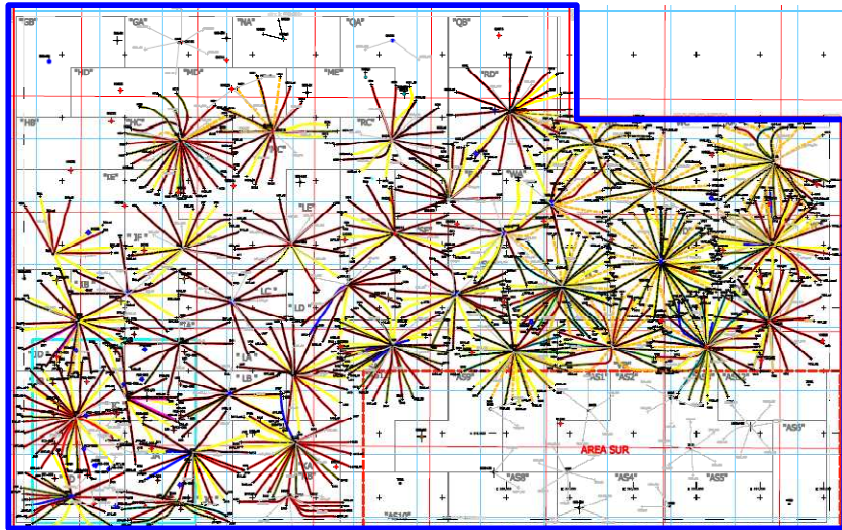
180 MBPD synthetic crude oil @ 32° API  
6000 TONPD Coke  
900 TONPD Sulphur

# PRODUCTION

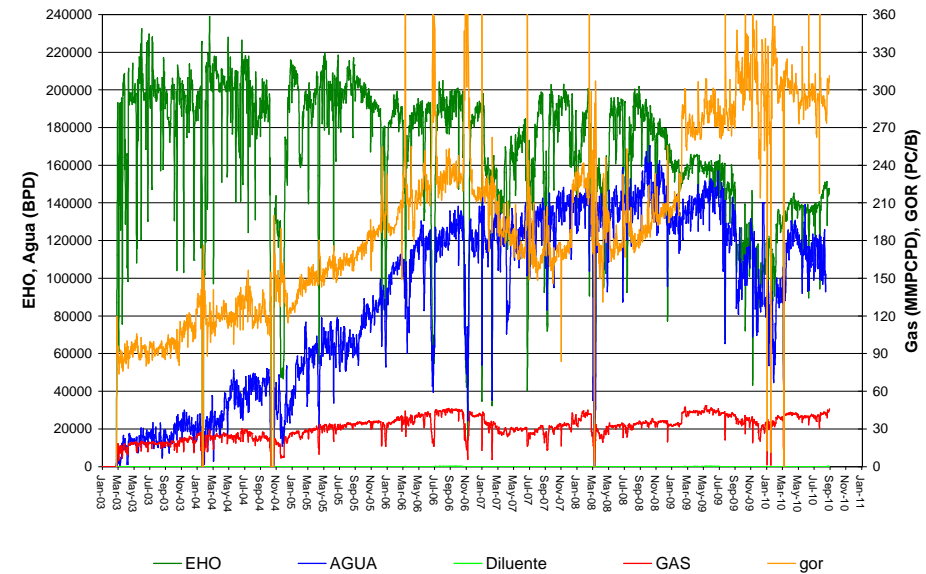
- **Field Overview**
- **Subsurface organisation and tasks**
- **Development studies**
  - **Geophysics**
  - **Geology**
  - **Reservoir**
- **Main activities :**
  - **Wells preparation and follow-up**
  - **Field optimisation**
  - **Wells stimulations**

# Field Board

Block : 400 km<sup>2</sup>

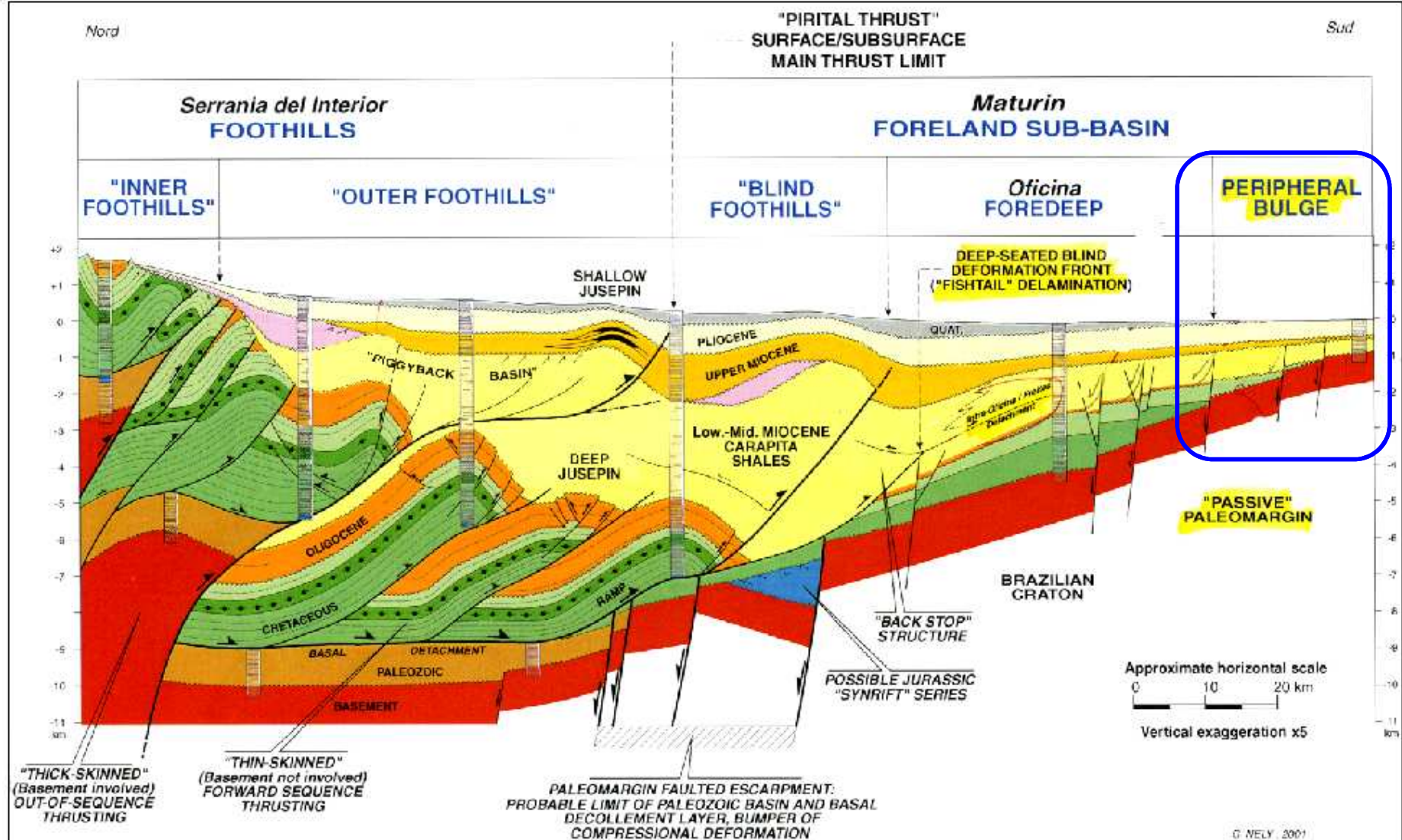


Petrocedeno: Historia de Produccion



<b>Sediment type</b>	<b>unconsolidated sand</b>
<b>Sediment origin</b>	<b>deltaic and fluvial</b>
<b>Porosity</b>	<b>~ 30 %</b>
<b>Swi</b>	<b>~ 15 %</b>
<b>OOIP :</b>	<b>~ 40 MMMbbls</b>

<b>Fluid Gravity</b>	<b>~ 8.5 °API</b>
<b>Fluid viscosity :</b>	<b>~4000 cP</b>
<b>Fluid Rs :</b>	<b>~ 50 scf/bbl</b>
<b>Depth :</b>	<b>~ 1500 feet TVD</b>
<b>Production (current)</b>	<b>130 kbopd</b>
<b>Reserves</b>	<b>783 MMbbls</b>



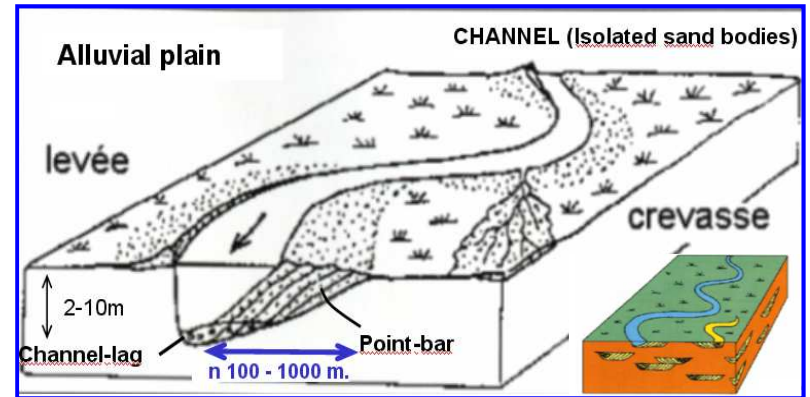
**Petrocedeño: Late Foreland deformation (Peripheral bulge)  
Structural inheritance and smooth Fault reactivation**

# Main Depositional Systems Fluvial & Deltaic

## Fluvial



## Deltaic



### MEANDERING RIVER SYSTEM :

- medium to large-scale Channels (100m – 3km)
- lateral migration of points-bars create sand-sheet = channel belt
- shaly flood-plain background
- **distributaries** (singel chl.) in **distal part of the delta**
- Incl. overbank & mouth bars

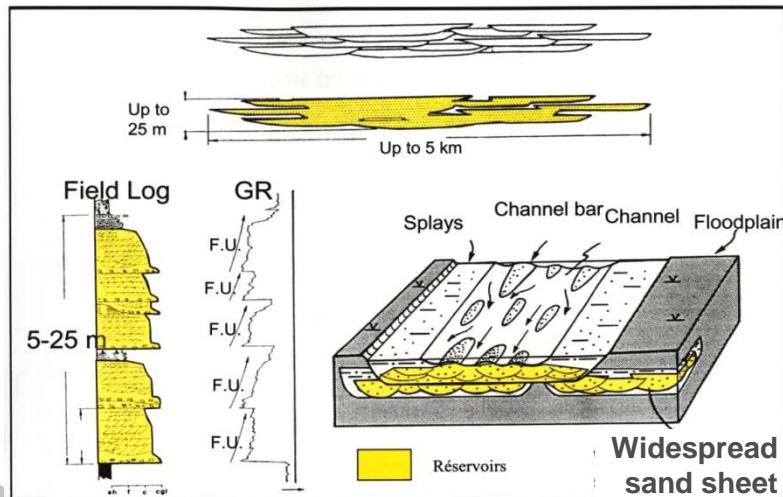


Transitional  
facies belts

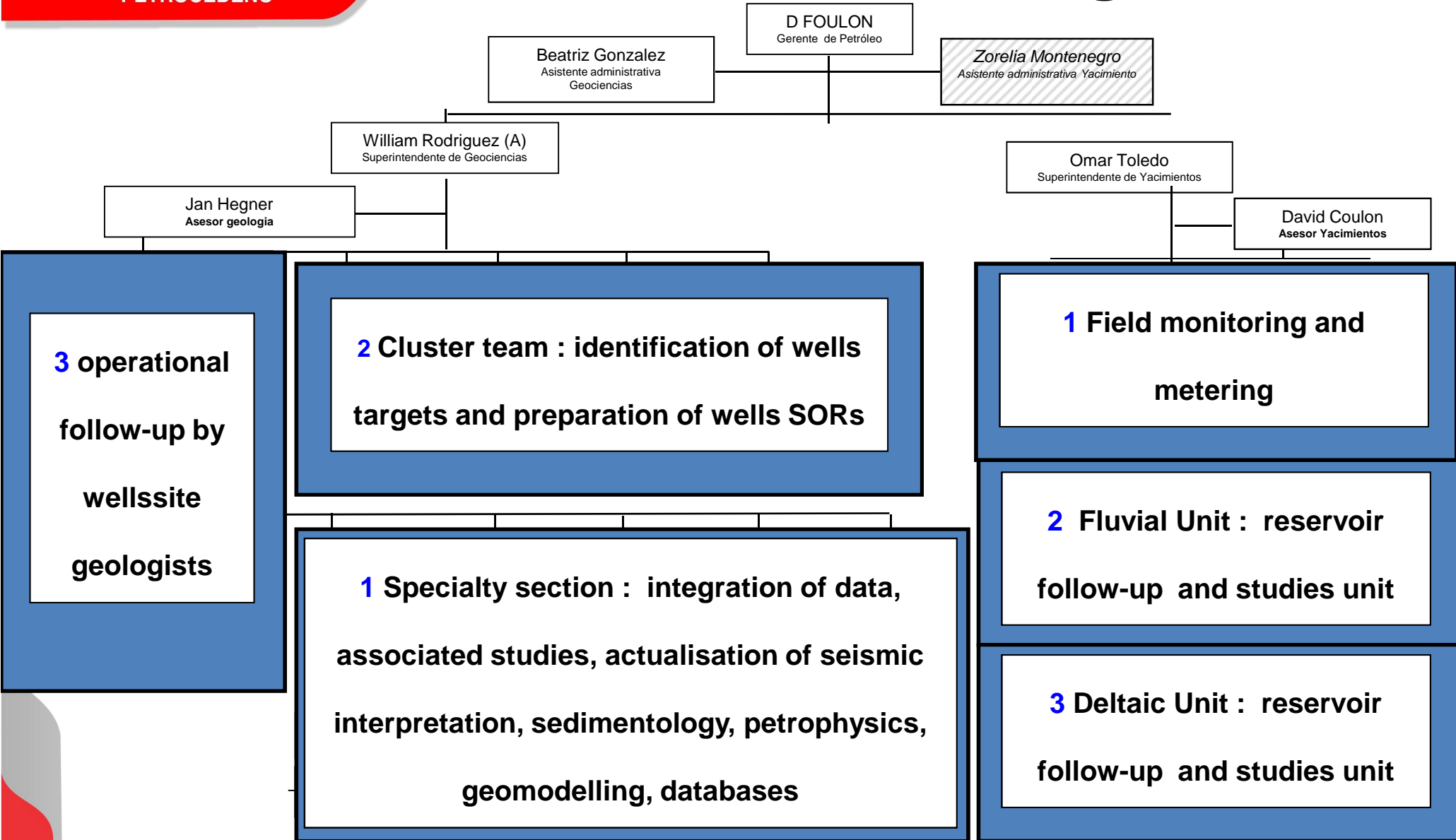


### BRAIDED RIVER SYSTEM :

- stacked sand, coarse grained (>10m thick)
- widespread sand sheets (1-5km)
- interbedded shales (interfleuves) (potential perm. barriers)
- **proximal position**



# Subsurface Organization





**GEOSCIENCES**



EEII

Resources Base

Delineation and  
production  
studies

Geological  
Operations

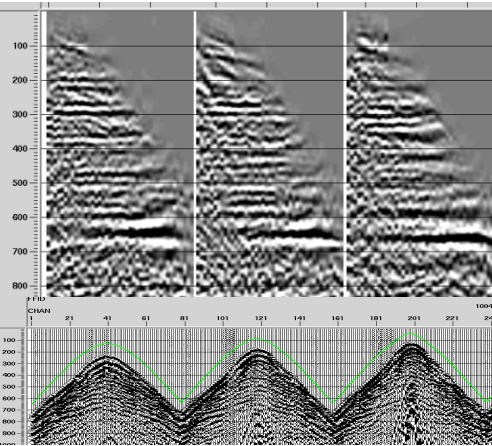
Production  
optimisation



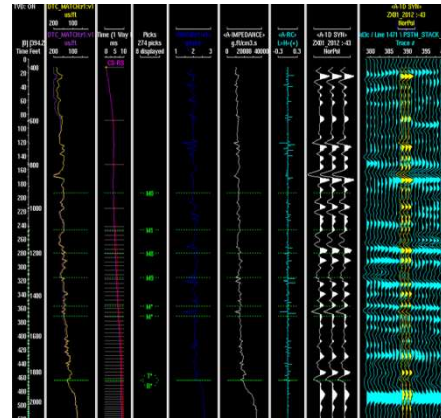
**RESERVOIR**

# Development Studies (EEII)

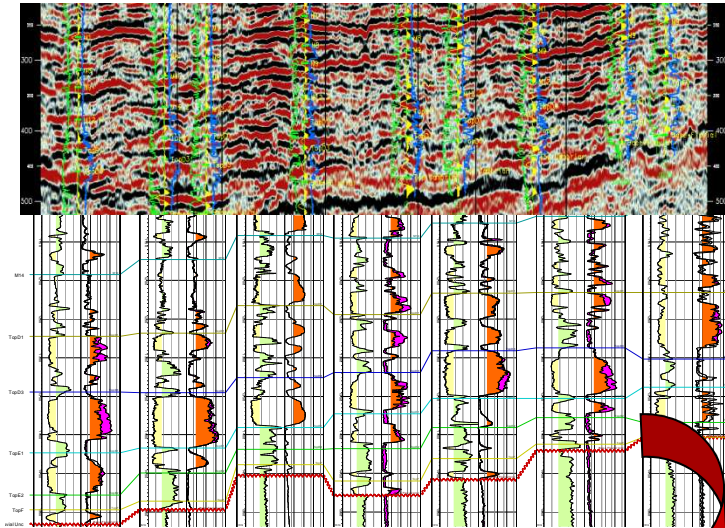
# Geophysics Workflow



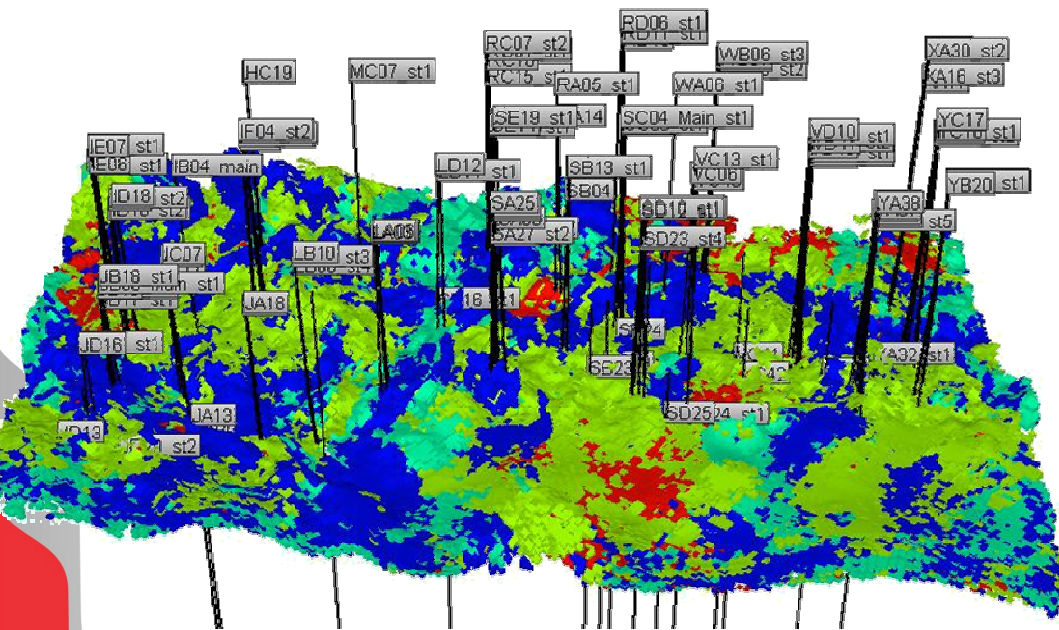
**1. Seismic Processing**



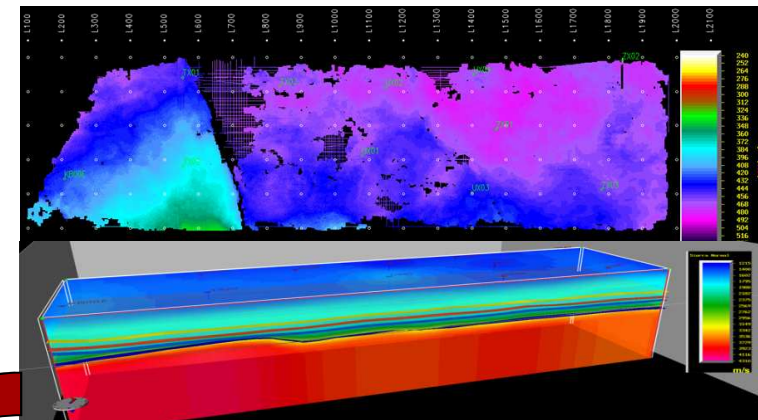
**2. Seismic-well Calibration**



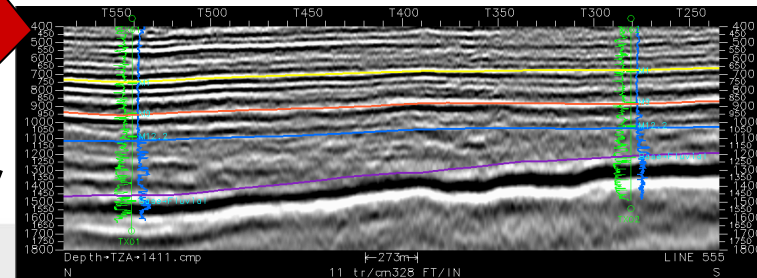
**3. Time Seismic Interpretation**



**5. Geostatistic Model**



**4. Time-Depth Conversion**



# Geophysics Database and Historical Review

## Seismic data for Sincor98 (Main Area)

- 395 Km2
- 53.000 shots
- Bin size 15\*15
- Fold 23
- Dominant frequency  $\pm$  40Hz
- Vertical resolution  $\pm$  36',
- Seismic-well calibration : 84 wells (VSP/CheckShot 100%)
- 300 stratigraphic wells

## Seismic data for El Lindero (South Area)

- 3D3C
- 92 Km2
- 26.000 shots
- Bin size 10\*10m
- Fold 66
- Dominant Frecuency.  $\pm$  65Hz
- Vertical Resolution  $\pm$  25feet
- Seismic-well calibration : 12 wells with VSP/CheckShot 100%
- 104 stratigraphic wells

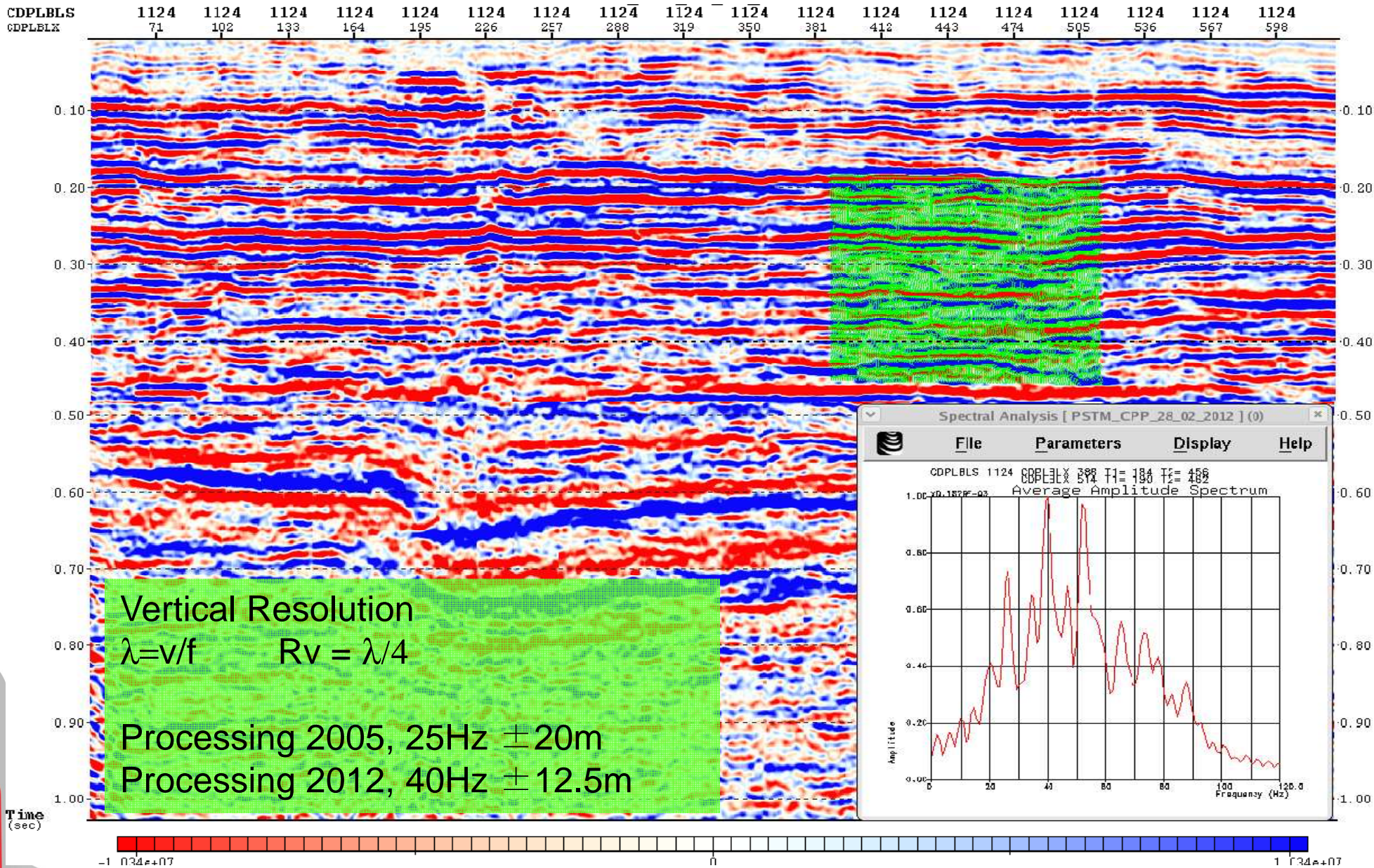
**2011-2012: Reprocessing**

**2011: Acquisition**

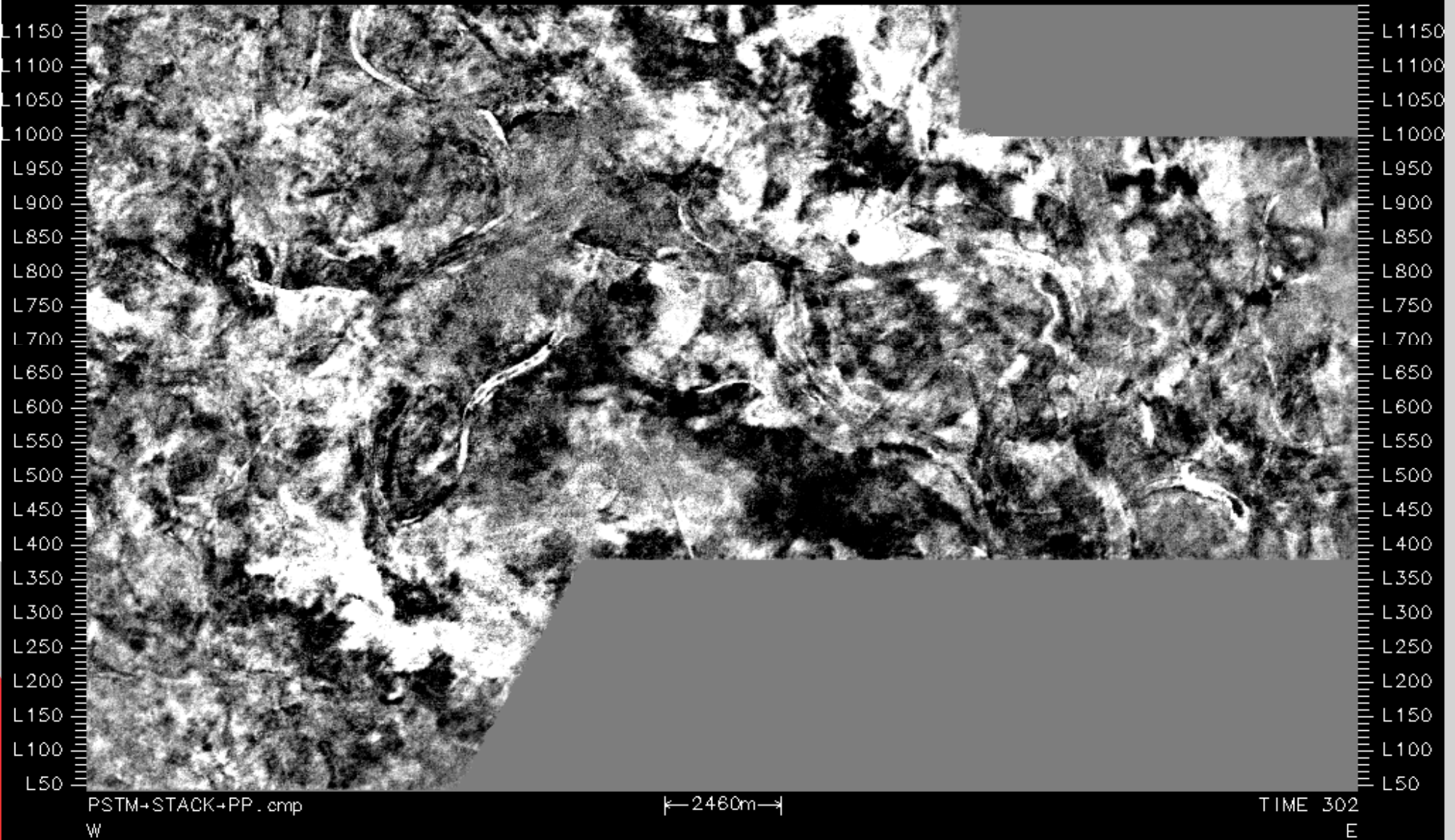
**2012: Processing**

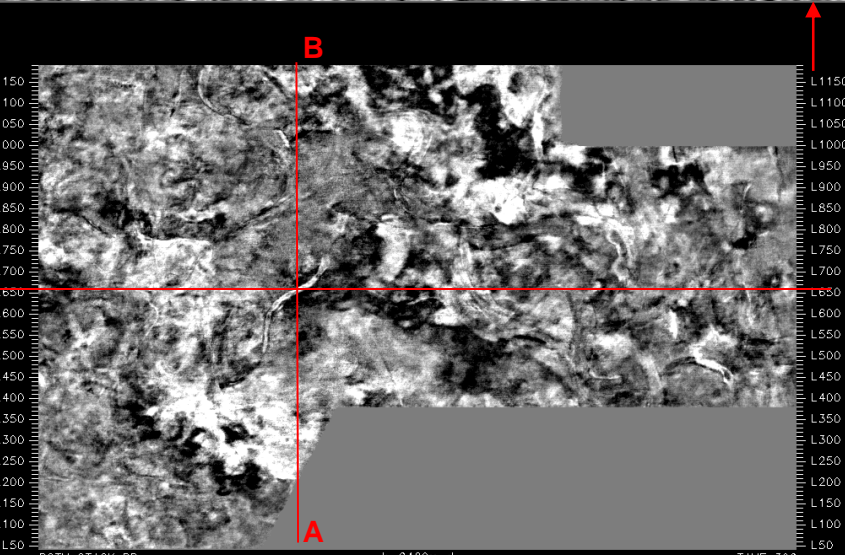
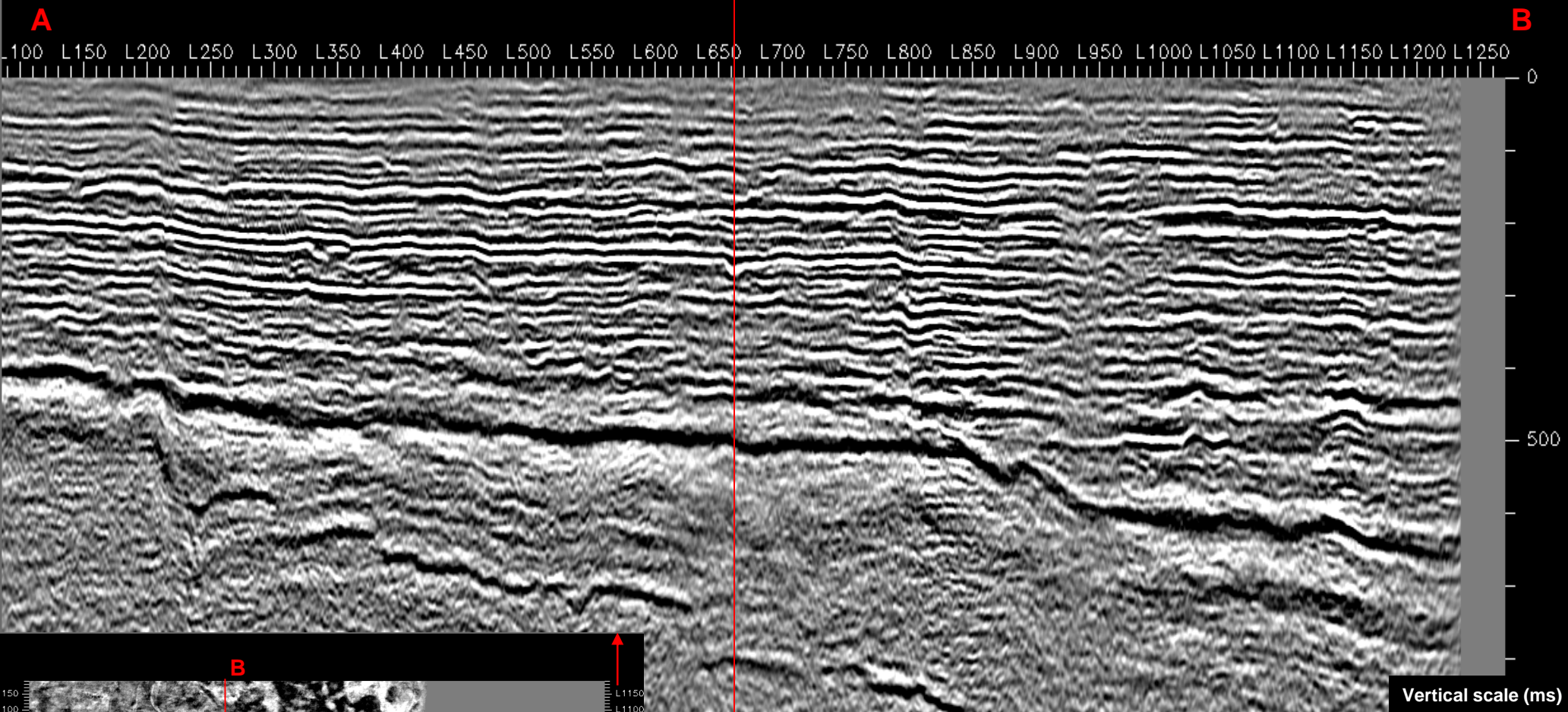
**2012/2013 : Merge, and Interpretation**

# Main Area Reprocessing: Example



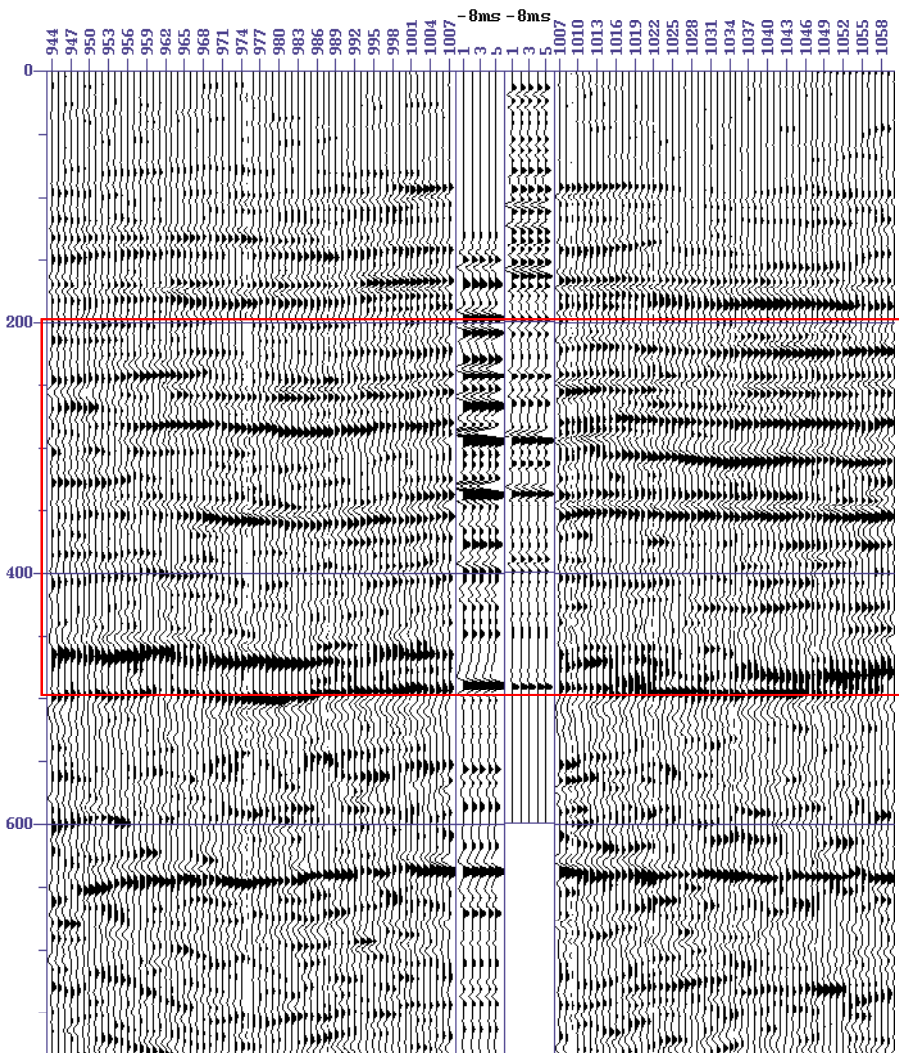
“Time slice” @ 302 ms.



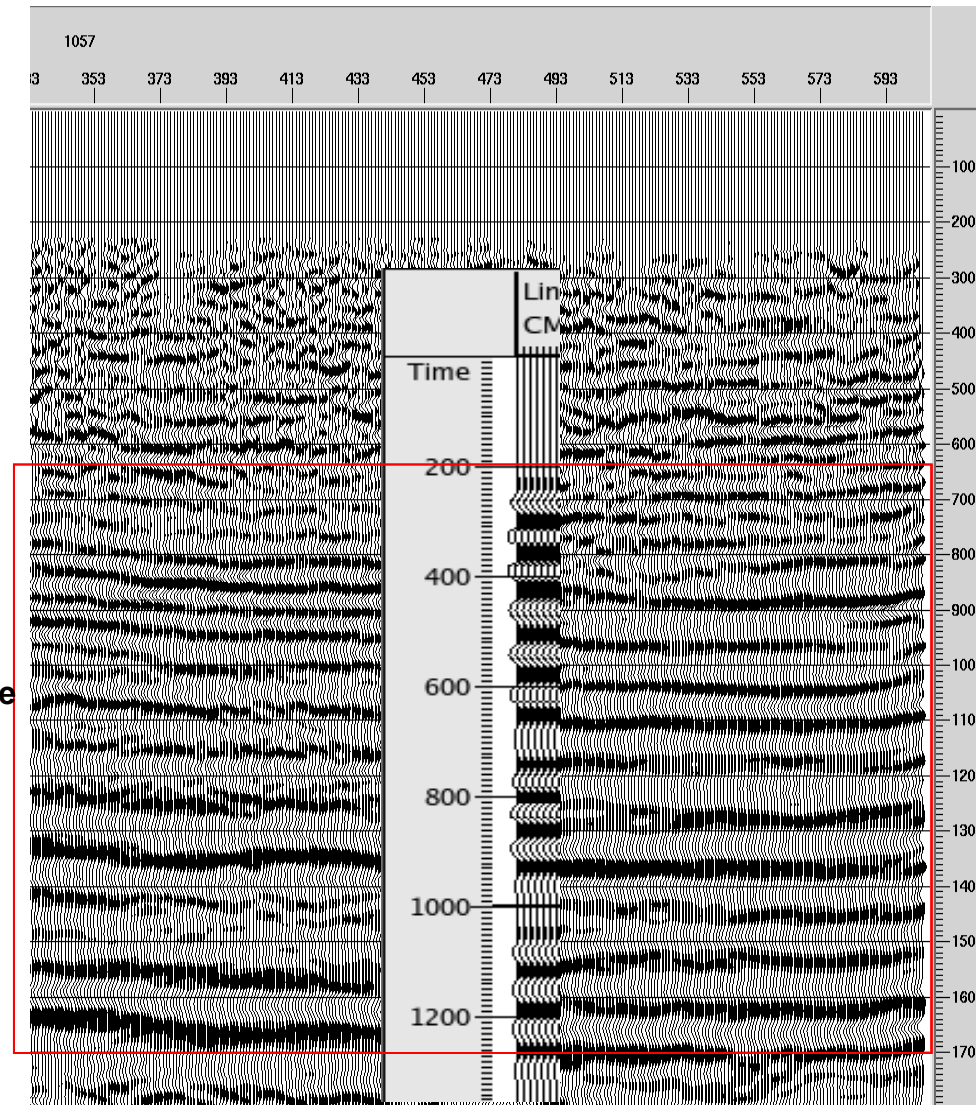


**Target Zone** ± 300ms to 600ms (800 to 2000 feet)

**CORRIDOR STACK FROM VSP CALIBRATION  
P WAVE**



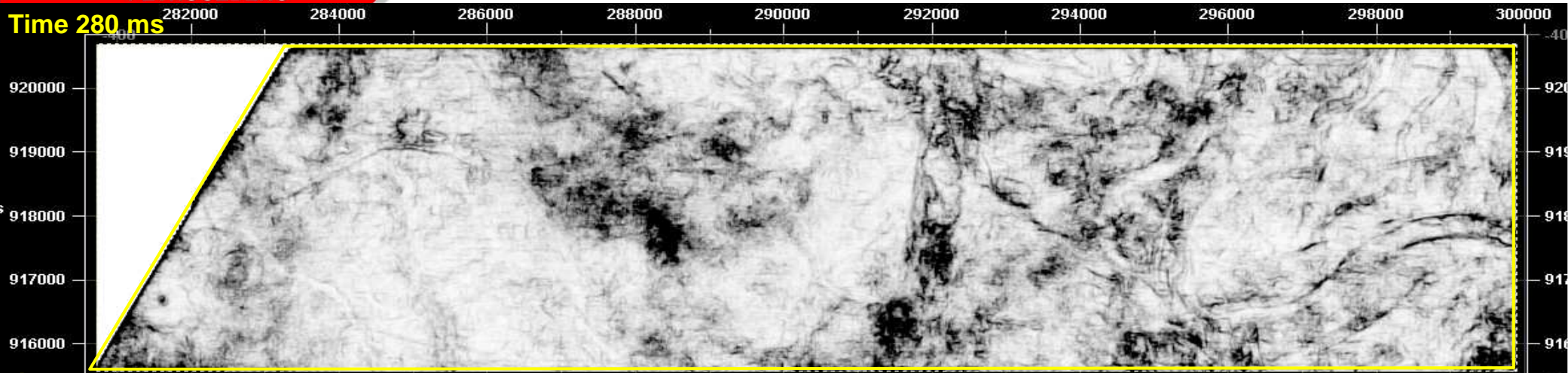
**CORRIDOR STACK FROM VSP CALIBRATION  
P-S (CONVERTED) WAVE**



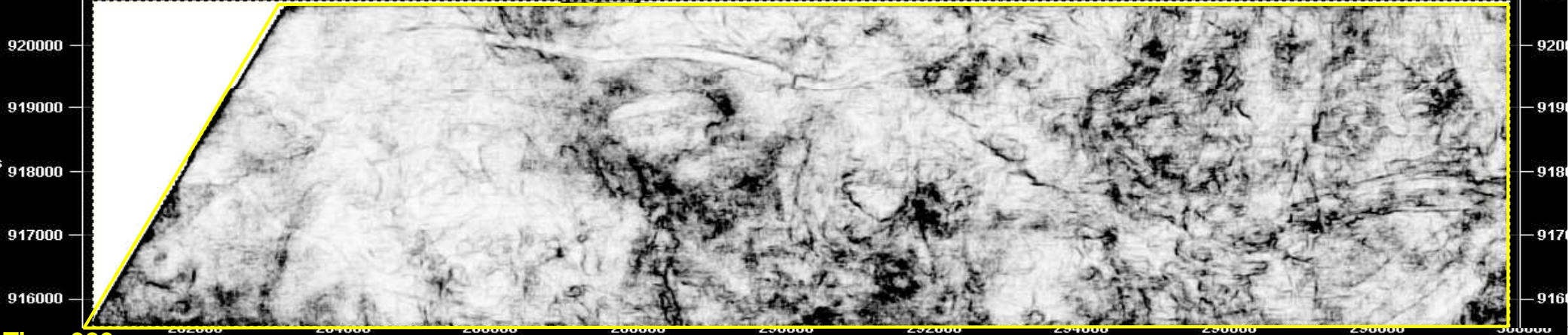
Target Zone



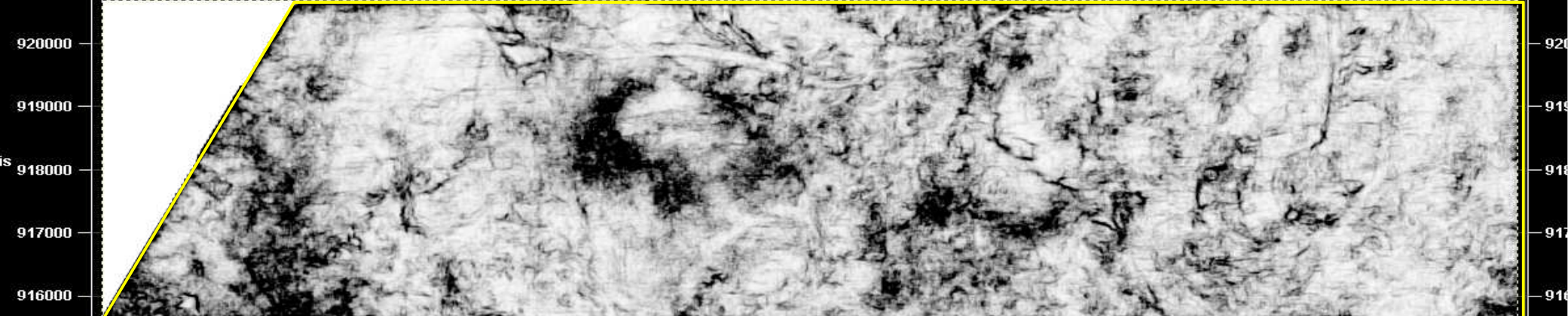
Time 280 ms



Time 300 ms



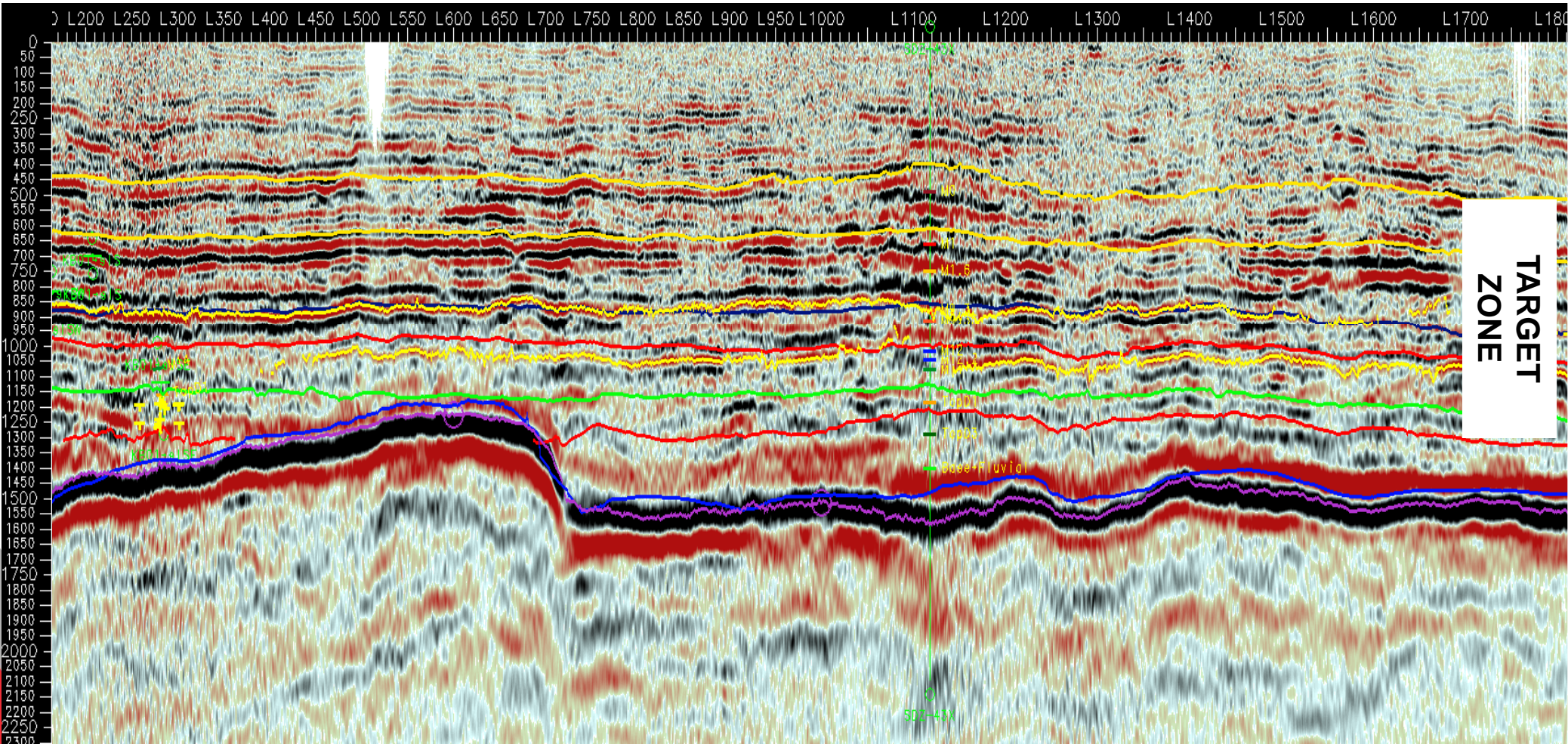
Time 320 ms



# Main Area East West Section

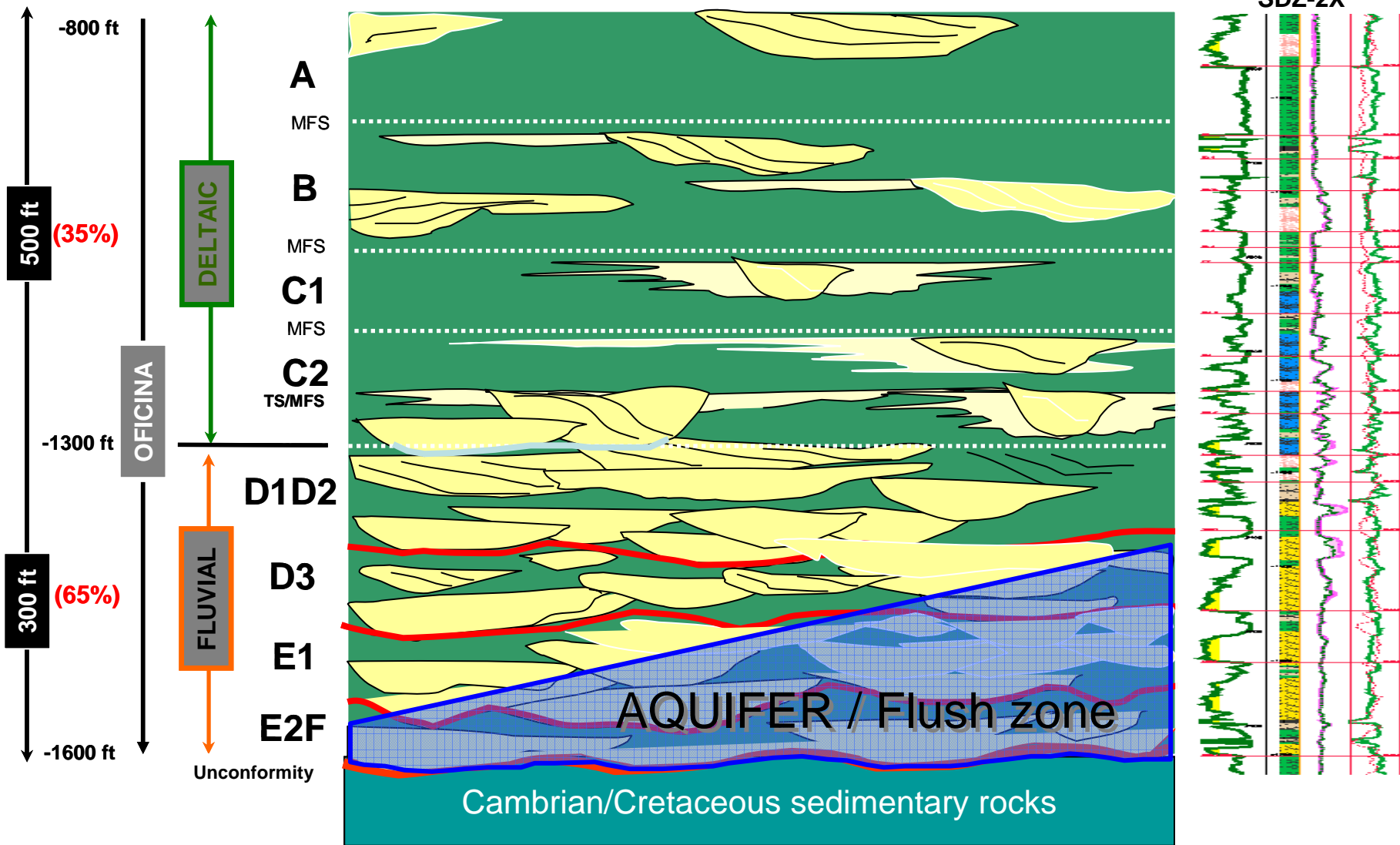
West

East

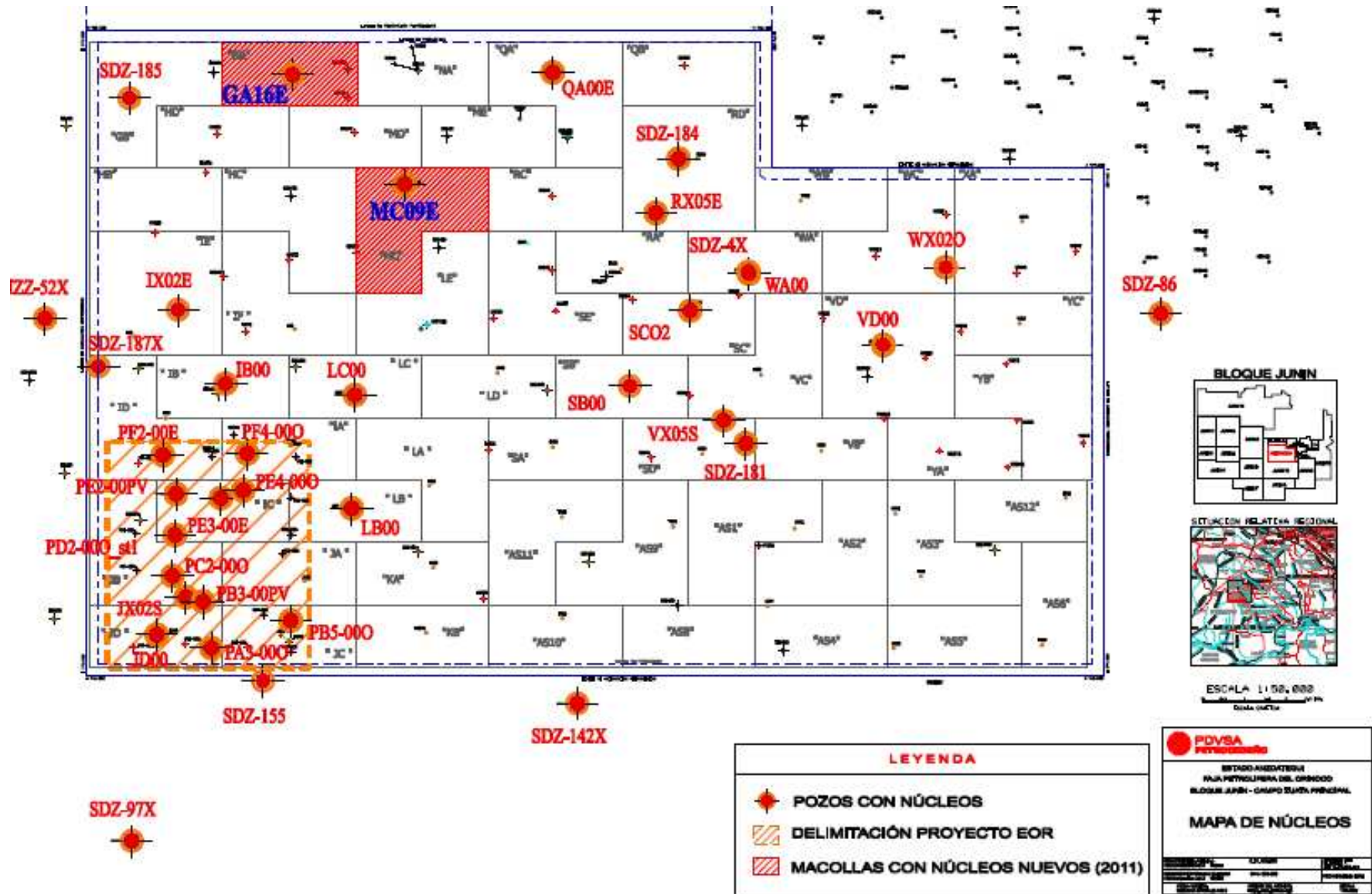


# Geology: Petrocedeno Stratigraphic Column

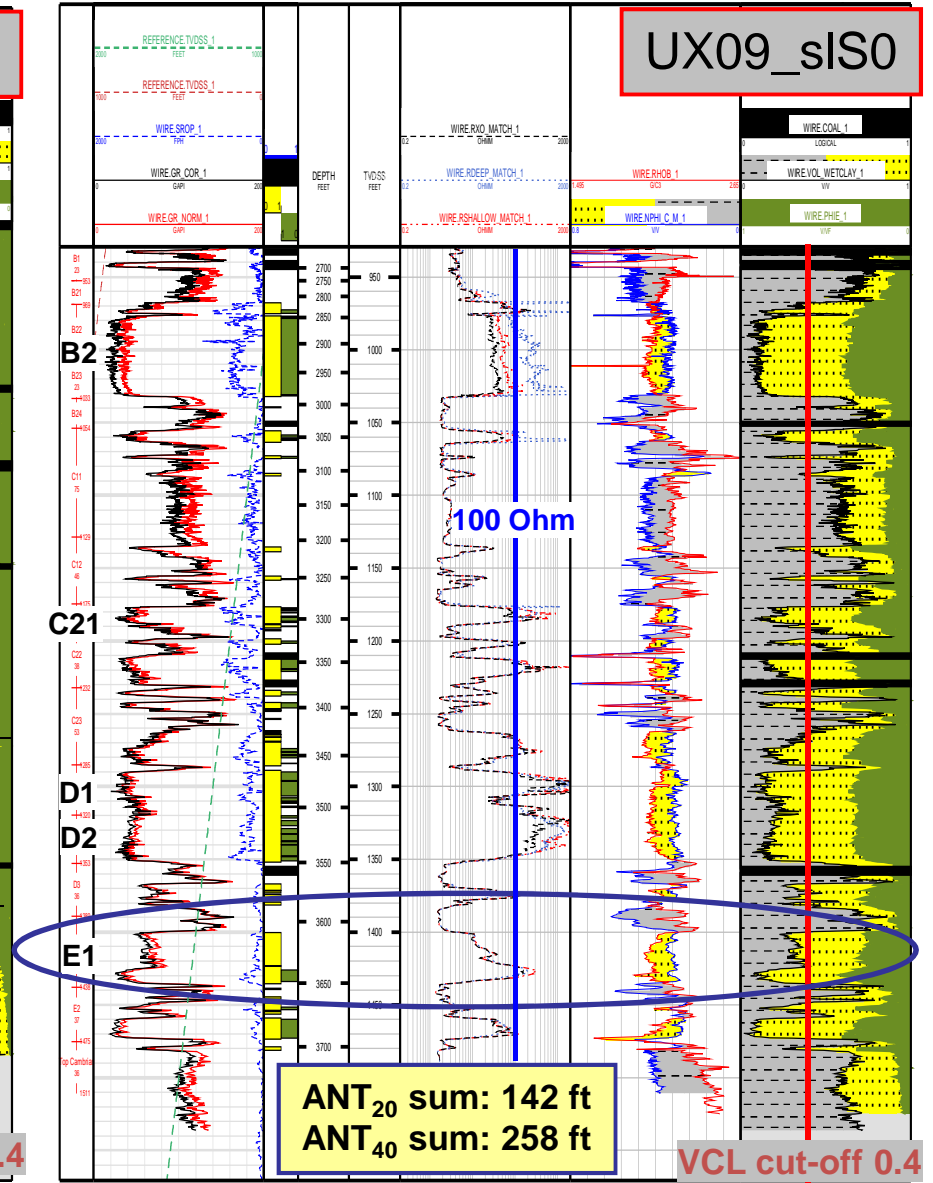
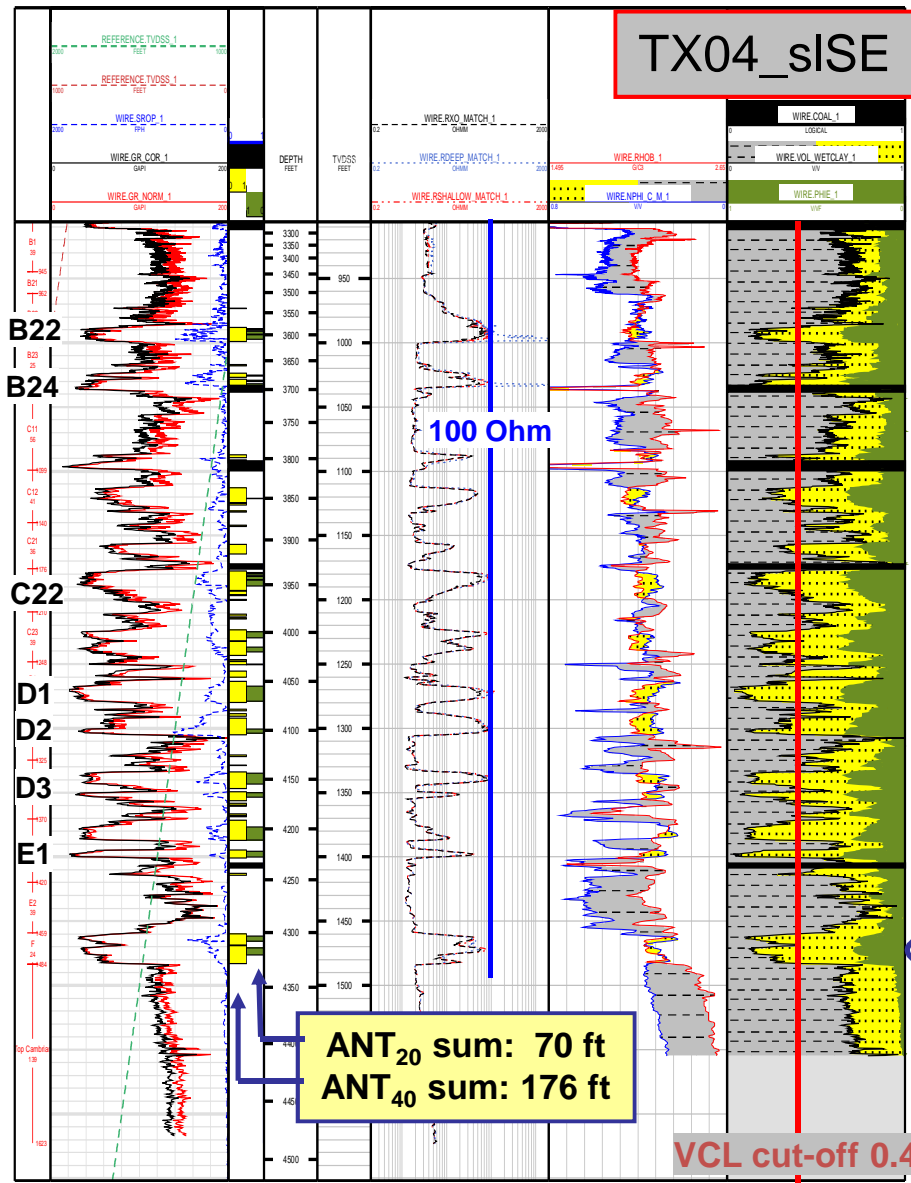
## STRATIGRAPHY

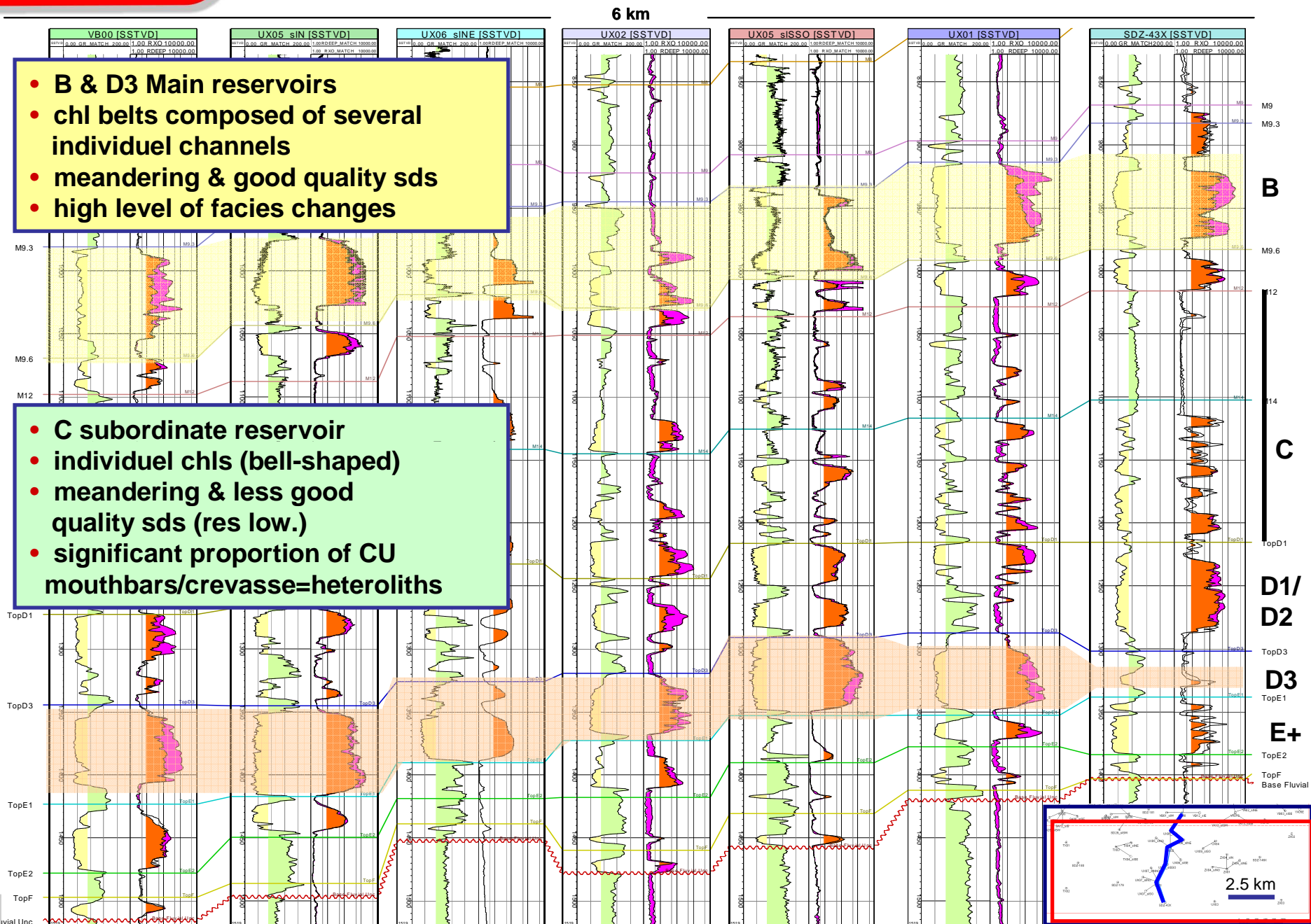


# Geology Database: Core Data, a Primary Asset in Petrocedeno



# Geology Database: Typical Well logs and Interpretation





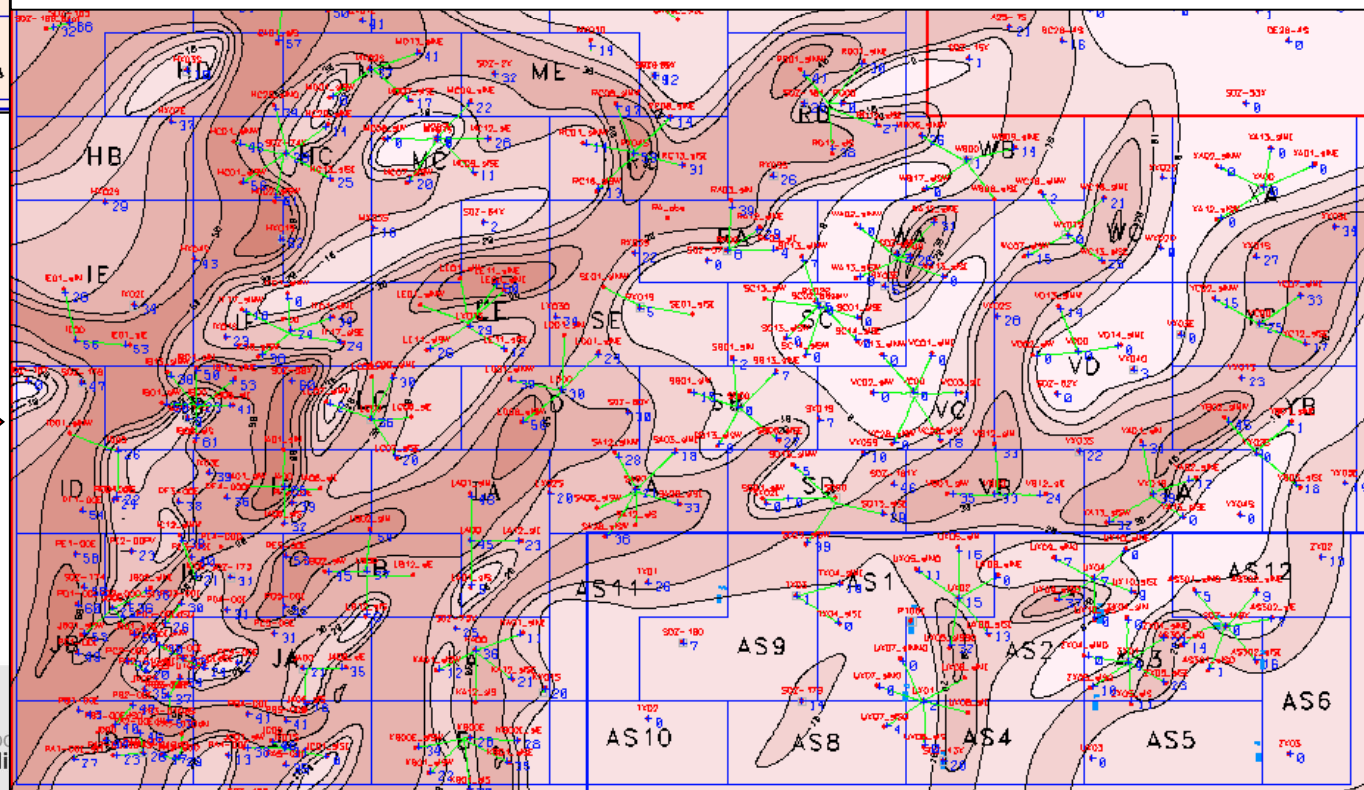
# MAPA DE ARENA NETA TOTAL D2

# Geological Studies: Net Sand and Quality Maps (D2)

← Vsh ≤ 0.4

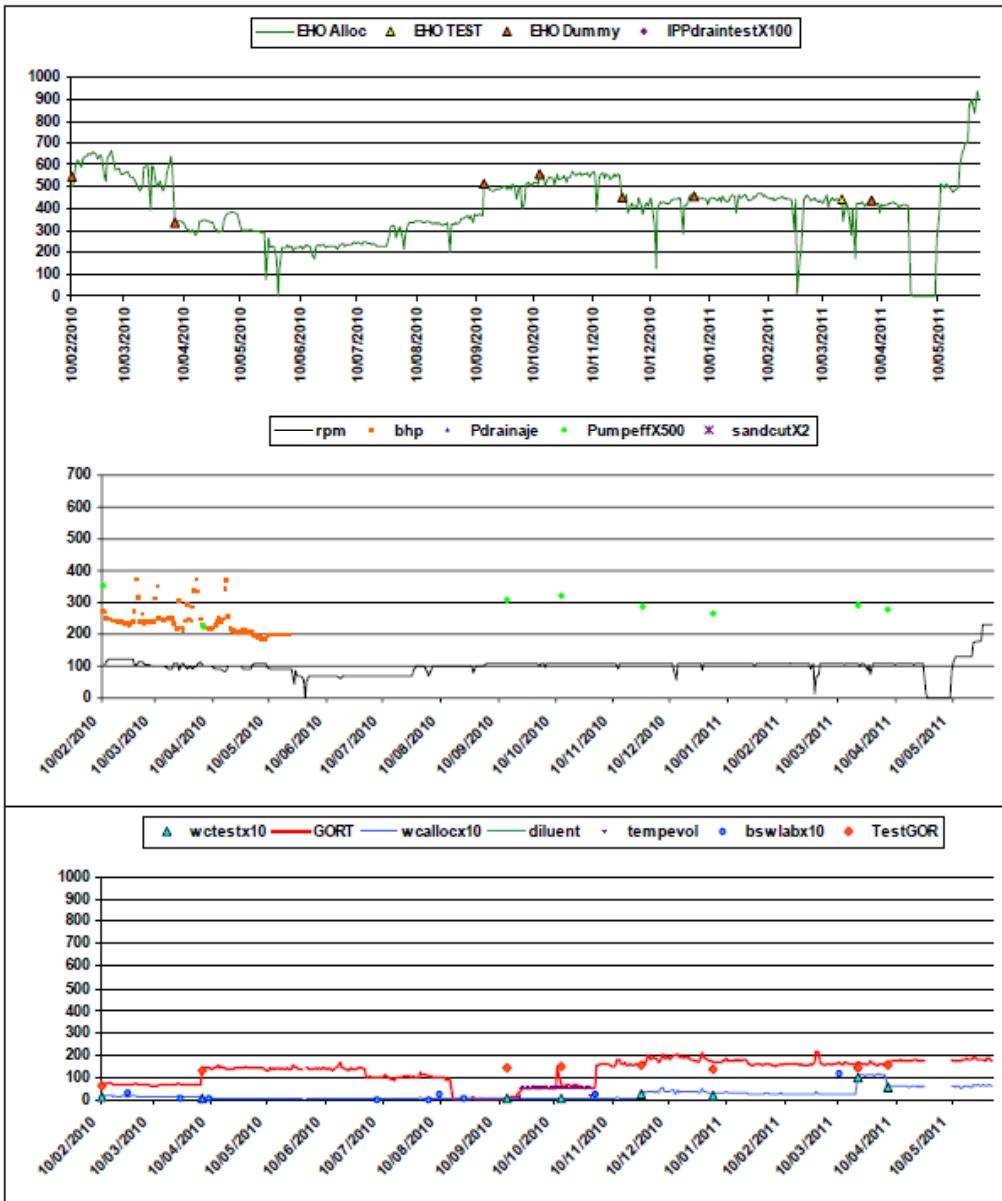
# MAPA DE PROSPECTIVIDAD DE ARENA D2

Vsh ≤ 0.4 y RDeep > 80 →



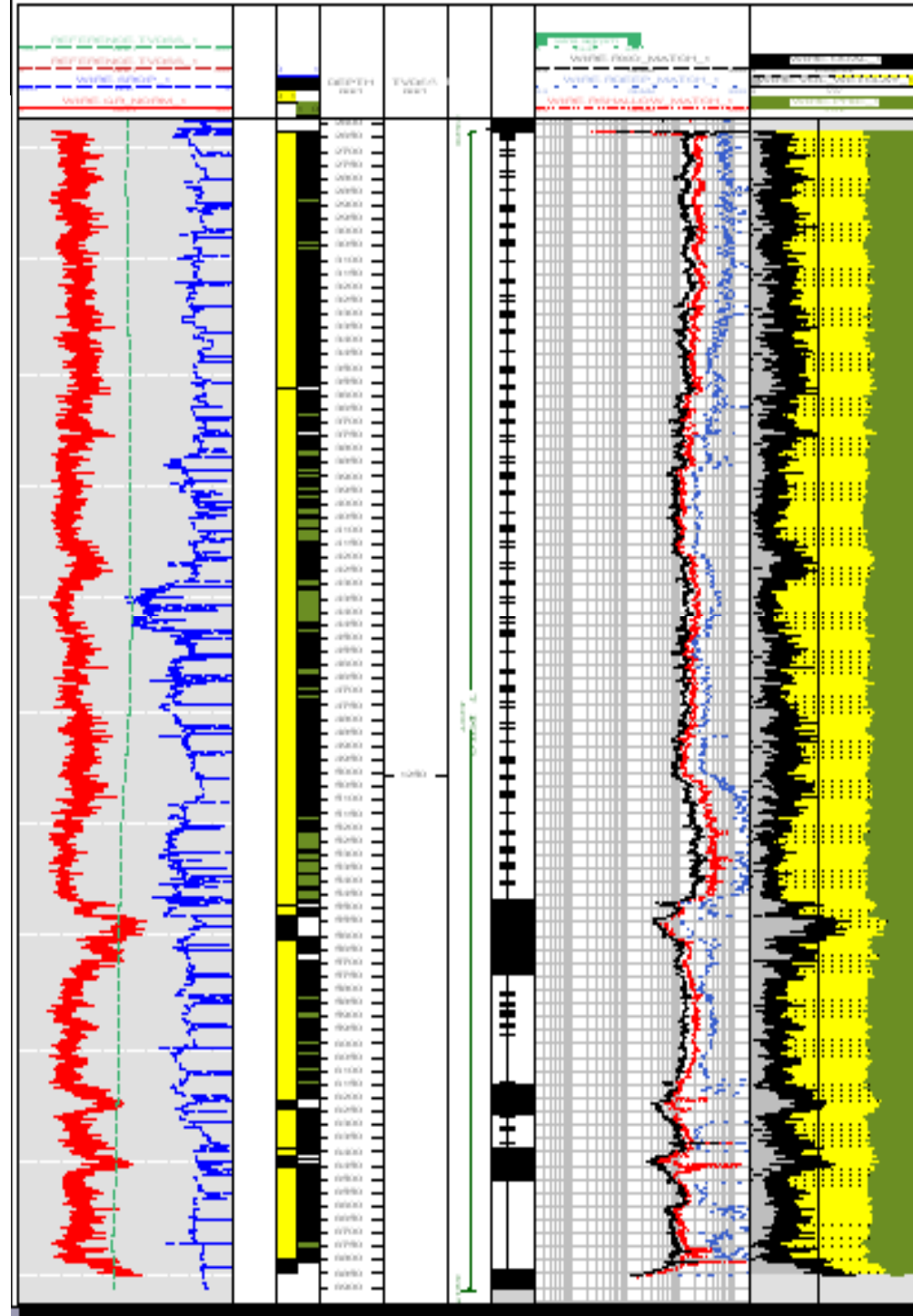
# Integrated well summary

Operar a Pmin



## SB11 (C2)

Netsand Reservoir = 4146 ft (97%)  
Netsand Open = 3666 ft (86%)



# Wells Preparation and Follow-Up

# Context: Petrocedeno Field Map

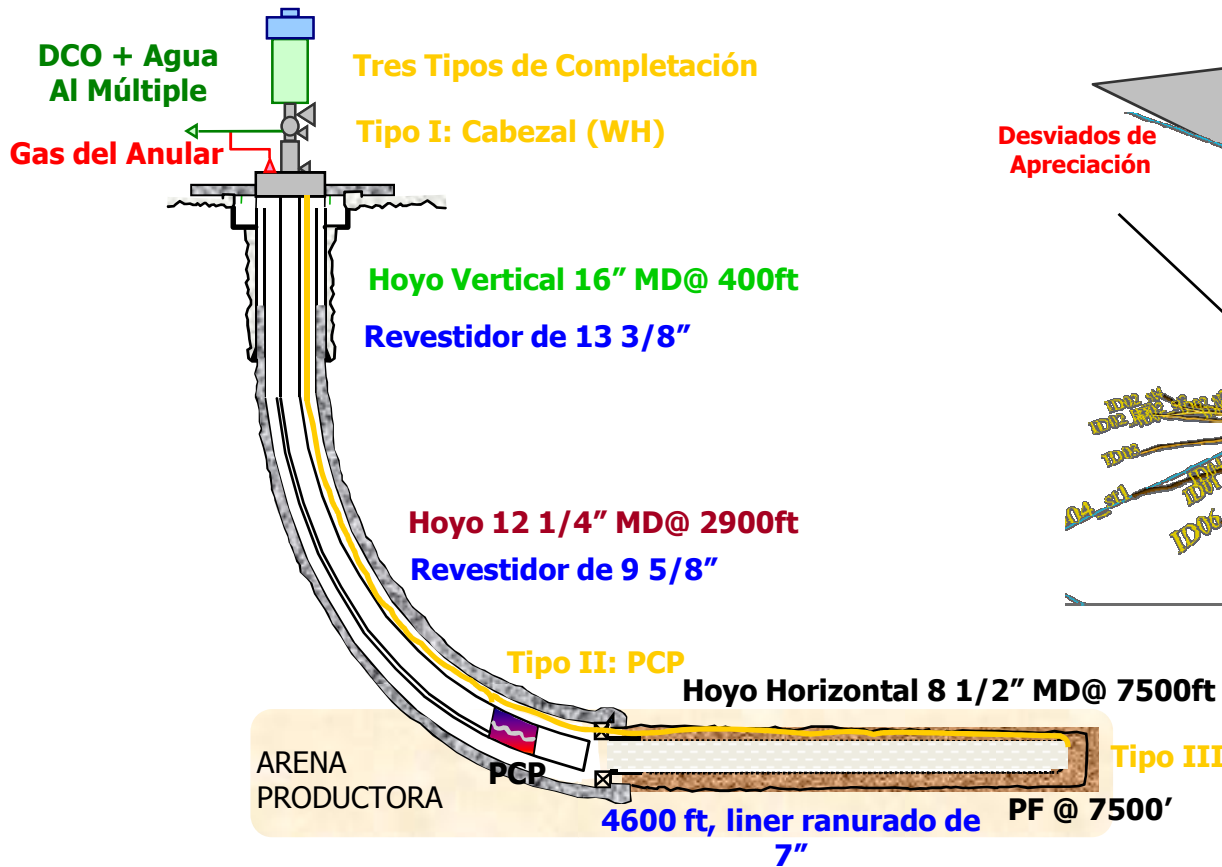
North zone : 6 water injectors

North Area : First oil 2013

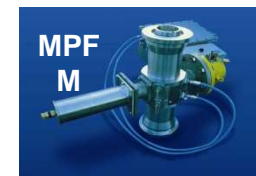
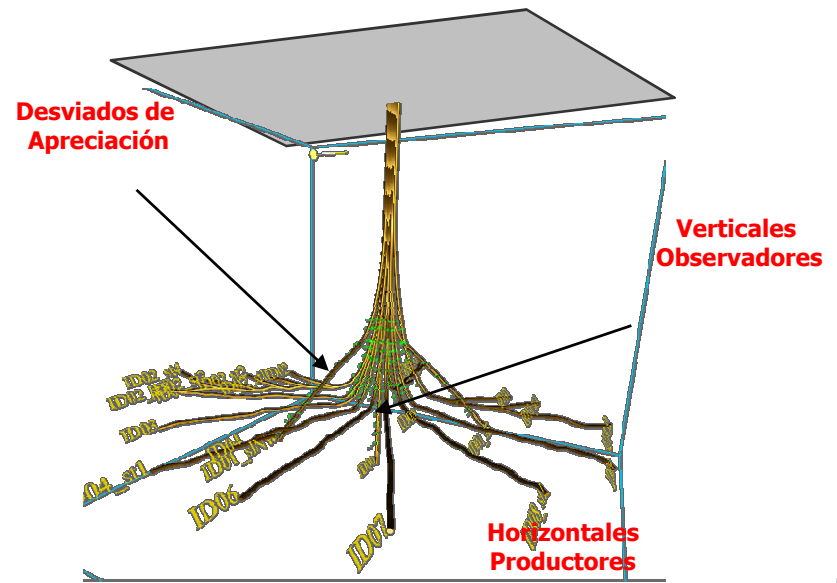
Main area :  
300 stratigraphic and observer wells  
700 horizontal producers

South Area : development started in  
2012, first oil 2013

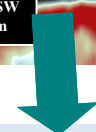
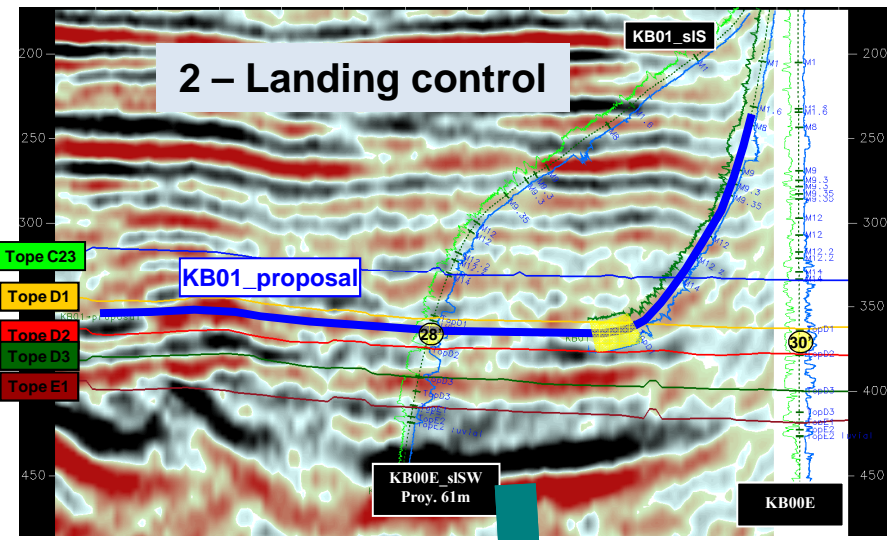
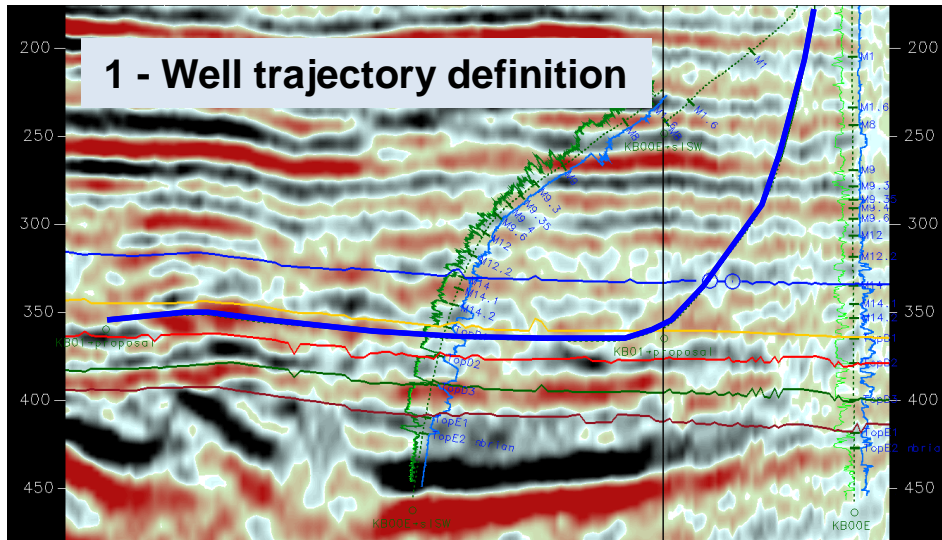
# Description of Well and Surface Equipments



Vista 3D Pozos en la Macolla



# Wells Preparation and Follow-Up: Process



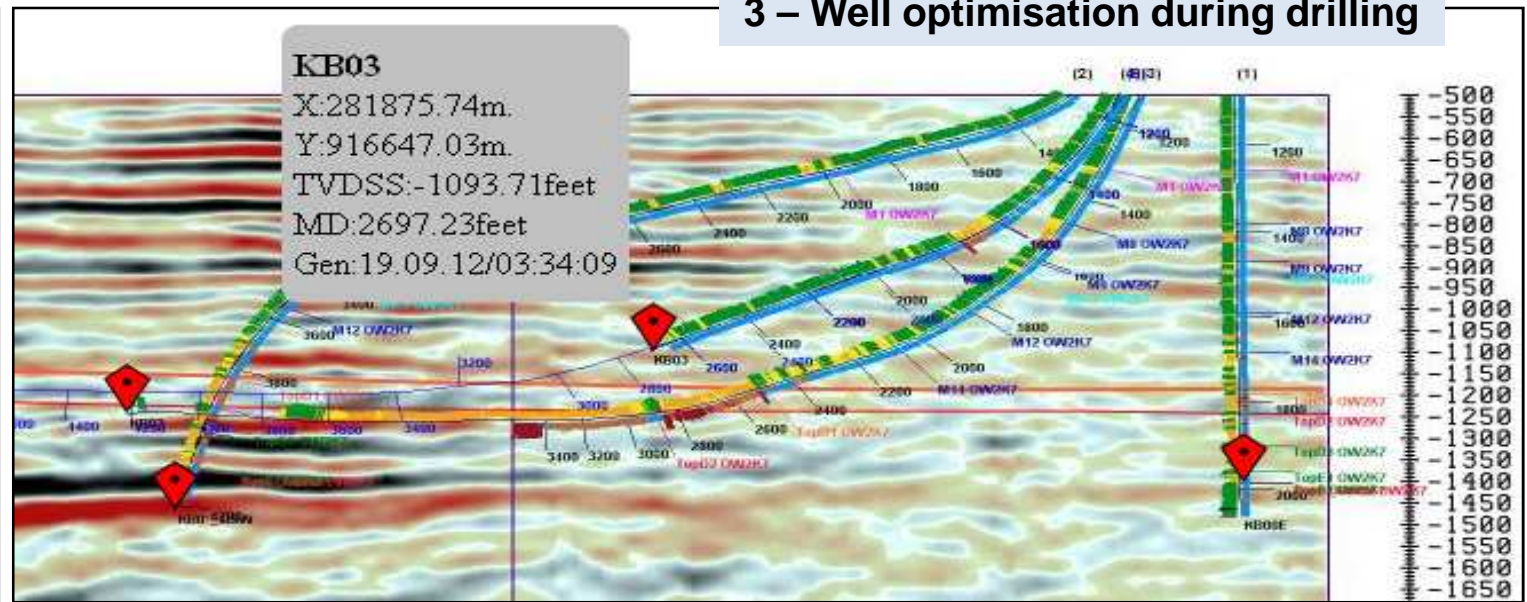
**KB-04 Int**  
PDV-25

Rig Activity	Value
Hole Depth	<> (ft)
Bit Depth	<> (ft)
TVD	<> (ft)
TVDSS	<> (ft)
ROP	<> (fph)
Annular Press	<> (psig)
Internal Press	<> (psig)
ECD	<> (ppg)

Flow In: 750-250-500  
Standpipe: 5750-1250-2500  
ABI (deg): <>

Tempo sin Datos: 00:00:47  
Rig @Time <Time> <Date>

GR\_RT, ROP, TVD, TVDSS, ROP, ABI



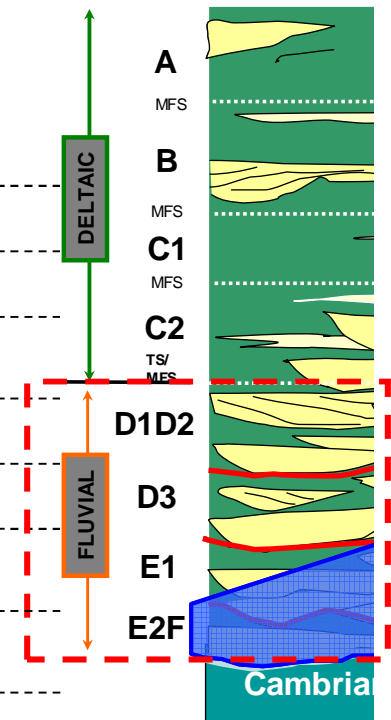
# Wells Preparation and Follow-Up: Milestones

- **KOM (1 year before drilling):**
  - Presentation of the drain catalog and all previous studies
  - Officialize dataset for field study.
- **Studies and wells propositions :**
  - Based on KOM results and recommandations
  - Integrated static and dynamic presentation
  - Wells propositions before ultimate revision.
- **Ranking :**
  - Presentation of all trajectories and selection of the definitives ones.
- **MENPET report : (60-90 days before drilling)**
  - Except in emergency cases, 45 days required for approval
  - Approval valid for 6 months

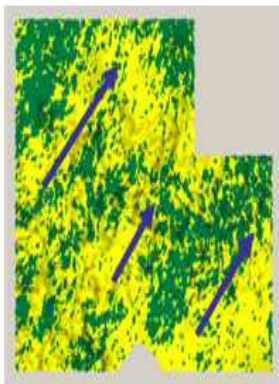
# Dynamic Studies

# Fluvial Model Characteristics

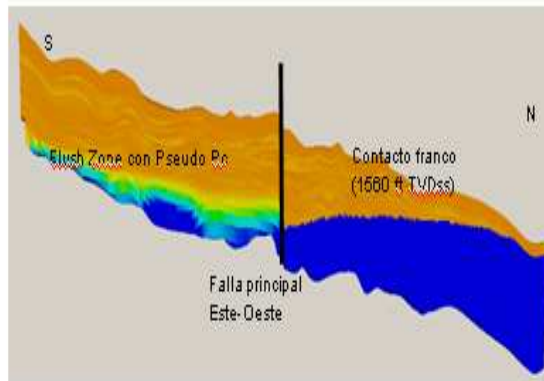
Type:	BlackOil (IMEX – CMG)
Beginning date	01 Enero 2001
Matched until:	Mayo 2011
Model size :	1.857.024 celdas (208x248x36) (Activas 663.081)
Cells size:	150x150 m
Number of wells :	490: 490 (Prod) + 6 (iny) + 59 (slants, verticales)
Other :	Dos zonas de PVT, Acuífero explícito, Modelo Rotado



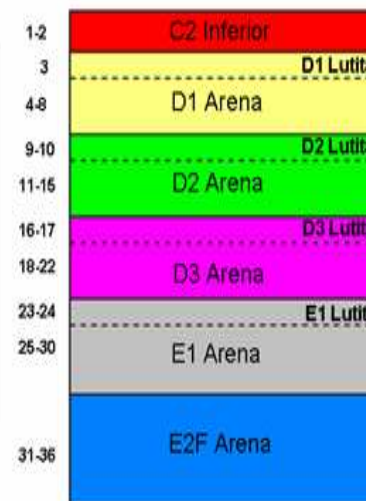
Extracción del modelo de facies al Tope D2



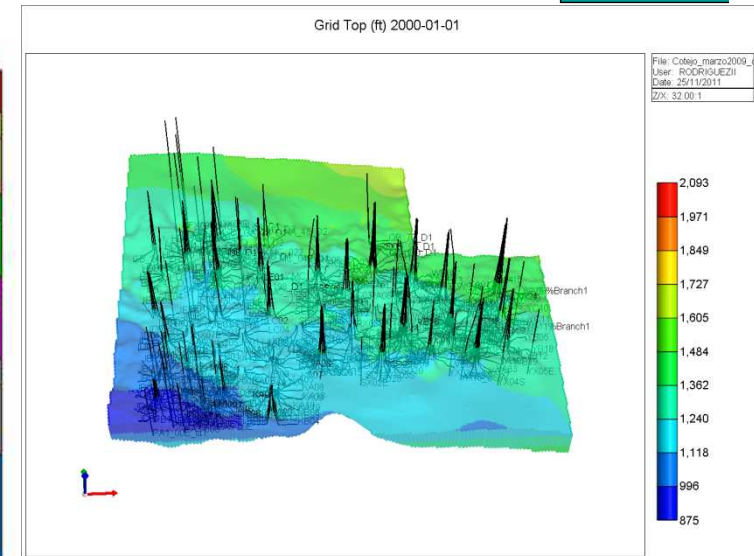
Saturación de agua inicial – Corte Sur-Norte



# CAPAS



Grid Top (ft) 2000-01-01

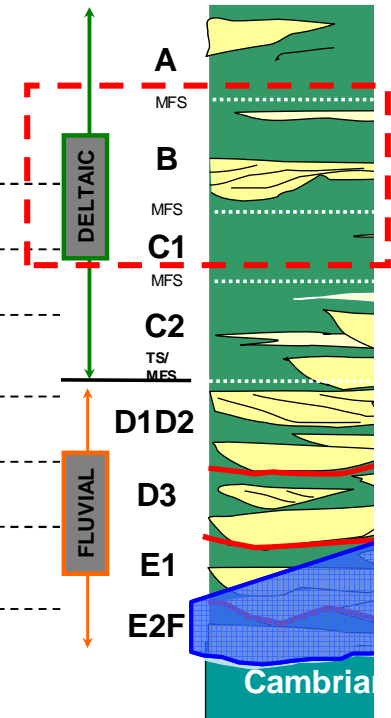


Eje de la malla correspondiente a los ejes de canales.

■ Arcilla ■ Arena

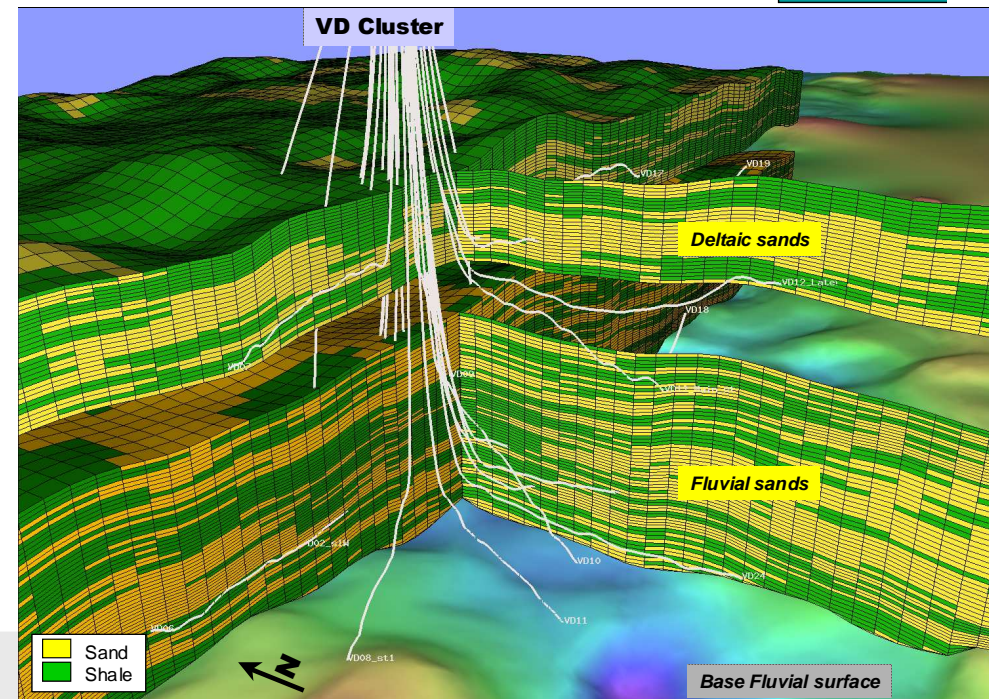
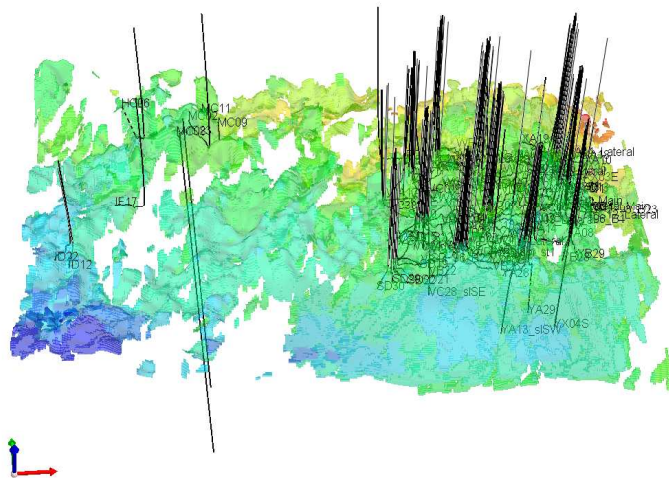
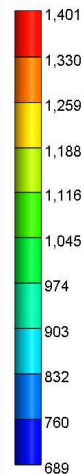
# Deltaic Full Field Model Characteristics

Type:	BlackOil (IMEX – CMG)
Beginning date :	01 Enero 2001
Matched until :	Octubre 2010
Model size :	1.327.256 celdas (274x173x28)
Number of wells :	126: 115 (Prod) + 11 (slants, verticales)
Other :	Cinco zonas de PVT



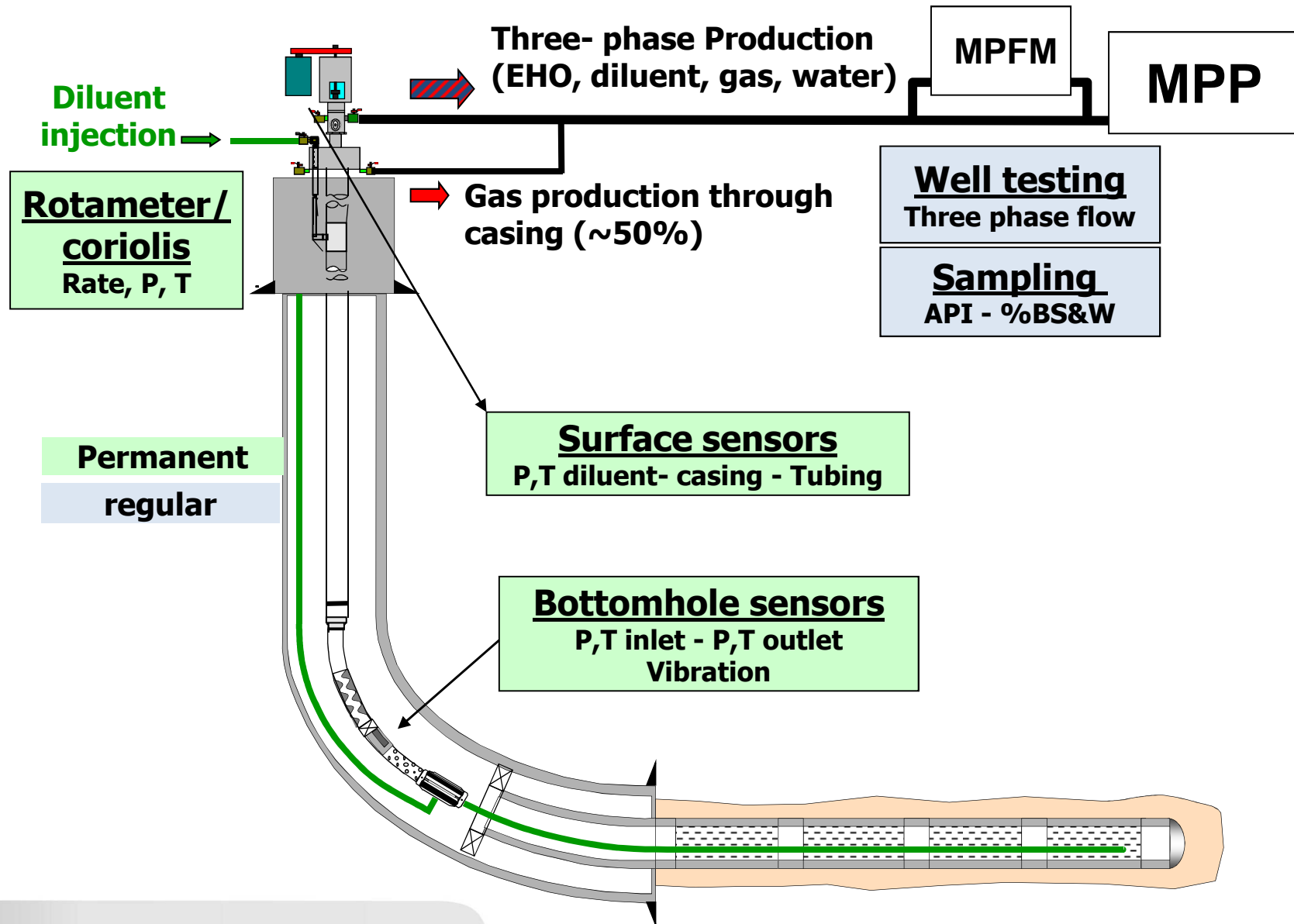
Grid Top (ft) 2001-01-01

File: Base\_cotejoABRIL12  
User: pintorb  
Date: 25/10/2012  
Z/X: 57.00.1



# Monitoring and Field Optimization

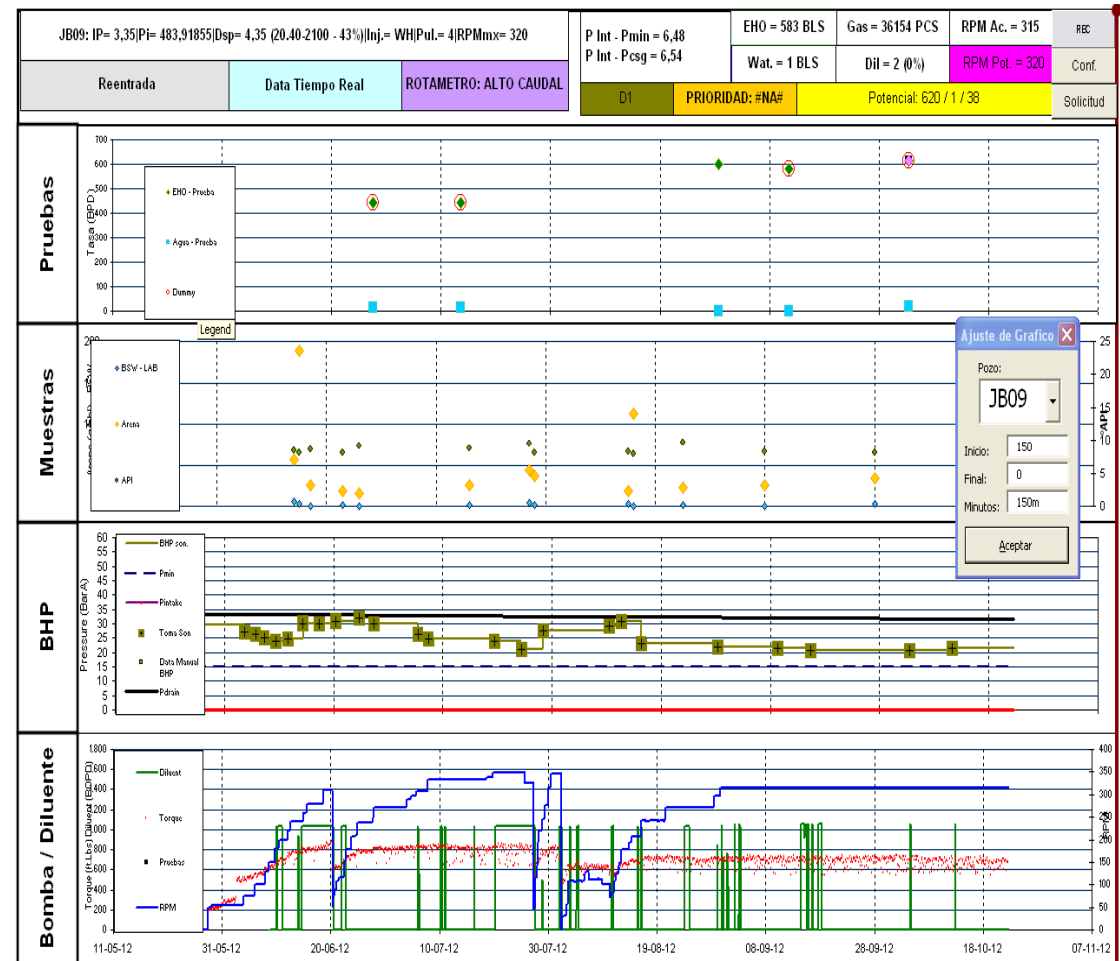
# Type Well and Associated Real Time Monitoring



# Field Optimización

## Through Well Monitoring and Metering

- **Welltest validation**
  - Through Multiphase Meter or through dummies tests
  - 400 tests a month (90% of field production)
- **BHP and diluent injection optimisation according to the type of well**
  - Follow up by well, and regular update on optimum BHP based on well behavior and available pump.



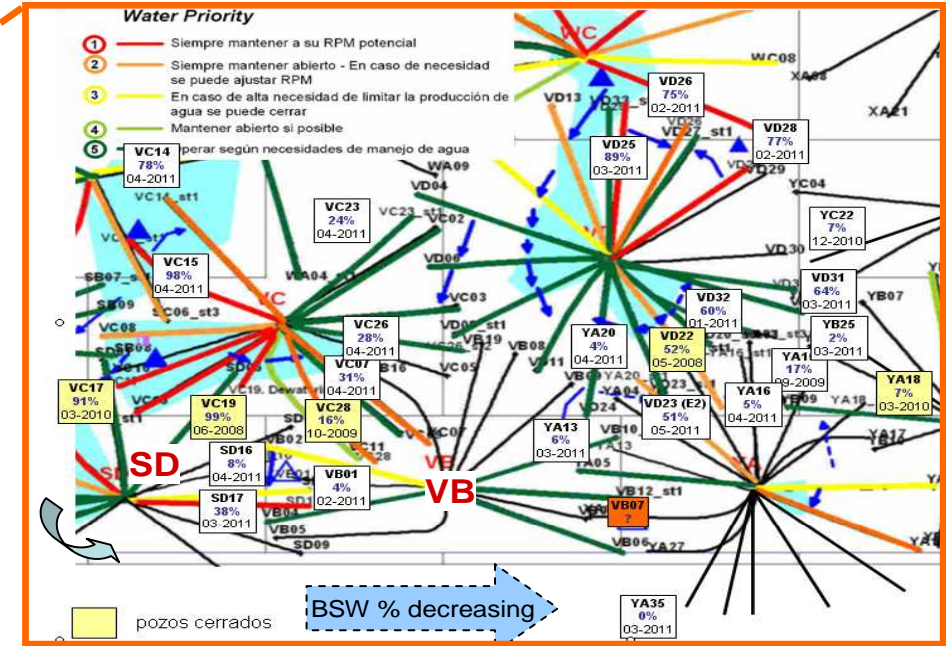
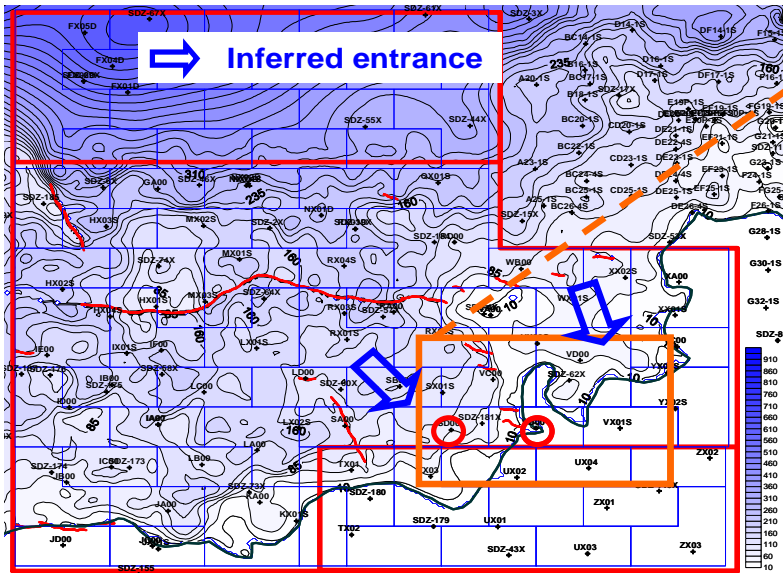
# Wells Startup Requirements and Monitoring

- **Specific procedures for wells kicks-off per type of wells :**
  - sand production risk
  - water production behavior
- **Specific procedures for wells kicks-off per status of well :**
  - post-stimulation
  - new wells in in cleanup

Tipo de Rampeo	Criteria	Rampeo	Observaciones
1	Pozos Arena/Surfactante/Agua	0-50 RPM en 3Min	Garantizar la estabilidad de la Presión de fondo (BHP), para no generar daños/perdida de Producción
		50 RPM cada 12 hrs hasta alcanzar su RPM Operacional	
		Tiempo de Optimización= A juicio del Custodio	
2	Pozos < 100 RPM Operacional	0-50 RPM en 3min	Sin problema de Arena/ Agua y sin tratamiento con surfactante
		Estabilizando a 50 RPM por 20 Min	
		Cada 20 Min llevar de 50 RPM a su RPM operacional	
3	Pozos > 100 RPM Operacional	0-50 RPM en 3min	Sin problema de Arena/ Agua y sin tratamiento con surfactante
		Estabilizando a 50 RPM por 20 Min	
		Cada 20 Min llevar de 50 RPM a su RPM operacional	
		Tiempo de Optimización= 120 Min	

# Example: Water Management Plan

Flush/water - zone isopach



## Actualization of the Water Management Plan 2012

Integrating subsurface understanding, PCP limitations and MPP limitations torque and vibration

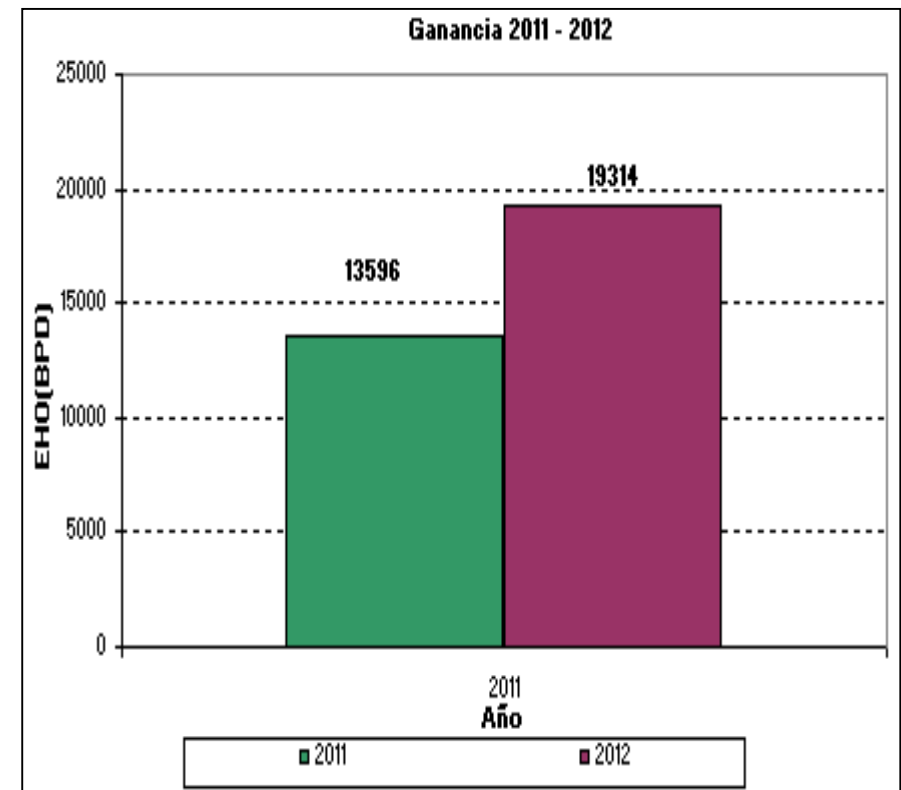
Prioridad	Descripción
1	Siempre mantener a su RPM potencial
2	Siempre mantener abierto - En caso de necesidad se puede ajustar RPM
3	En caso de alta necesidad de limitar la producción de agua se puede cerrar
4	Mantener abierto si posible
5	Operar según necesidades de manejo de agua

# Stimulations

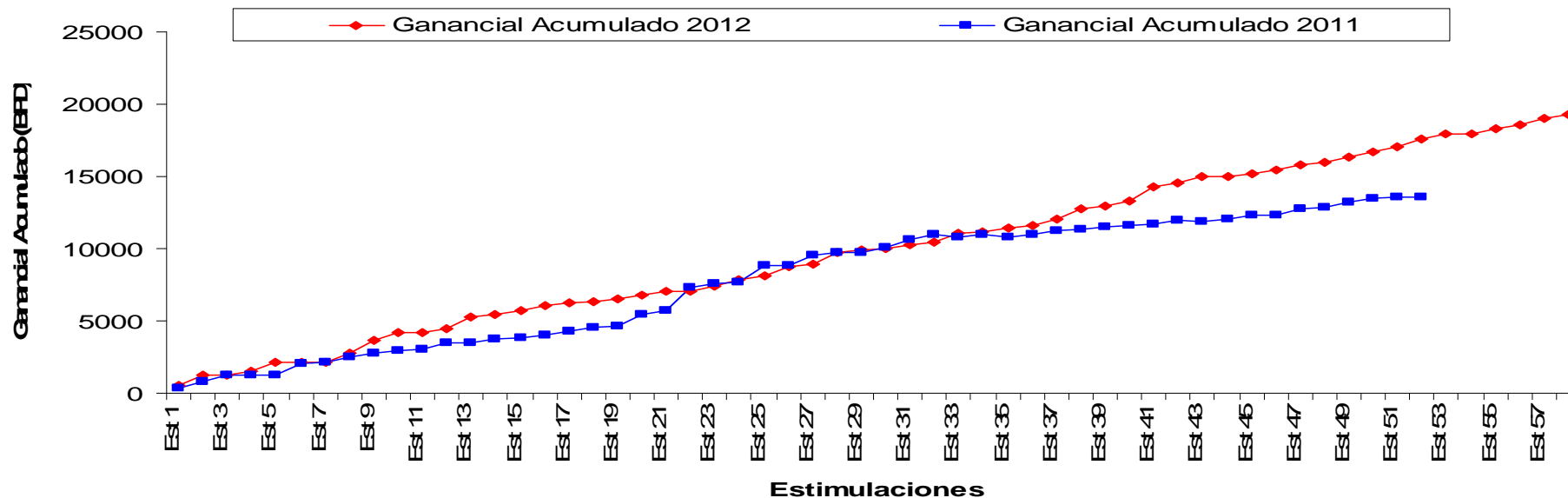
# Stimulations Methodology

- **Principle :**
  - Regular workover operations injecting a mixture of products to remove the damage at liner and near-wellbore levels
  
- **Work process :**
  - Identification of candidates based on detailed well behavior analysis (Ficha Estudio)
  - Definition of the stimulation sequence optimising between stimulation candidates, workover units operational sequence, and pump replacement programs.
  - Analyses of the stimulation results in the 3 months after the treatment

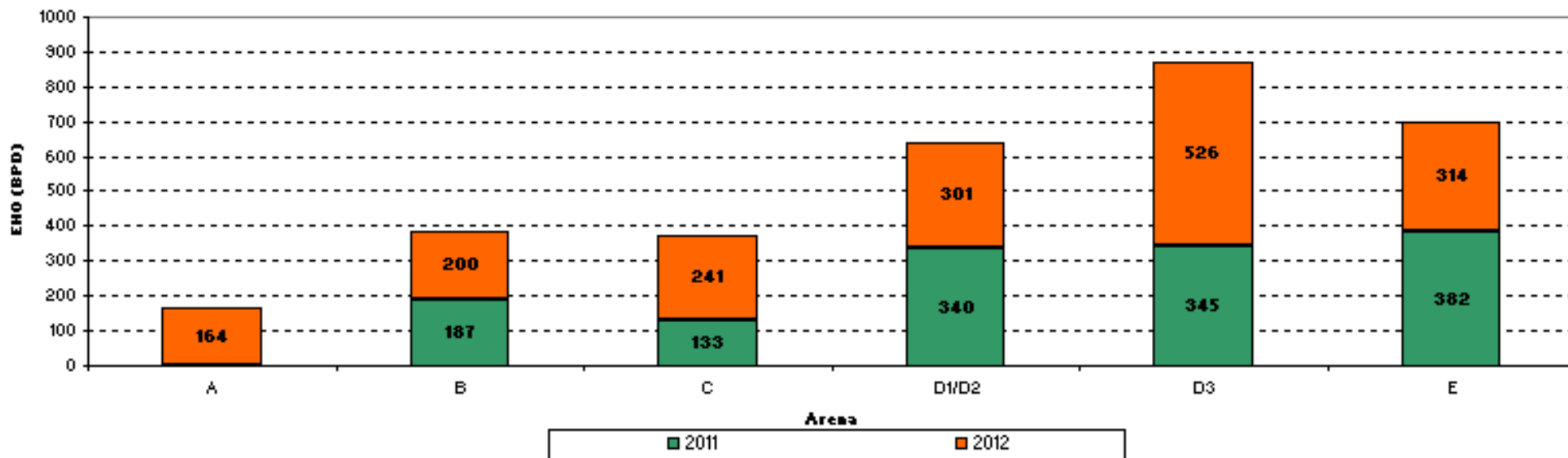
**N°wells : 53 in 2011 + 72 in Oct 2012**  
**Average gain + 60% Oil production**  
**Average cost 250 000 US\$**



## Ganancia Acumulada EV-03/CCT/Troil-05



## Promedio Ganancia por Arena. Método 1

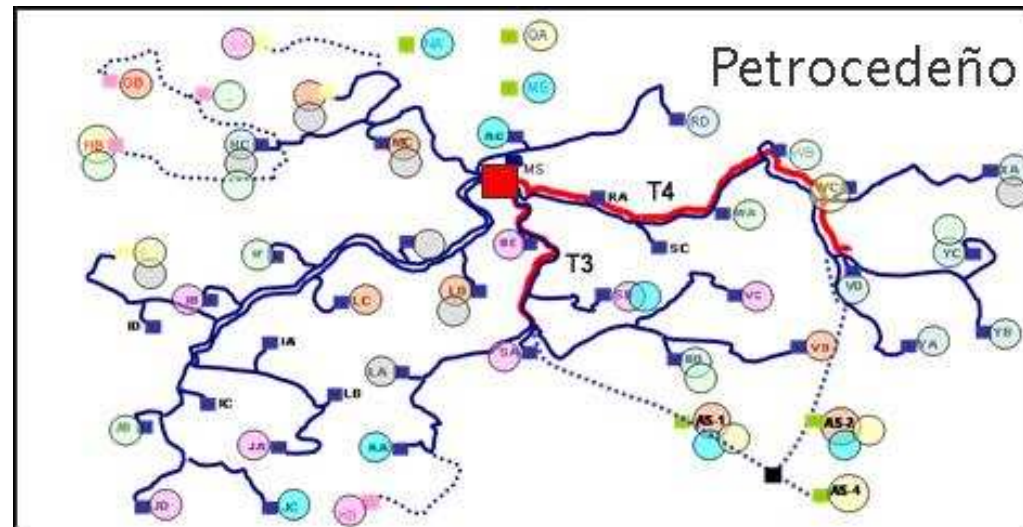


# Subsurface: Conclusions

- **Petrocedeno = High potential area :**
  - 40 Gbbl Oil in Place on 400 km<sup>2</sup> : large oil density
  - Low-intensity structural scheme : no field compartmentalisation
  - Reservoir Depth ~ 1500 ft TVD : easy access, low-cost wells
- **Data intensive development philosophy:**
  - From 3D seismic coverage on the whole field to regular cores and extensive log acquisition to automated wells monitoring
  - Objective : guarantee enough information to optimise field development
- **Extra Heavy Oil ⇔ High operational activity**
  - More than 1000 wells (producers + stratigraphic) drilled in 12 years
  - 130 stimulations planned in 2013 ...

# Well Technical Operations

- **Drilling activity in PDVSA Petrocedeno**
- **Organization**
- **Type of wells design**
- **Completion design**
- **Future**



## PETROCEDENO

- Mainstation with daily production of 130.000 Bls EHO/day
- Upgrader in Jose
- 8 drilling rigs, 4 currently in operation
- 4 workover and completion rigs
- 1 FBU and 1 Concentric Coiled Tubing unit
- Plans to produce with steam in the future



VD Cluster with 47 wells



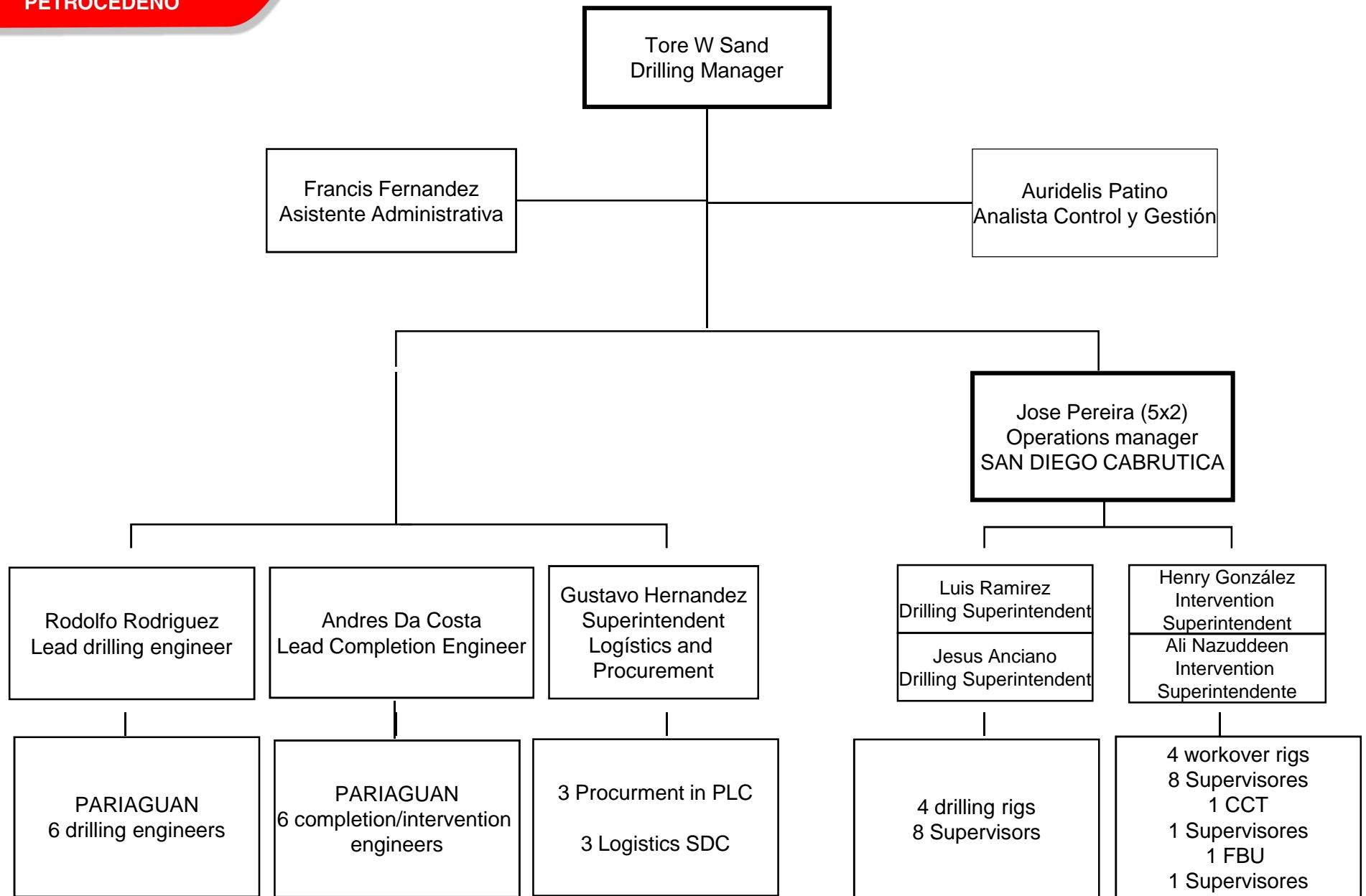
Drilling Rig, WO Rig and FBU

## Drilling:

- Horizontal producers: 10 - 25 days.
- To help well planning, drilling observation and estratografic wells.
- Drilling water producers and water injectors
- 10 – 30 horizontal wells / rig / year.

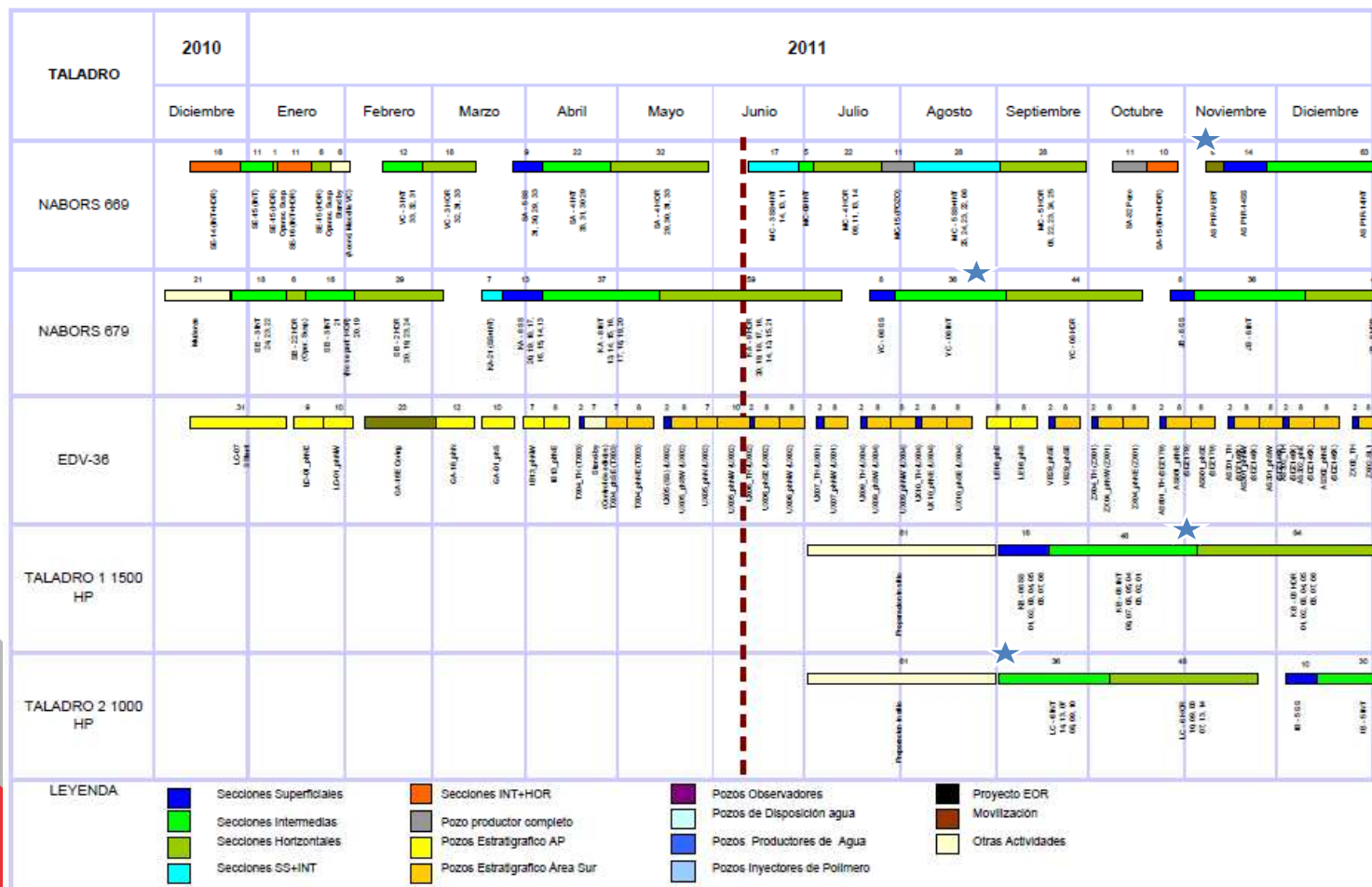
## Completion / Well Services:

- New completions: 1.5 days operation.
- Well Service operations: 2 - 4 days.  
Total 25 – 35 / month.
  - Change BCP
  - Leak in production tubing
- Optimizing production:
  - Stimulation with surfactant, 7 - 12 days
  - Sand clean out, 7-10 days



# Drilling

Responsible for the planning of wells to be drilled and the drilling operation. Preparing drilling schedules, implementing new technology and optimizing the drilling operation in terms of HSE, time and cost. At present operating/preparing 8 drilling rigs : Nabor 669, Elinca-02, EDV36, PDV-25, PDV-99, PDV-102, PDV-109 y PDV-113.









South Area (hot well design)

MLT

Screen completions

New drilling rigs

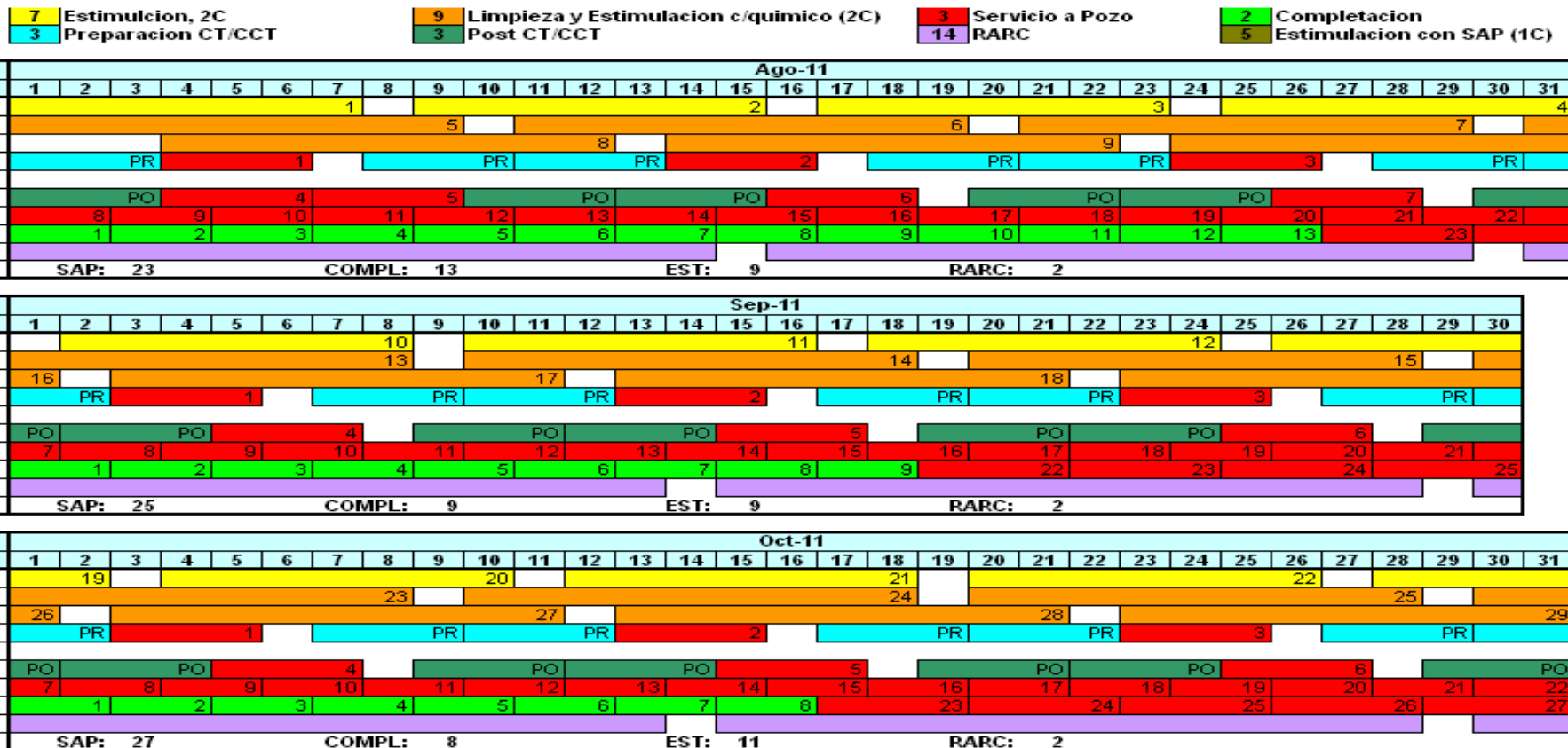
LEYENDA

-  Secciones Superficiales
-  Secciones Intermedias
-  Secciones Horizontales
-  Secciones SS+INT
-  Secciones INT+HCR
-  Pozo productor completo
-  Pozos Estratigrafico AP
-  Pozos Estratigrafico Area Sur
-  Pozos Observadores
-  Pozos de Disposicion agua
-  Pozos Productores de Agua
-  Pozos Inyectores de Polimeros
-  Proyecto EOR
-  Movilizacion
-  Otras Actividades

# Completion and Workover

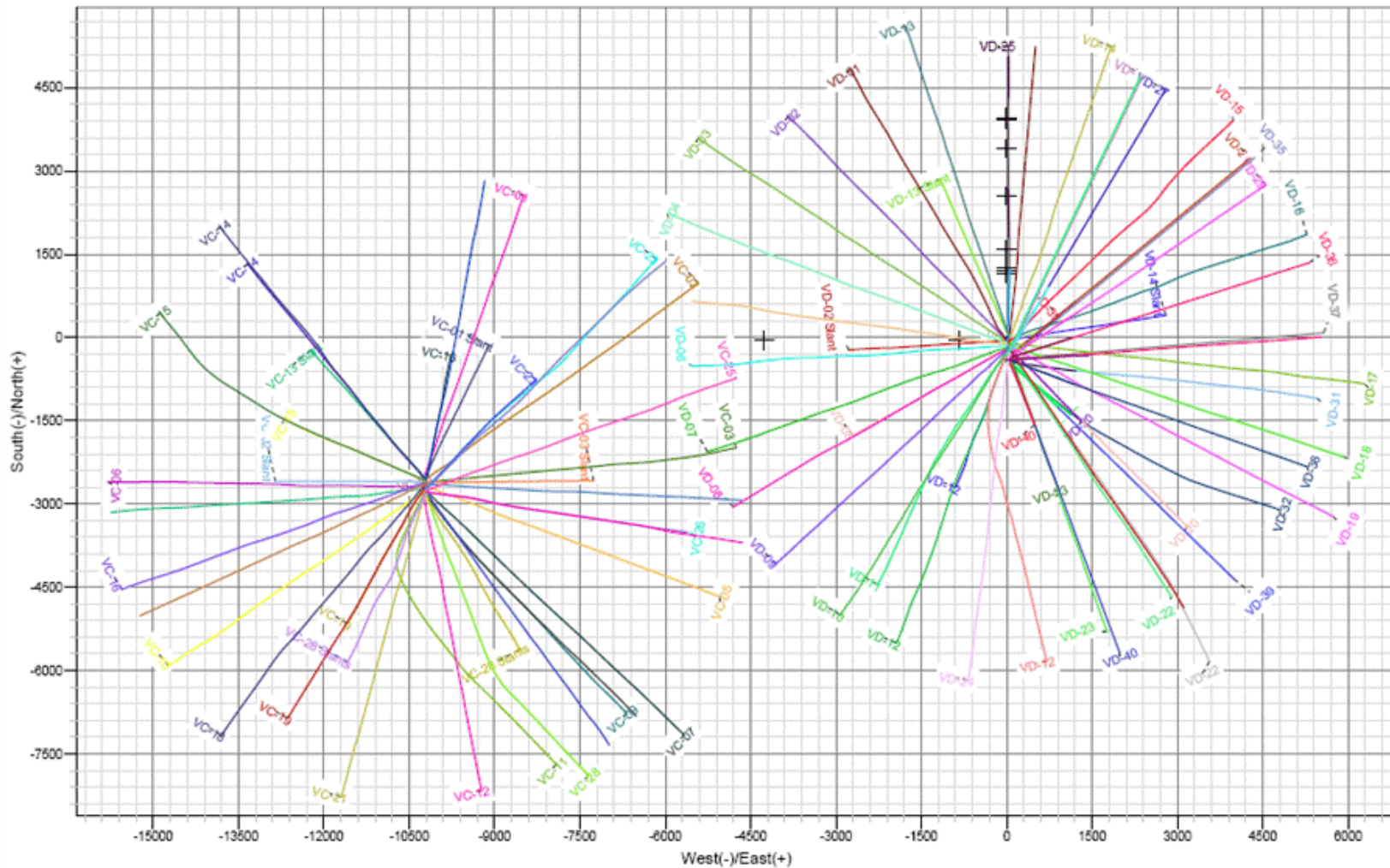
Responsible for the planning and operations of the completion and workover rigs. Operating different rigs and operations as completion, RA/RC, stimulation, sand cleanout, change of BCP, replacing leaking tubing, etc.

At the moment, there are 4 workover rigs in operation (Evertson-3, Evertson-5, Global 103 y Troll-05), one FBU and one Concentric Coiled Tubing unit.

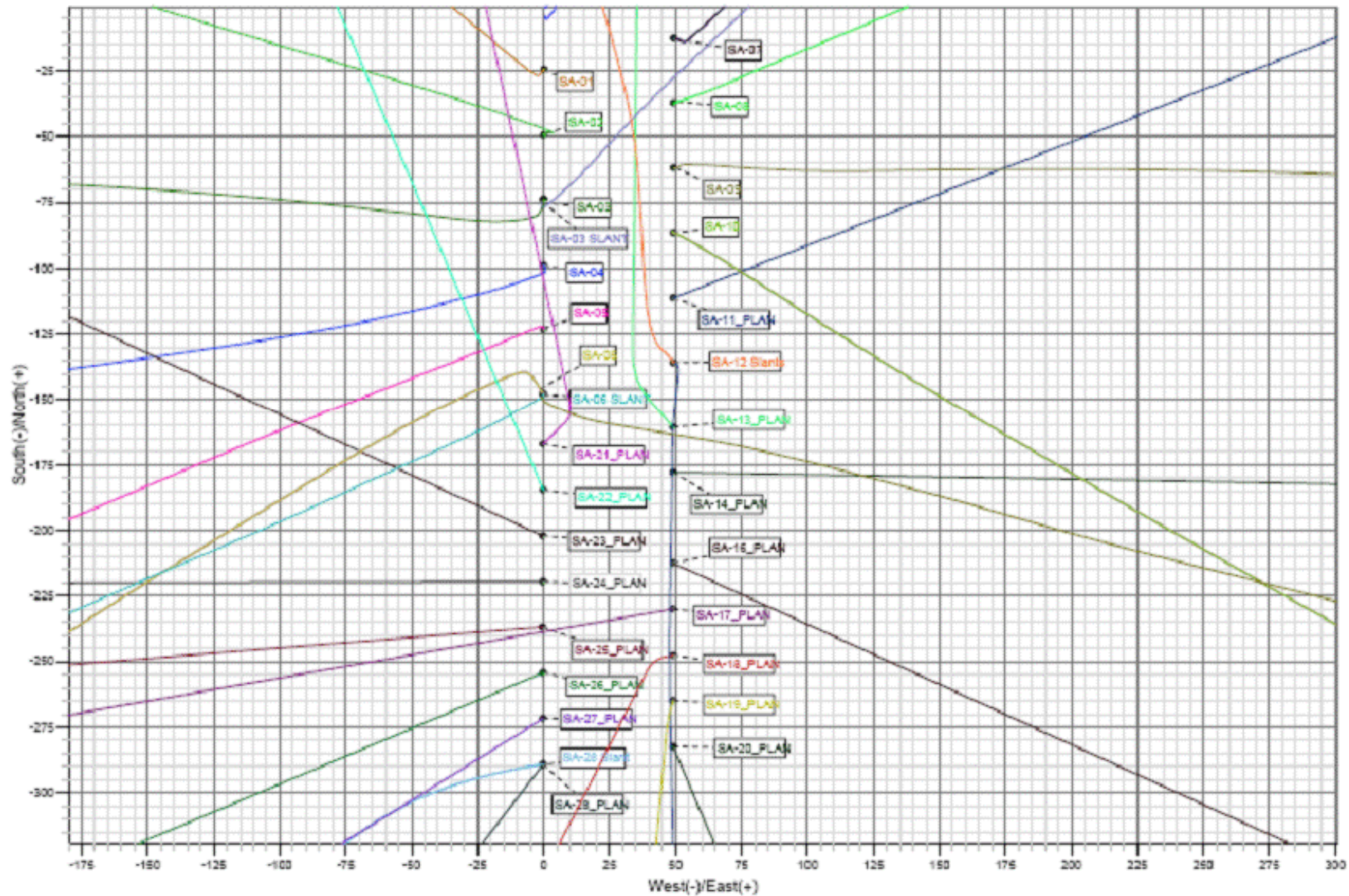


- The reservoir correspond to depositions from fluvial / deltaic
- Well clusters with up to 40 wells
- 6 different type of wells
  - Stratigraphic Vertical
  - Stratigraphic deviated / Slant
  - Observers
  - Water Injectors
  - Re-Entry
  - Horizontal producers
- TVD between 1100 feet to 2000 feet.
- Horizontal reach of 4600 feet.

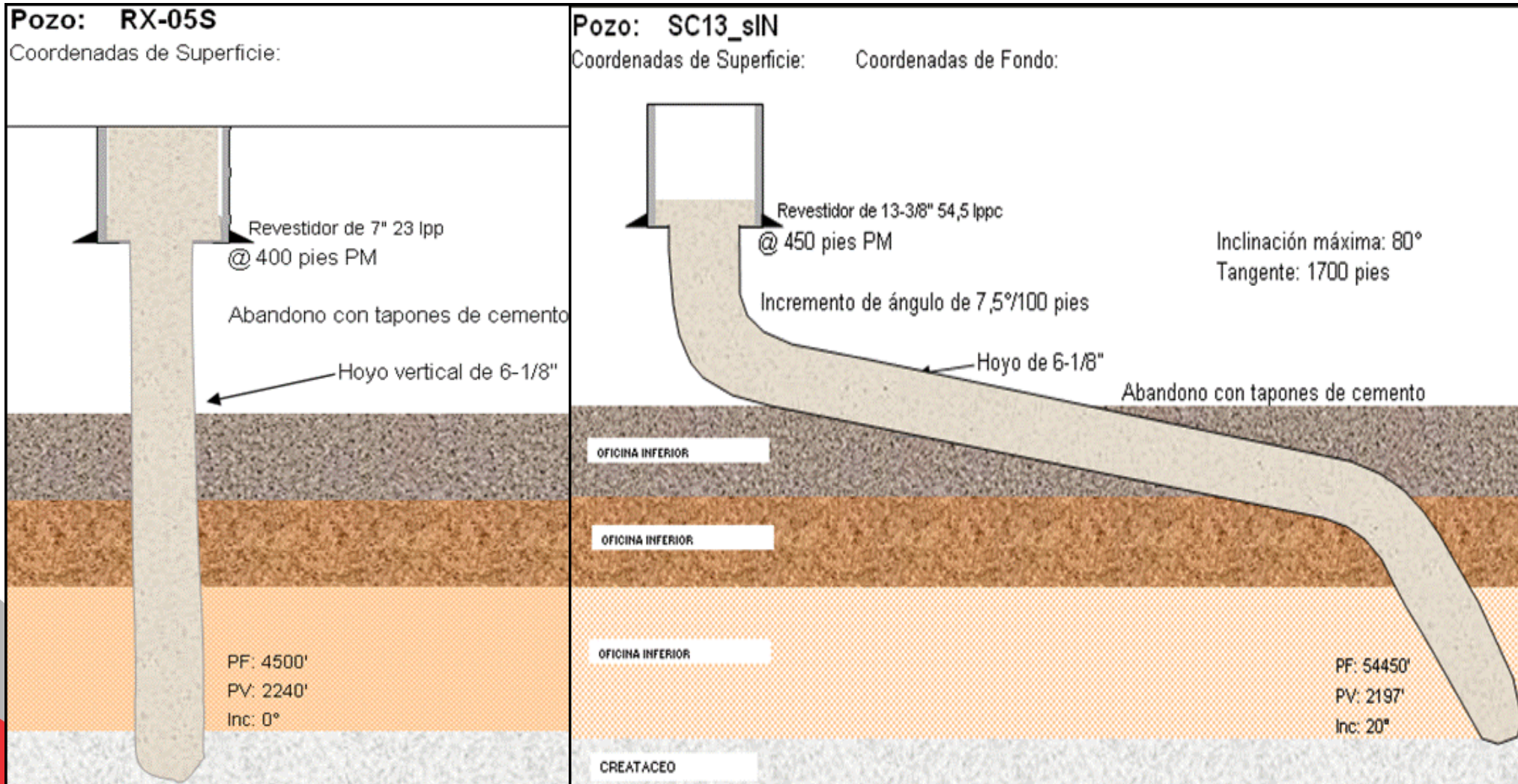
# Cluster Well Design and Anti Collision

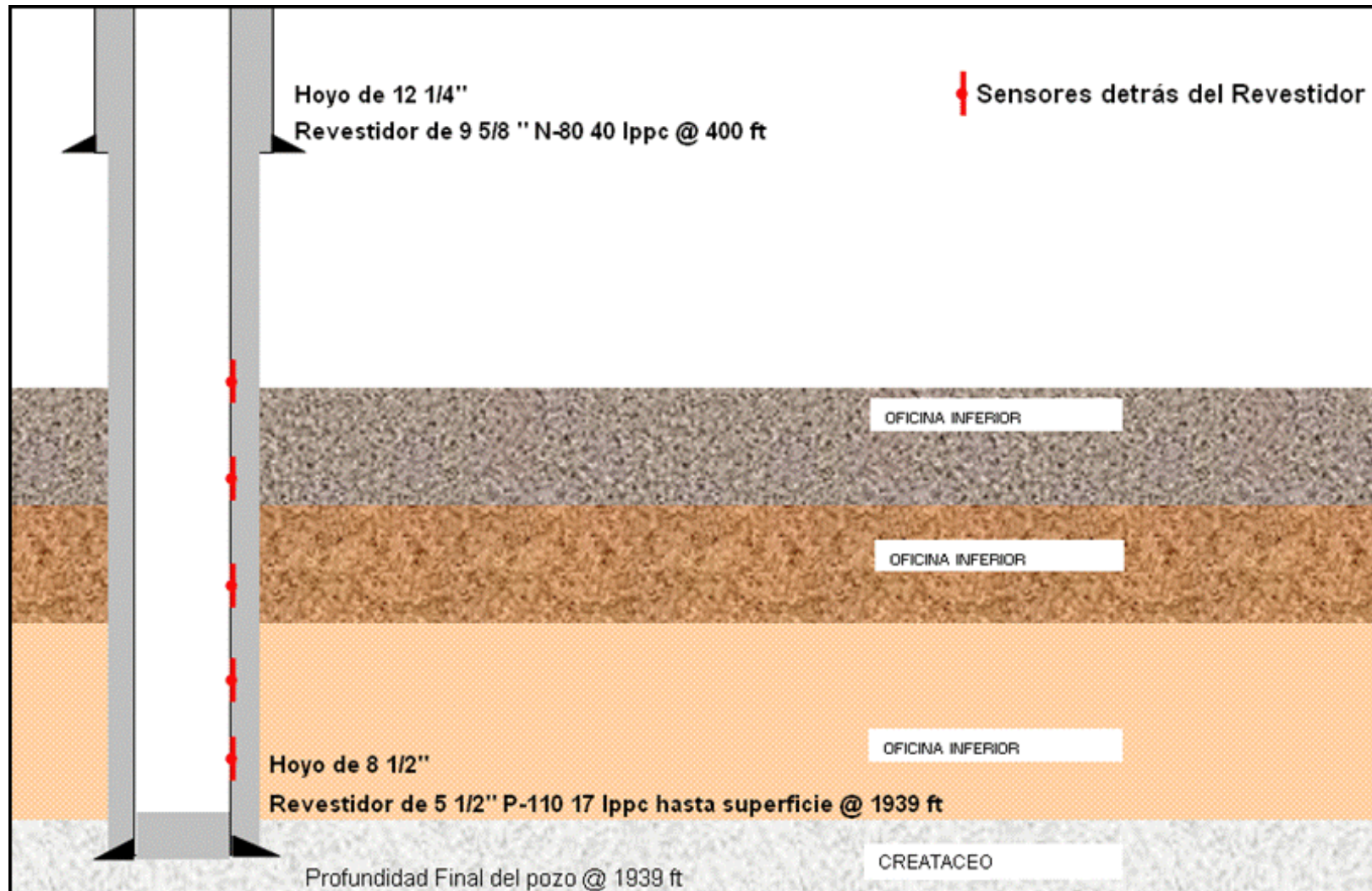


# Cluster Well Design and Anti Collision

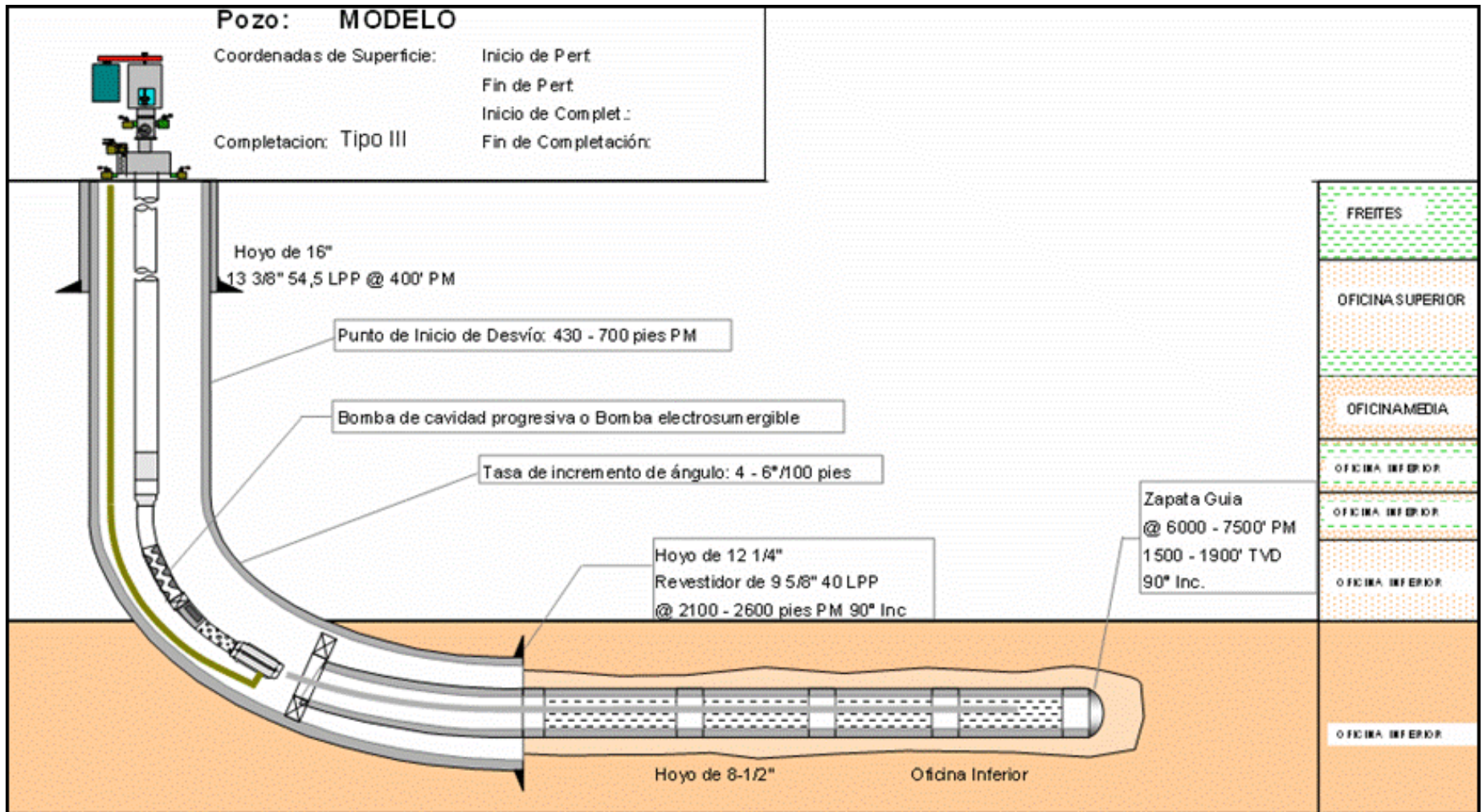


# Stratigraphic Wells

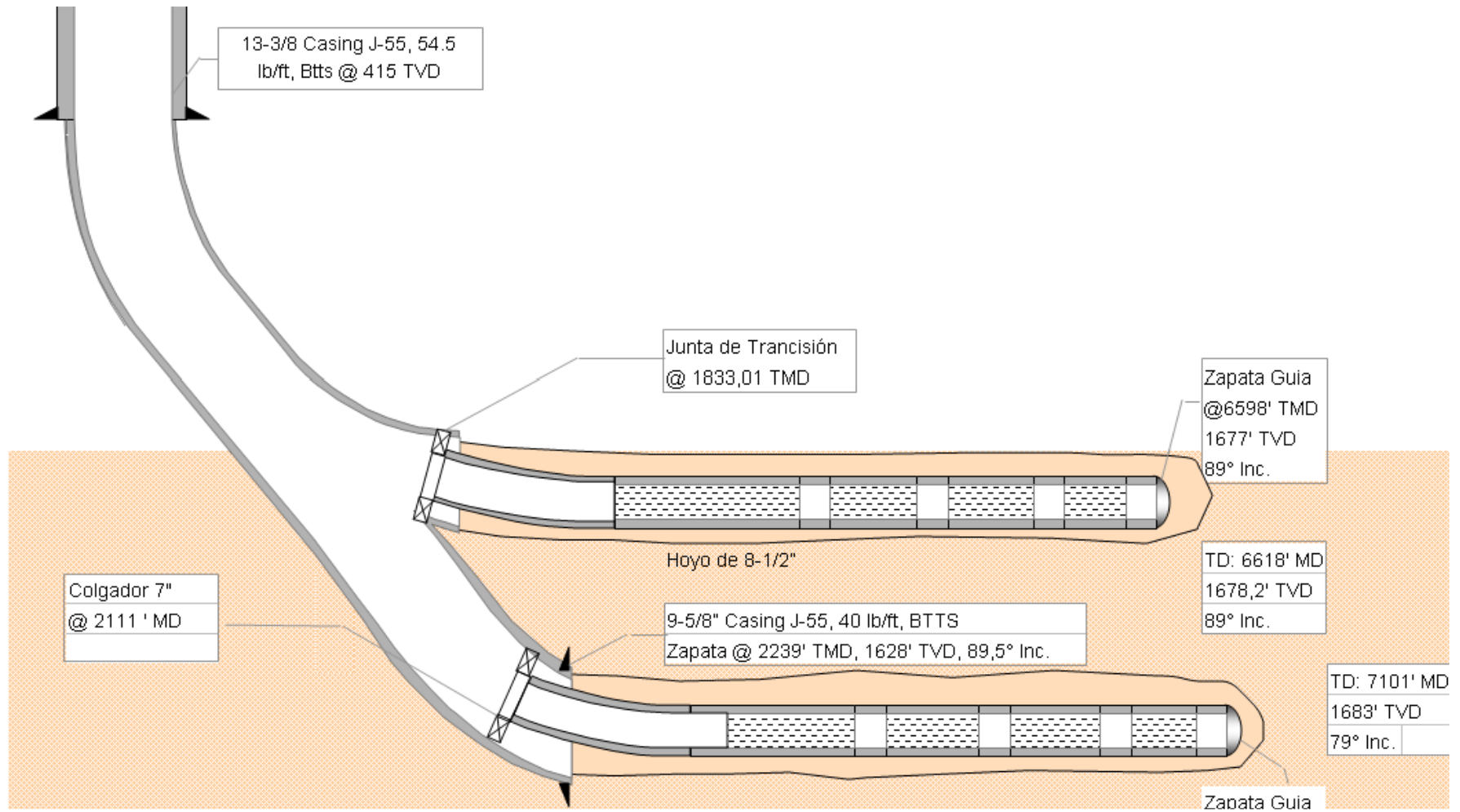




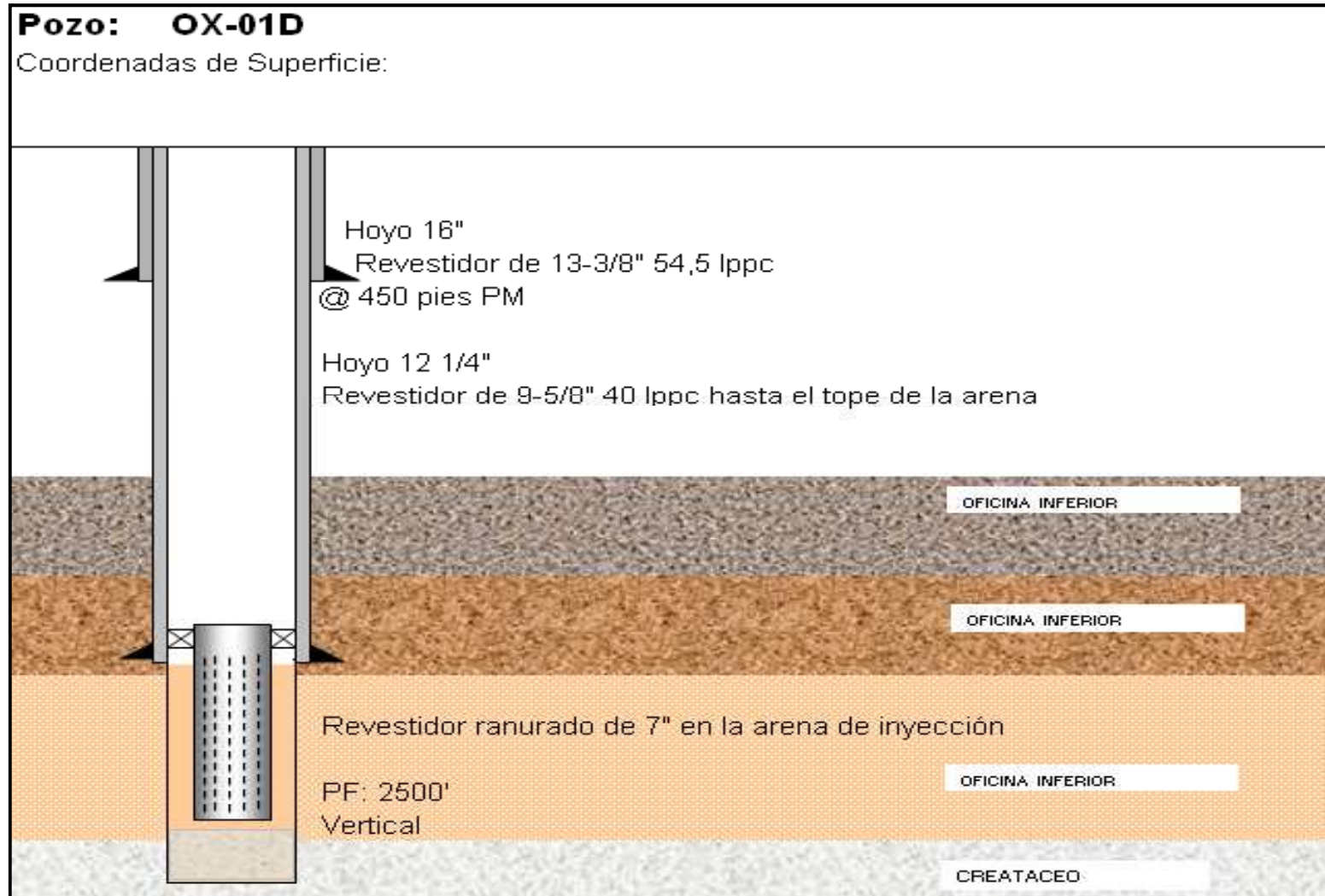
# Horizontal Producer "Typical Well"



# Re-Entry

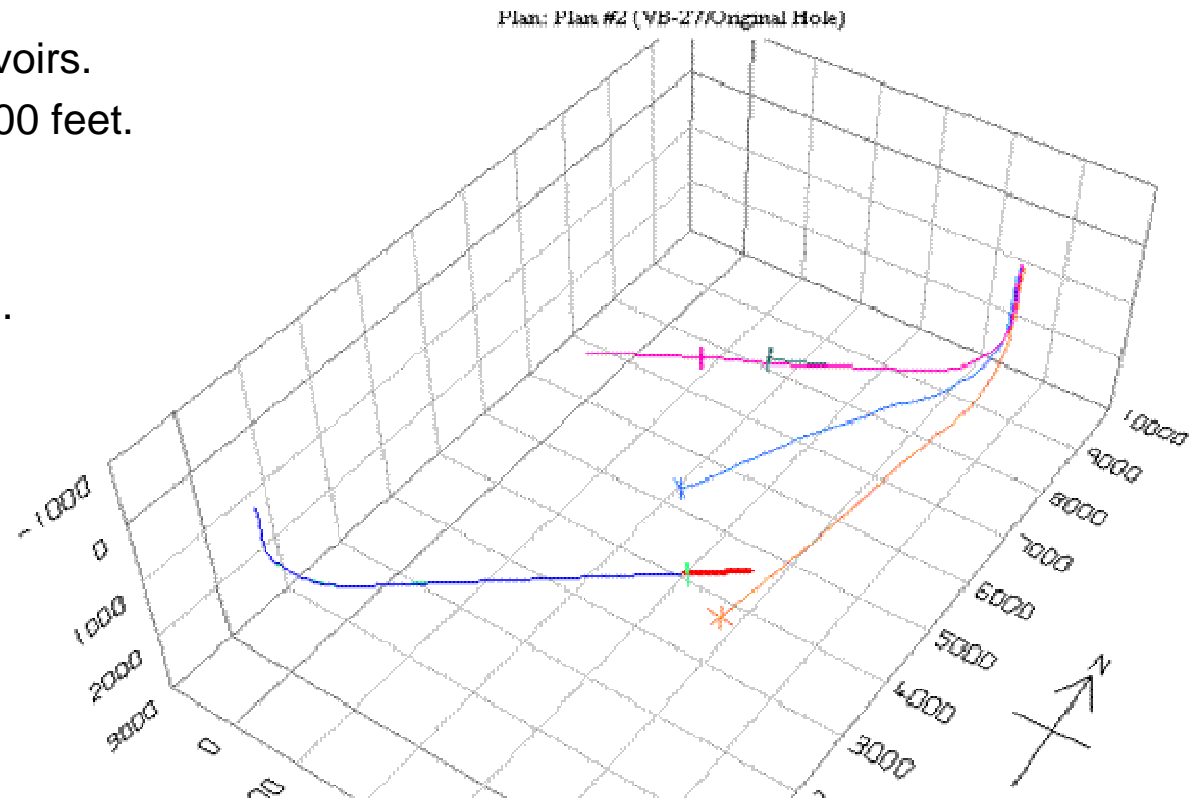


# Water Injector



# Drilling Challenges

- 30 to 40 feet thick sand reservoirs.
- TVD between 1100 feet to 2000 feet.
- Horizontal reach of 4600 feet.
- Unconsolidated sand.
- Sand channels not connected.

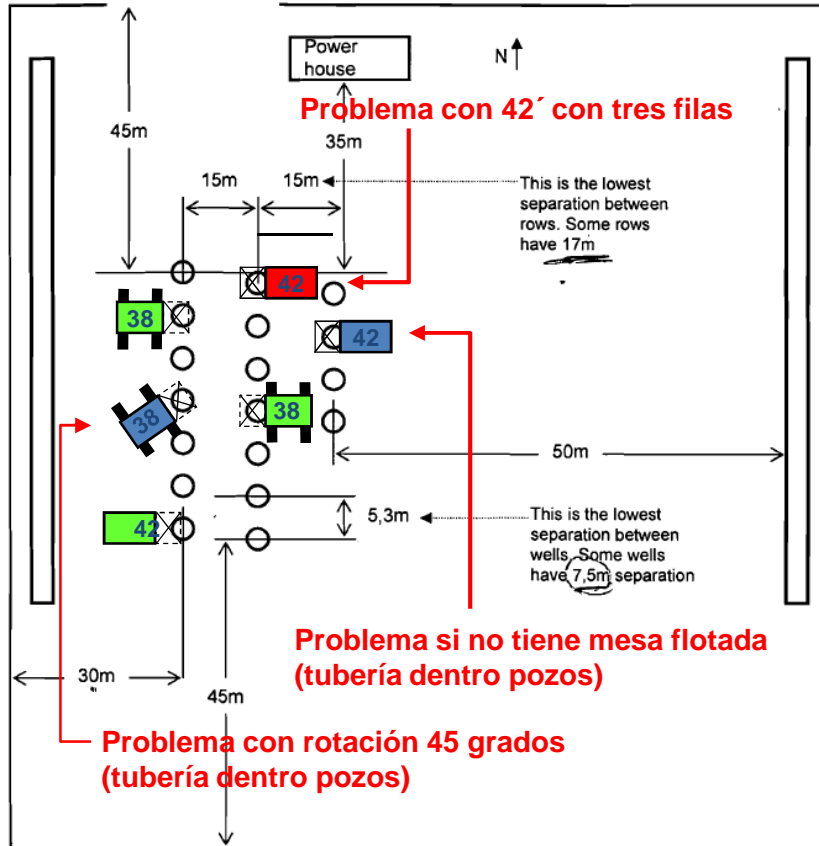


- Anti-collision with the other the wells drilled
- Maintain a clean well and a low ECD, given the high inclination and extended reach.
- Directional Control limited by weight available at bit.
- Weight available at bit is a limiting well design factor.

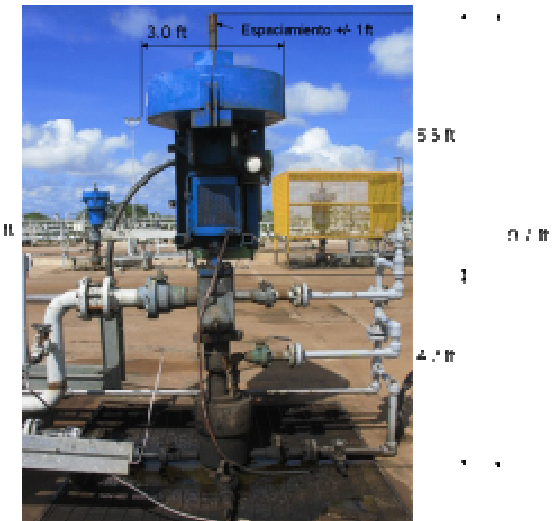
## High Catwalk



## Well cluster design - Petrocedeño



## Well heads

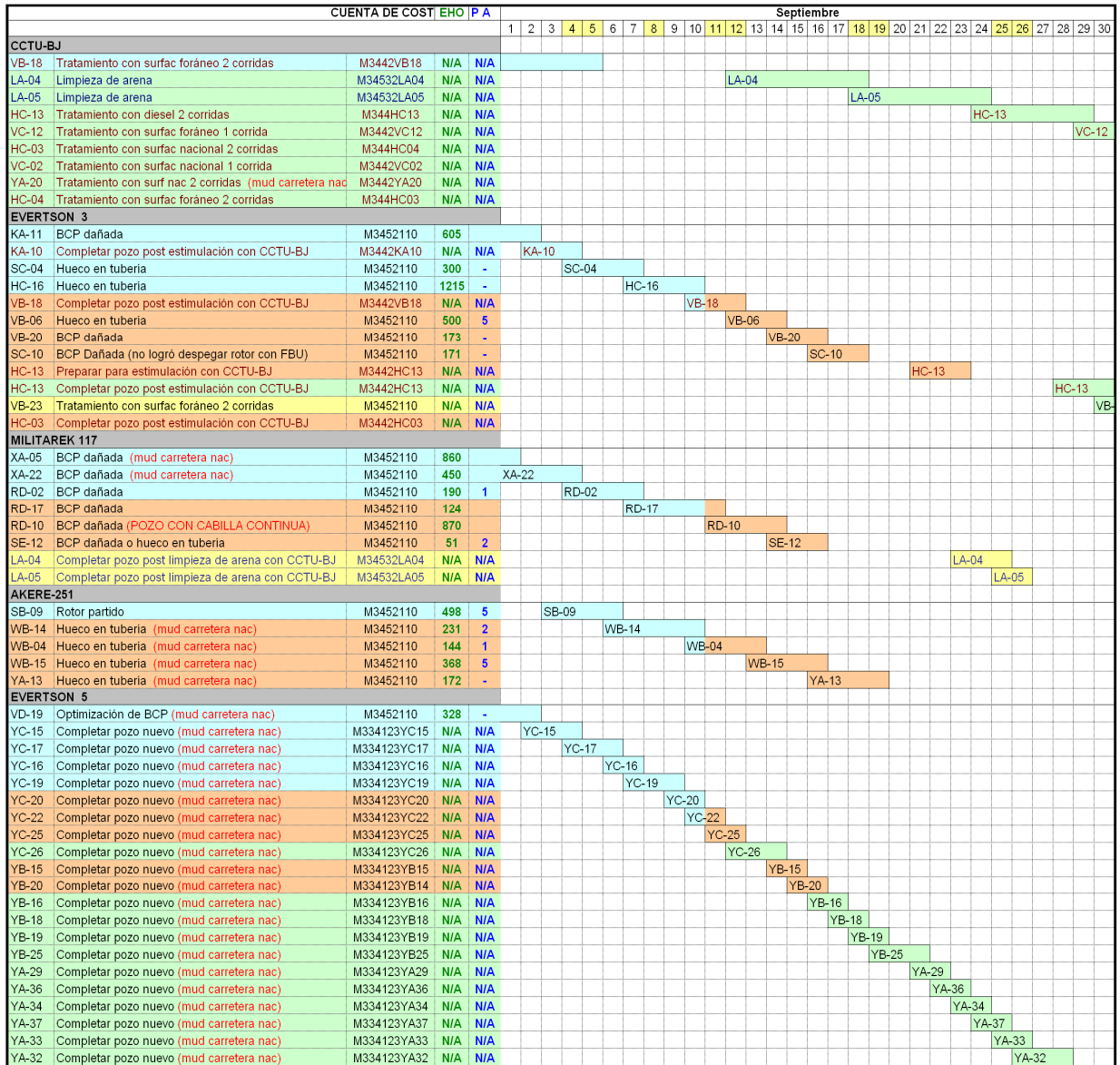


# Completion and Workover Operations

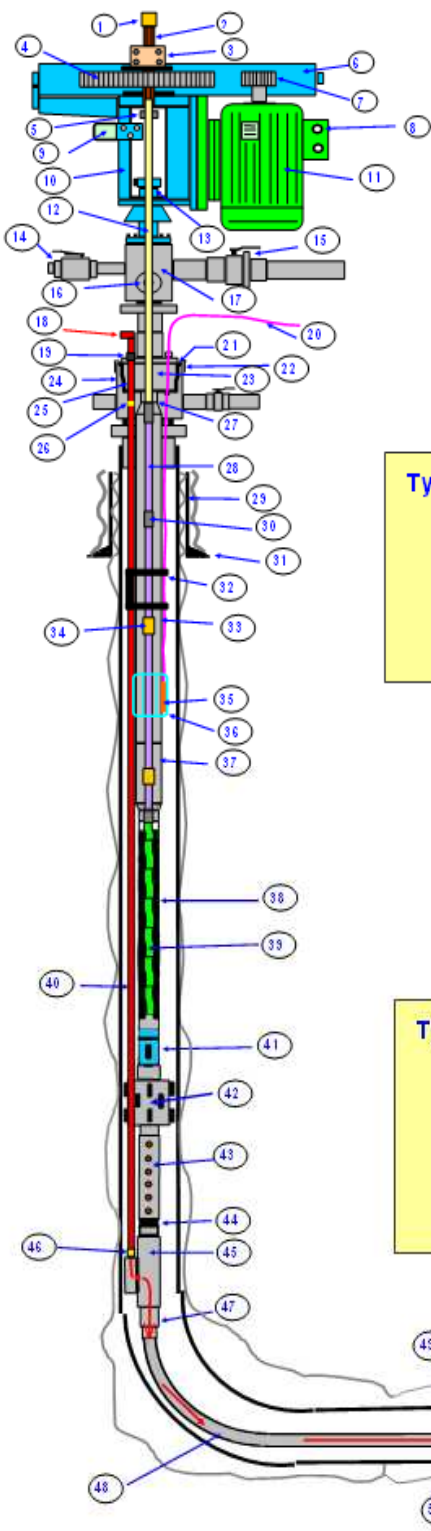
A very dynamic work as you can never plan for when a well will fail. It is important to keep the operations as efficient as possible to keep the lost production due to wells shut in as low as possible at all times.

## Main challenges:

- Make sure that materials are available to comply with the plans
- Verify and make sure the high standard and quality of rigs, contracts and equipment.
- Make sure the organisation is prepared for the required workload, including projects. Make sure that the necessary contracts are available to perform the required work together with PDVSA Services.



# Completion with Artificial Lift



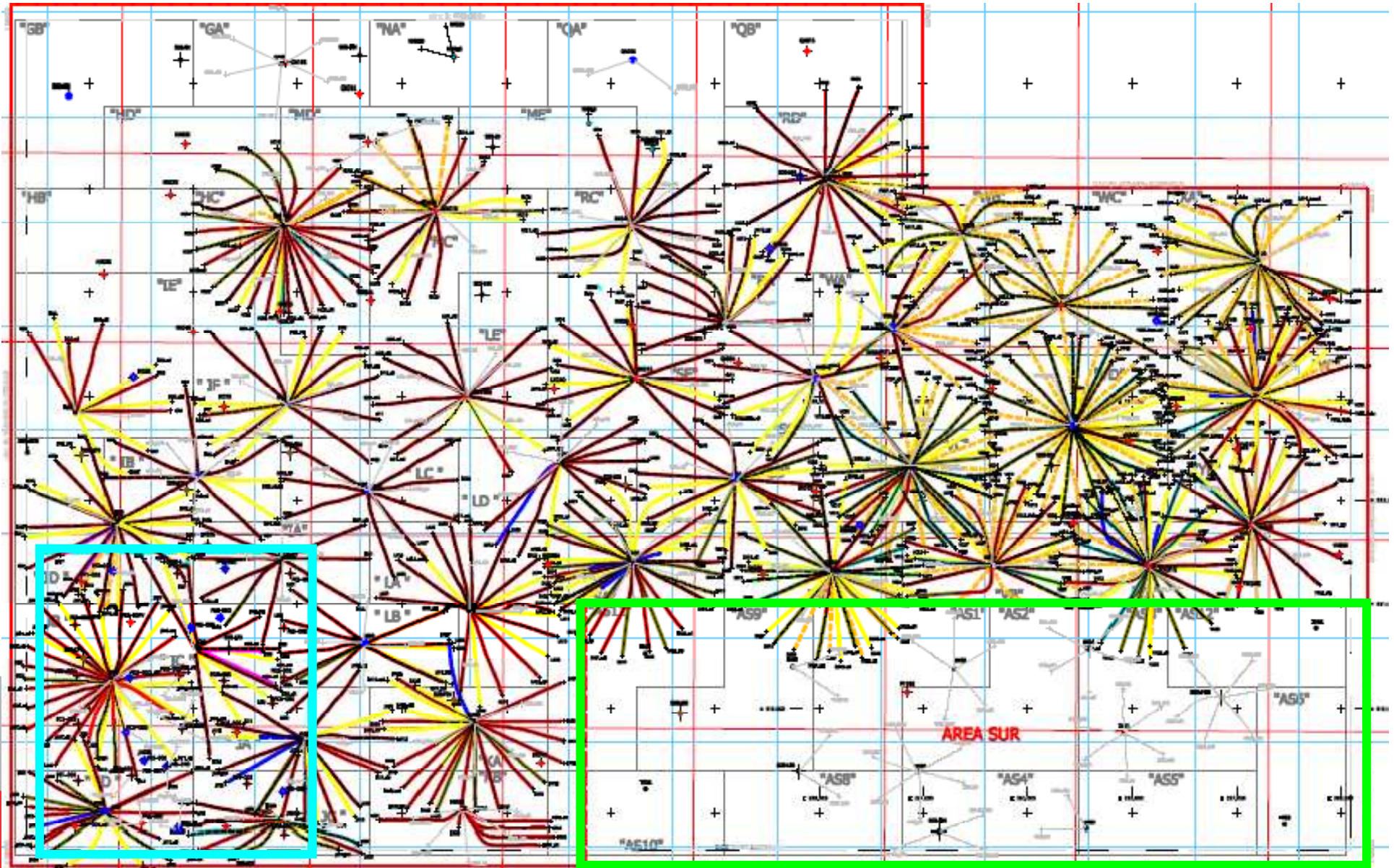
## Type I (Diluent Injection in wellhead)

- EHO potencial < 400 bpd (can vary)
- Nafta Injection rate 15 - 20%
- 22% of the wells are completed Type I

## Type III (Diluent Injection at the bottom hole)

- EHO potential - 400 to 3500 bpd
- Nafta Injection rate 15%
- 78% of the wells are completed Tipo III

1	Coupling 1"x 1 1/8"
2	Hexagonal 2 x 28" x 1"
3	Clamps retenedor de la Barra Hexagonal
4	Polea Cabezal
5	Grampa Retenedor de Barra Pulida
6	Protector de Poleas
7	Polea del Motor
8	Conexion Cables Electricos
9	Filtro de aceite
10	Cabezal de Rotacion "KUDU" VH-100
11	Motor Electrico ABB 100 HP 460 Voltios
12	Barra Pulida de 1 1/2"x 36 ft
13	Stuffing Box ( Empacaduras )
14	Valvula 2" LP
15	Valvula de 4" LP
16	Ranes 1 1/2" BOP'S para Barra pulida
17	T de Flujo
18	Entrada Diluyente
19	Adaptador linea de diluyente
20	Cable del Sensor Phoenix
21	Lockdown Ring
22	Protector Cap
23	Dual Tubing Hanger
24	Tubing Head
25	01 Pup Joint de 1.66" UN
26	X-over 1.315" x 1.66"
27	Cross,over de 4 1/2"EUE pin x 5 1/2" Pin BTC
28	+/- 80 Cabillas de 1 1/4" x 1" Pin x 25 ft Grado 75,4.17 lbs/ft
29	Revestidor de 13 5/8" BTC 54,5 lbs/ft
30	Cuello de 1"
31	Zapata del Revestidor de 13 5/8"
32	Clamps para sujetar la sarta de 1,315" con la de 5 1/2" en cada cuello
33	+/- 80 Juntas de 5 1/2" x 30 FT BTC 17 lbs/ft
34	Coupling Tenaris (poliuretano) según simulación de desgaste
35	Sensor Phoenix (Presión, Temperatura y Vibración)
36	Protector del Sensor (gauge carrier)
37	01 Pup Joint de 5 1/2" x 10 FT 17 lbs/ft
38	Estator (BCP)
39	Rotor (BCP)
40	+/- 80 Juntas de Inyección 1.315" NU 1.7 lbs/ft
41	Niple de paro
42	Ancla de Torque de 9 5/8" con ranura para tubería de 1.315"
43	01 Tubo de 4 1/2" x 30 FT EUE 12.75 lbs/pie Perforado
44	Blank Sub de 4 1/2" EUE ( Tapon Ciego)
45	Injector Sub de 4 1/2" EUE x 1.66 UN
46	X-over 1.66" x 1.315"
47	Cross-over 4 1/2" EUE Box x 2 3/8" EUE Pin
48	+/- 135 Juntas de 2 3/8" EUE x 30 FT 4.7 lbs/ft
49	Colgador del Liner Ranurado de 7"
50	Zapata del Revestidor de 9 5/8"
51	Liner de 7" BTC x 30 FT 23 lbs/ft con ranuras de .020"
52	Jetting Nozzle 2 3/8" EUE
53	Zapata guía del revestidor de 7"

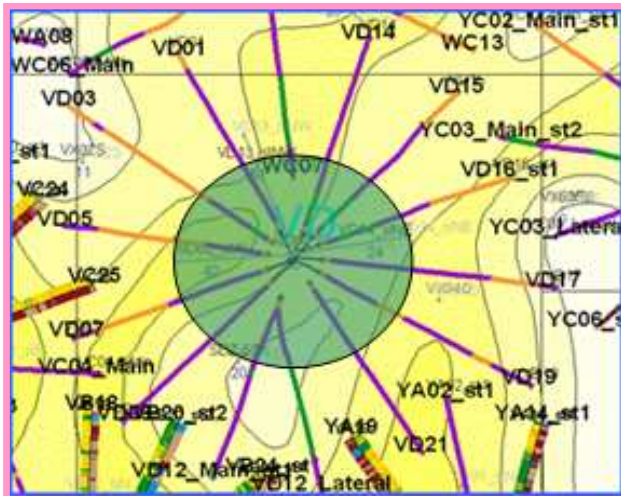


**AREA EOR**

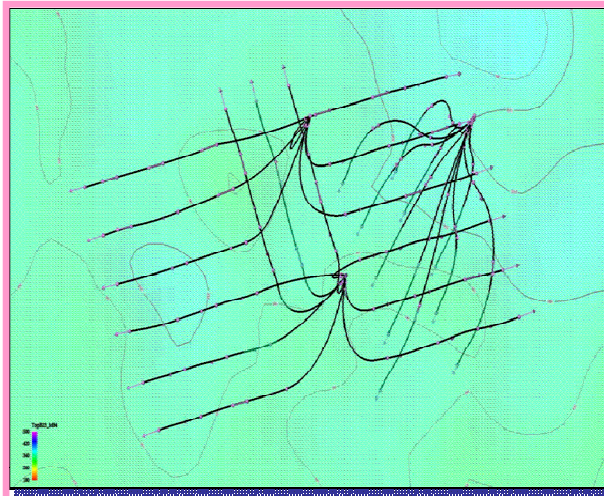
**AREA SUR**

# Increased Production

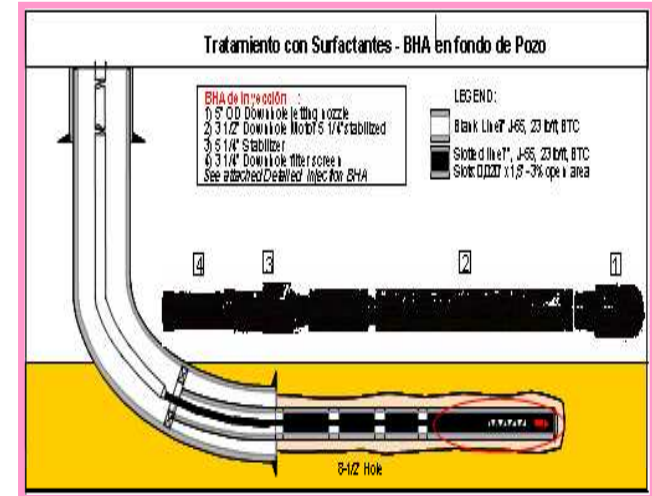
## 1) Radial Wells



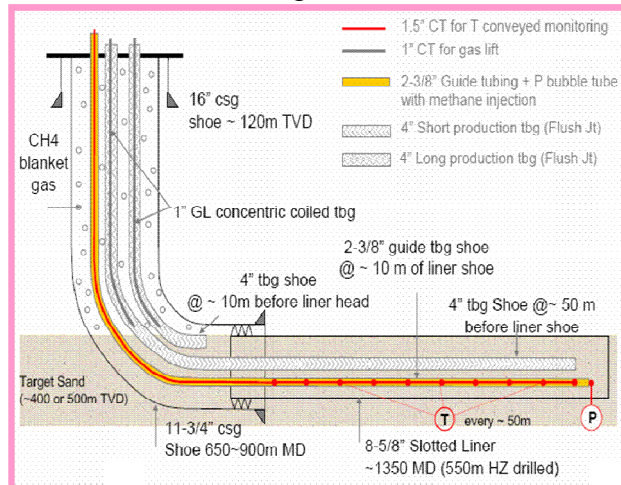
## 2) New well cluster and south area



## 3) Well stimulations



## 4) EOR (Steam injection)



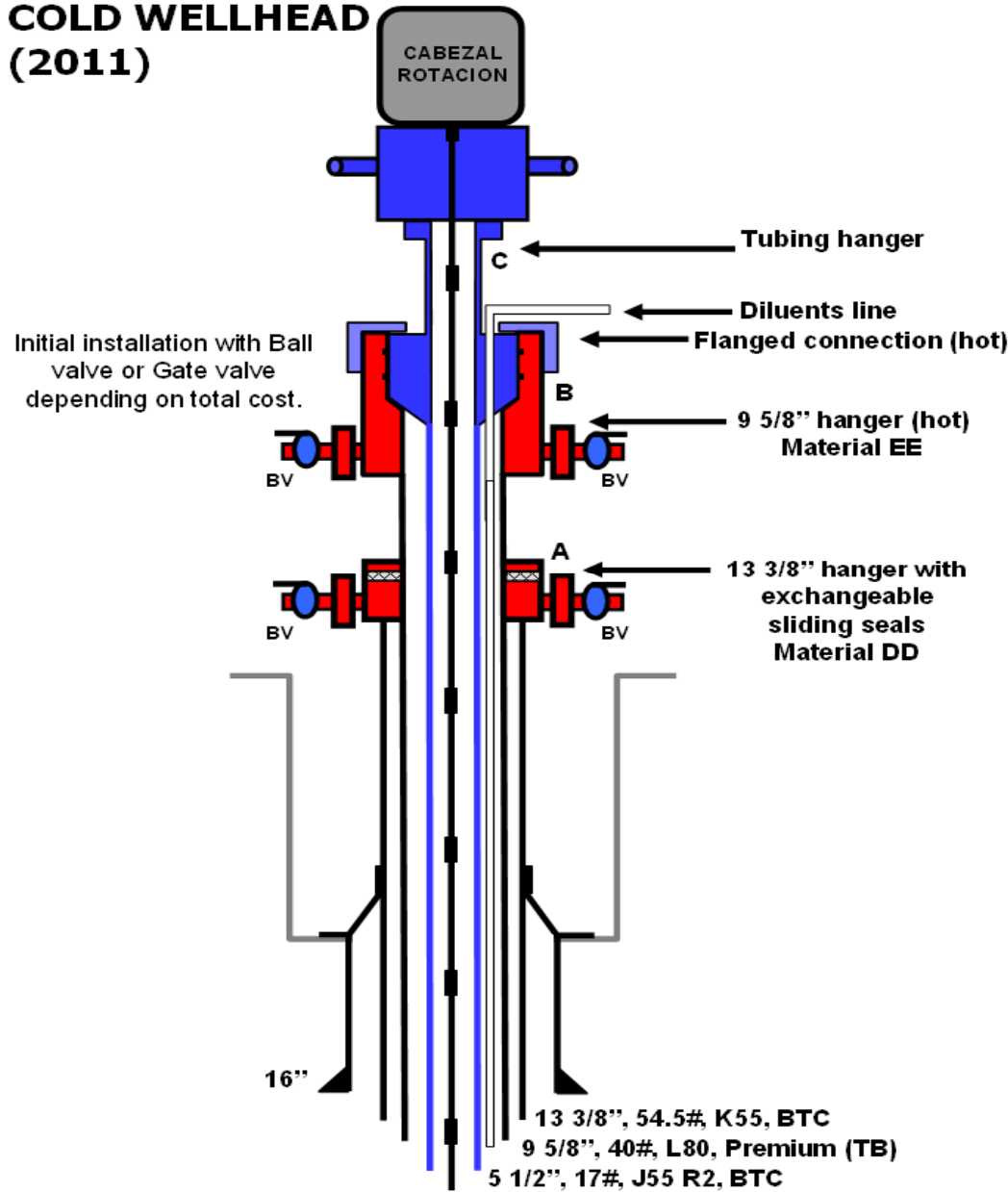
## 5) New rigs



## 6) QAQC

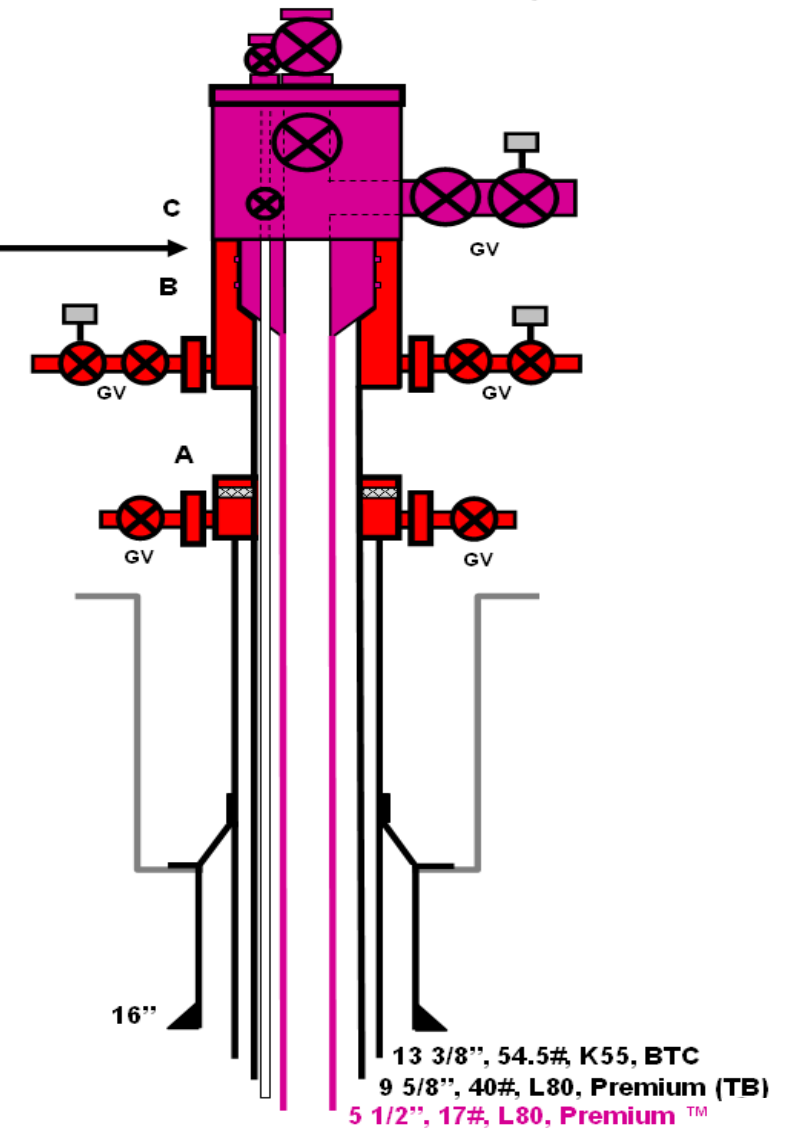
- Drilling Procedures
- Drill-in Fluids
- Completion design
- Failure investigation
- Well clean-up procedures
- Moving procedures
- Experience transfer

## COLD WELLHEAD (2011)

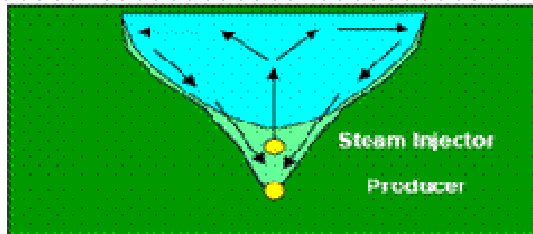


## HOT WELLHEAD (2017)

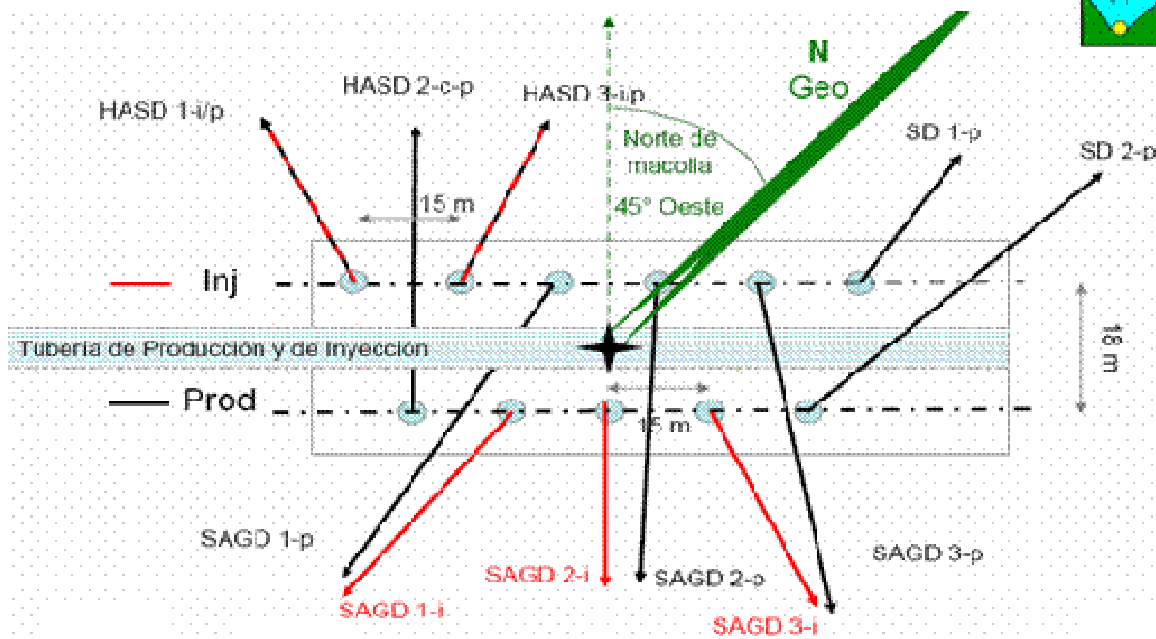
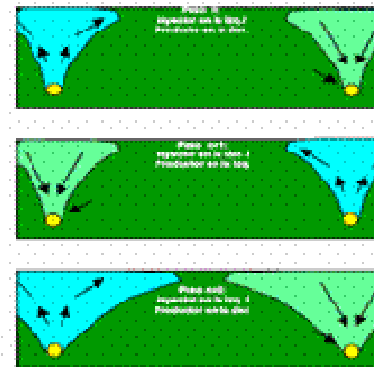
Final XMT and completion design depend on technical solutions available in 3 – 5 years.



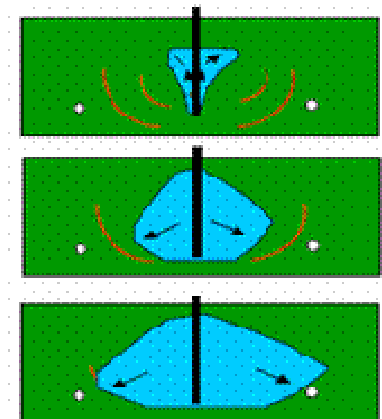
## Steam Assisted Gravity Drainage



## Horizontal Alternate Steam Drive



## Steam Drive



# Surface Facilities

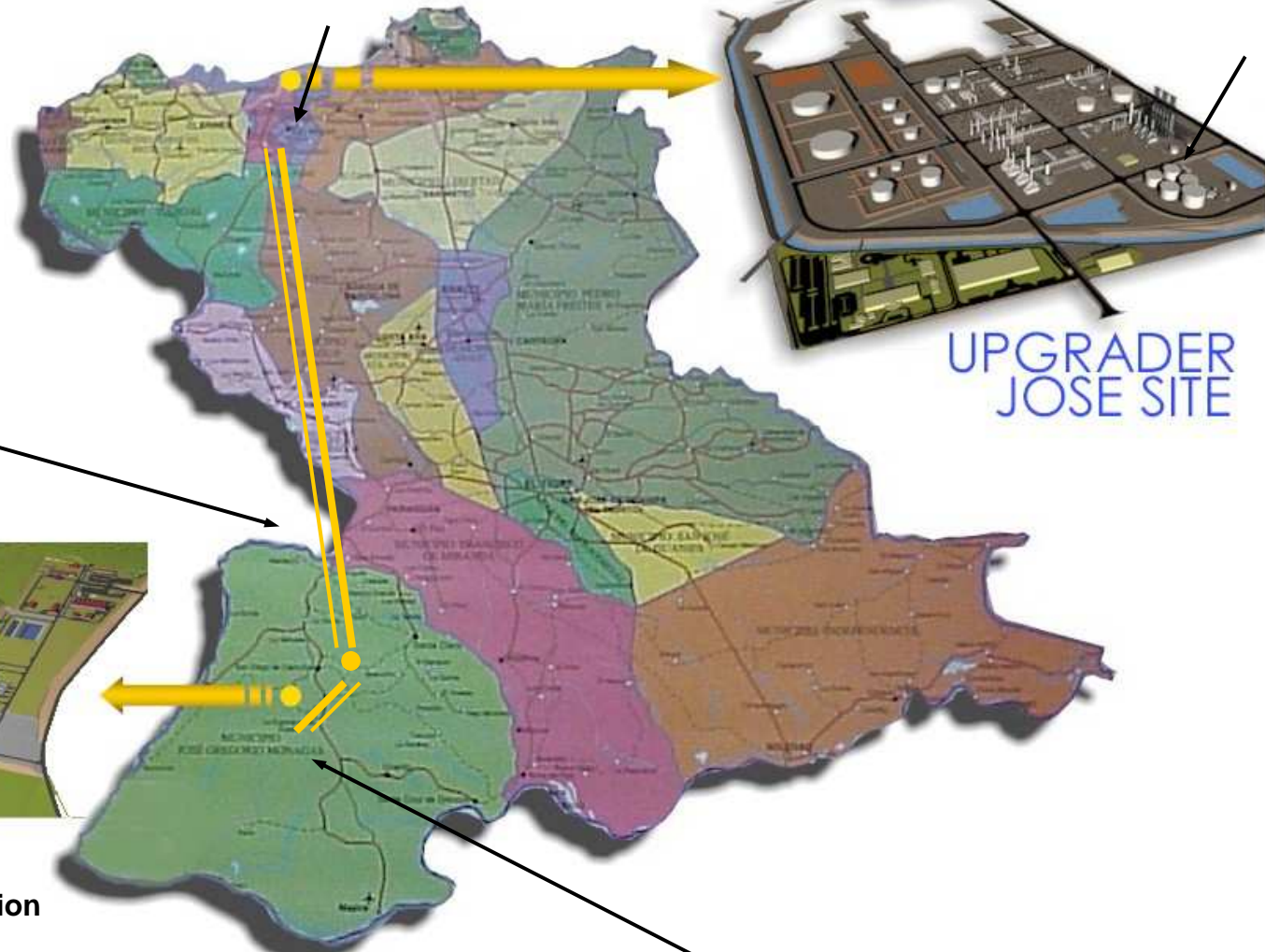
# Petrocedeño Operation Overview

- Petrocedeño Overview Process
- Wells and Clusters
- Main Station
- Production Process
- Water Treatment Plant
- Petrocedeño Pipeline-ZPS
- Zuata Pump Station
- Pipeline-ZPS-JOSE
- Metering System

# Petrocedeño Overview Process

- Upgrader: Production of a high quality synthetic light sweet crude (32°API)

Jose



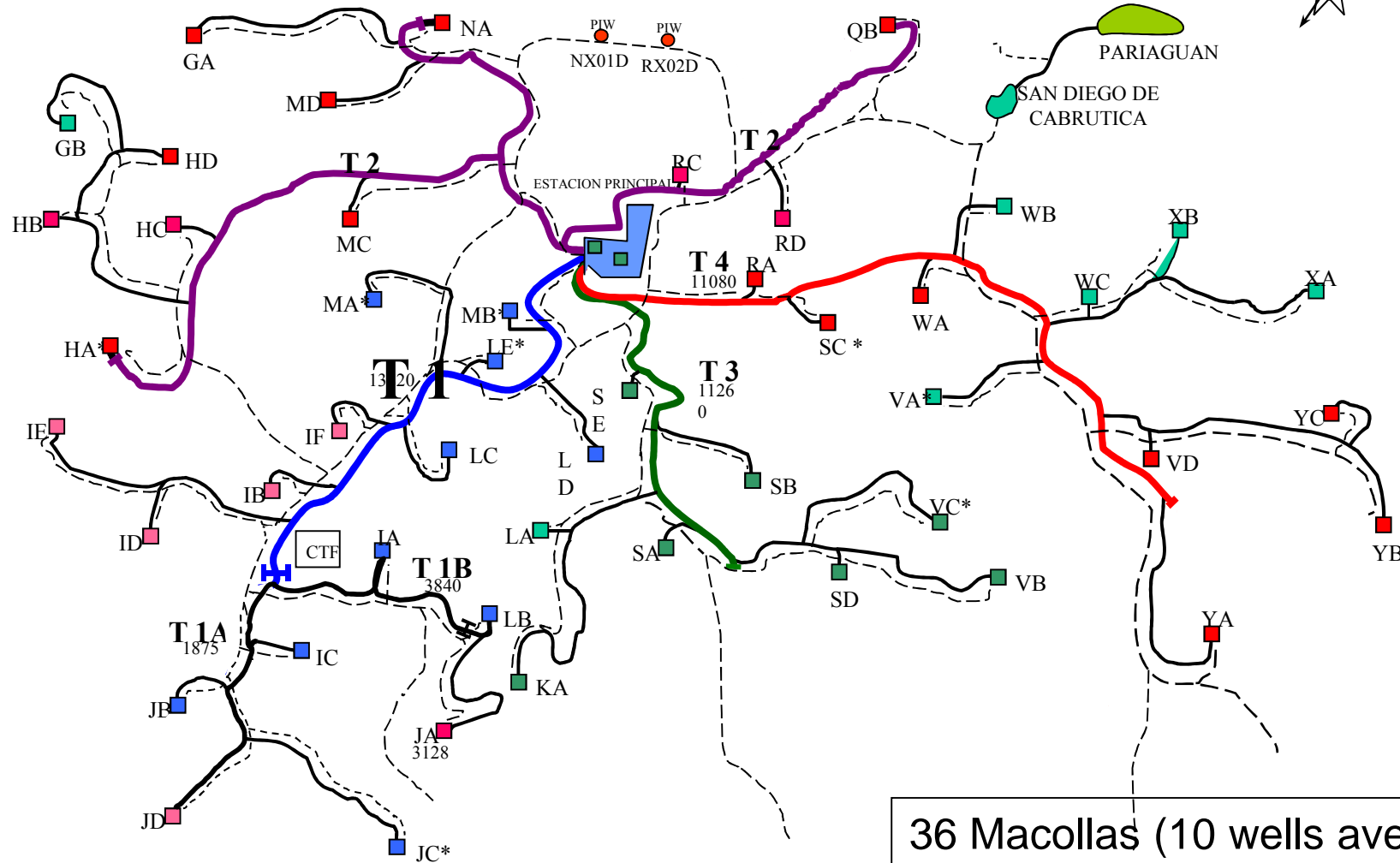
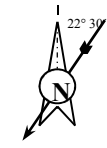
- Zuata duct 210 km:  
Transport of diluted crude and diluent



- Main Station:  
EHO treatment and production of a diluted crude oil

- Zuata Field:  
Cold Production of EHO 8 - 8.5°API

# Wells and Clusters



- - - - ROAD      ● Pozo inyector      — TRUNKLINE      — FLOWLINE      \* Pospuesto

36 Macollas (10 wells average)  
 300 Km DCO pipeline network  
 300 Km Diluent pipeline network  
 115 Km gas gathering network  
 500 Km internal routs

# Wells and Clusters



**MULTIPHASE PUMPS**



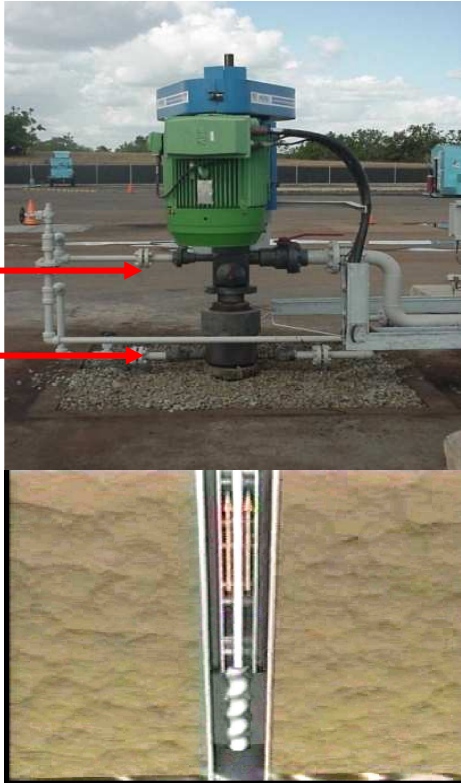
**WELLS**



# Wells and Clusters

## Diluent injection according to the type of completion

WellHead Injection  
Bottom hole injection

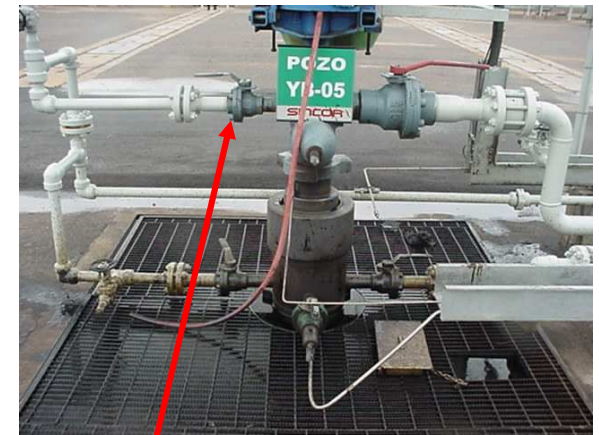


Completion Type III



Diluent Injection point

Completion Type I

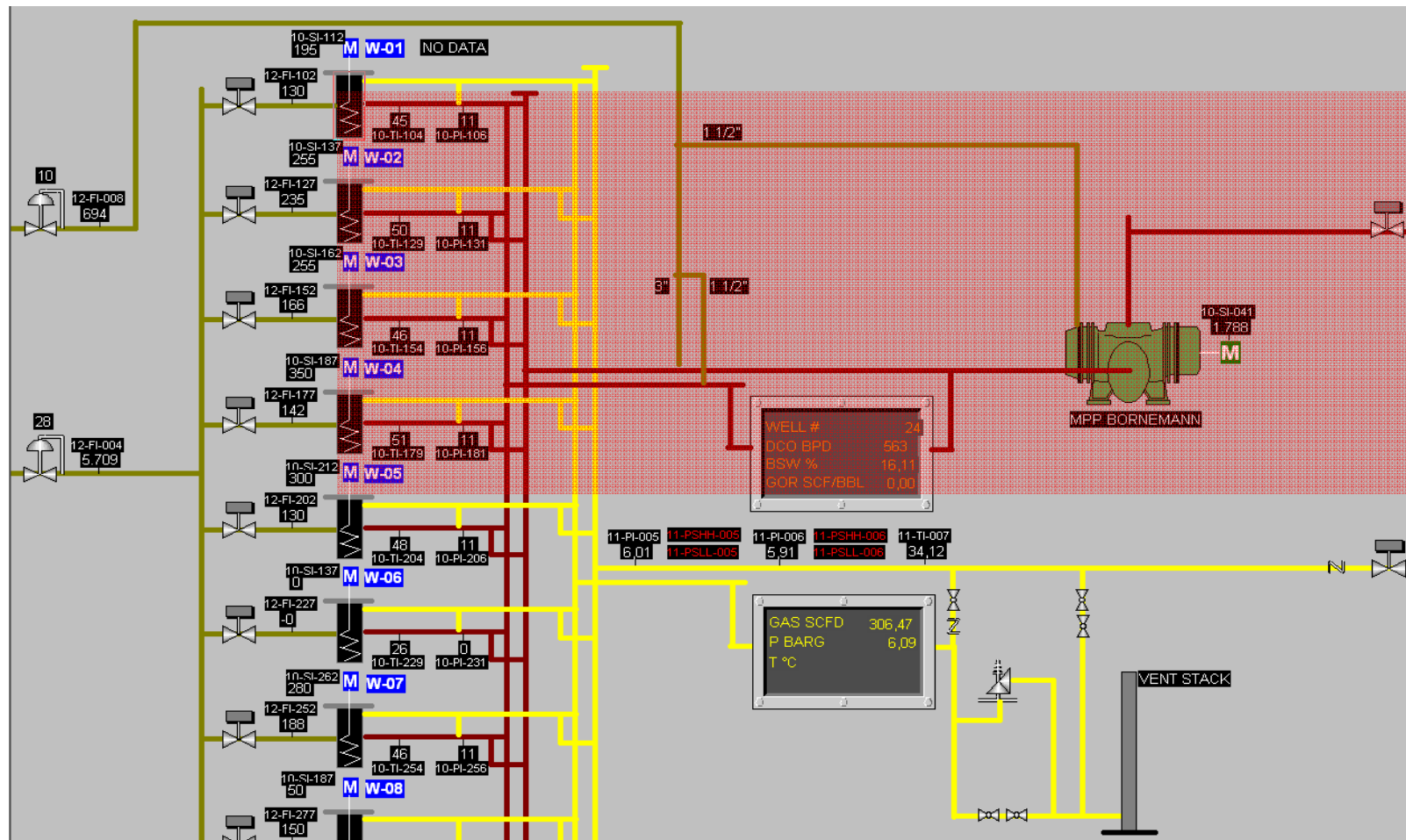


Diluent Injection point

# Production Process

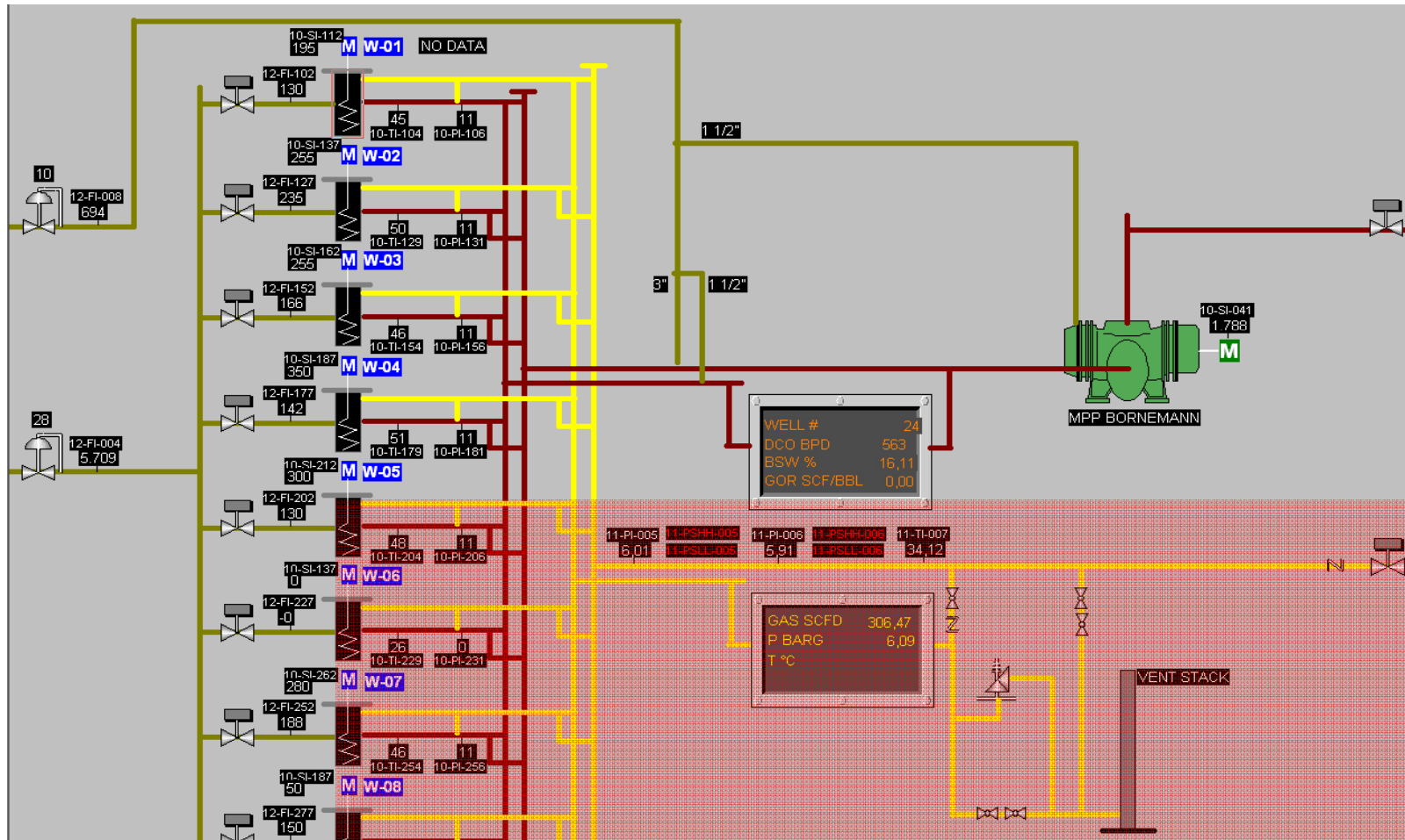
## 1. Oil + Water + Gas Produced to the MPP

### 1.1. Gas collection from wellheads directly to the gas gathering system



## 2. Oil + Water + Gas Produced to the MPP

### 2.1. Gas collection from wellheads directly to the gas gathering system



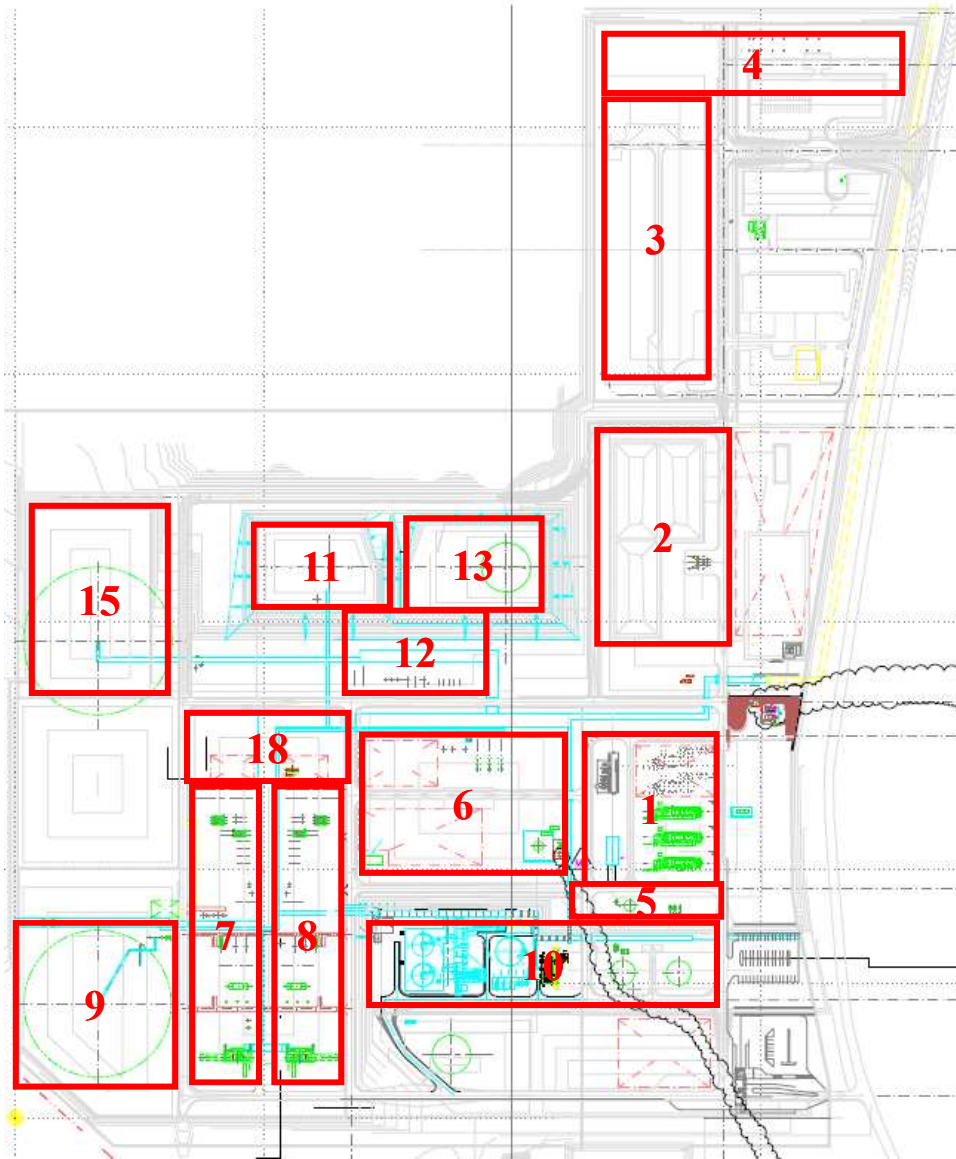
# Main Station

## Maximum Design Conditions

- 210.000 BPD EHO
- 286.000 BPD DCO
- 76.000 BPD DILUENT
- 100.000 BWPD



# Main Station



- Zone 1: Turbogenerators
- Zone 2: Fire Protection System
- Zone 3: Management Areas
- Zone 4: Dining and Hotel
- Zone 5: Water and General Services
- Zone 6: Compression of Gas and diesel
- Zone 7: Train A
- Zone 8: Train B
- Zone 9: Low Flare
- Zone 10: Water Plant
- Zone 11: Diluent Storage
- Area 12: Reprocessing, Export, Injection
- Area 13: Out of specification tank
- Area 15: Low-Low Pressure Flare
- Zone 18: Collection of Gas System

# Main Station

## Pumping of diluent from the T-3101 from the station to each Cluster/ Well

### T3101

#### Operating Conditions:

Volume: 113.000 BBL

Diam.: 39.56 m

H: 14.73 m

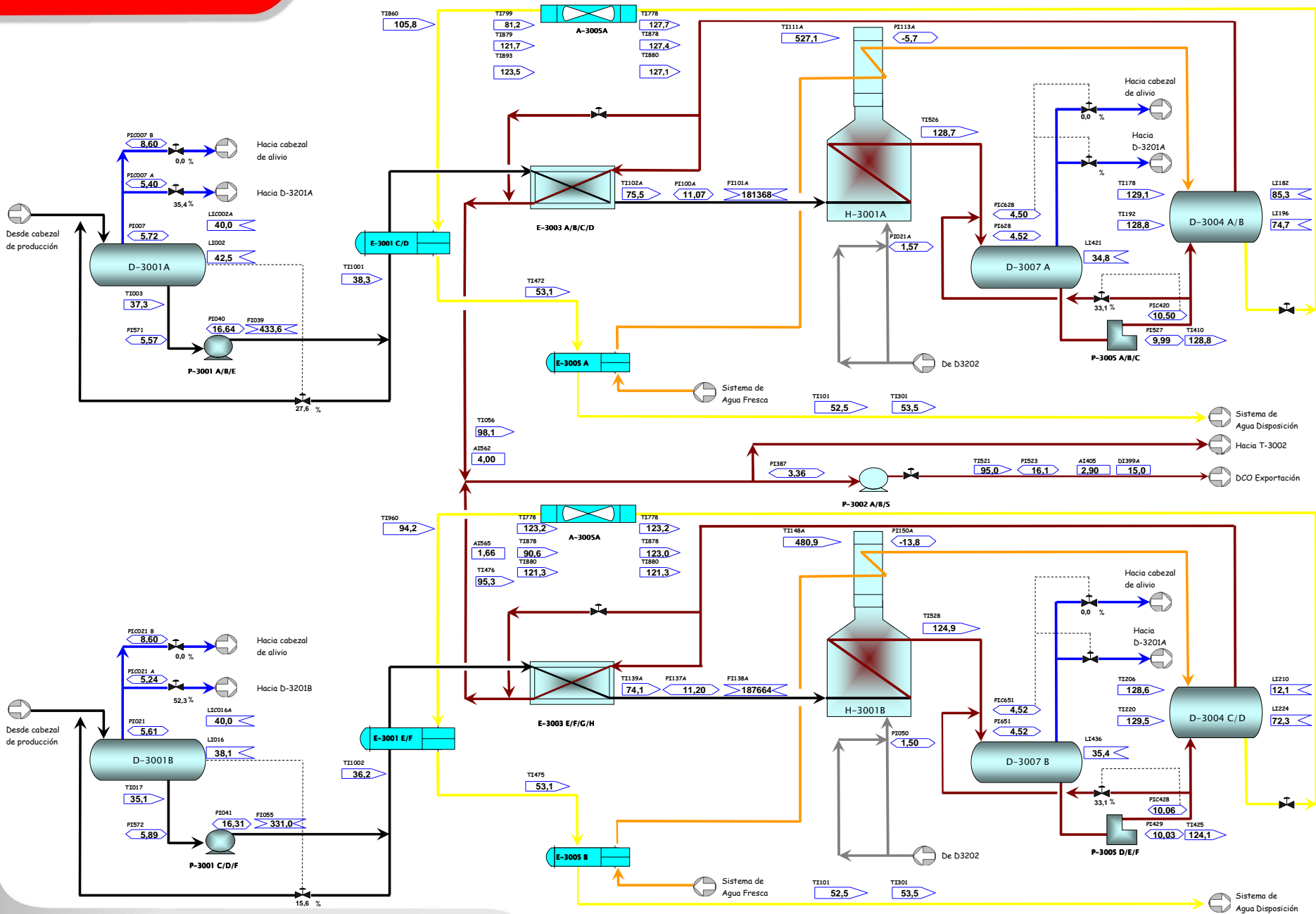
Pressure: 5/(-2.5) BARG

Temp.: 30-50 ° C



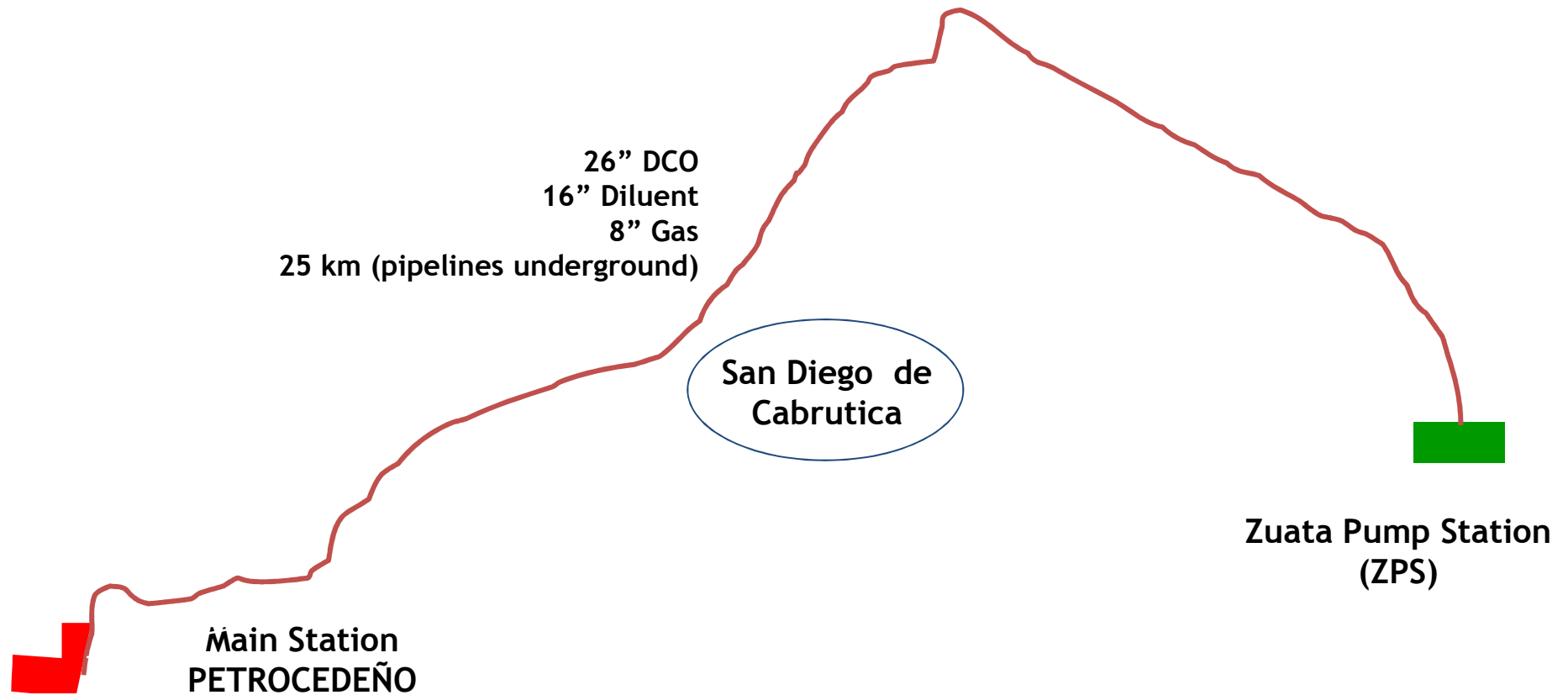
P3101 A/B/C/D/E/S  
Operating Conditions:  
Pressure: 35-40 BARG  
Temp.: 30-50 ° C

# Production Process

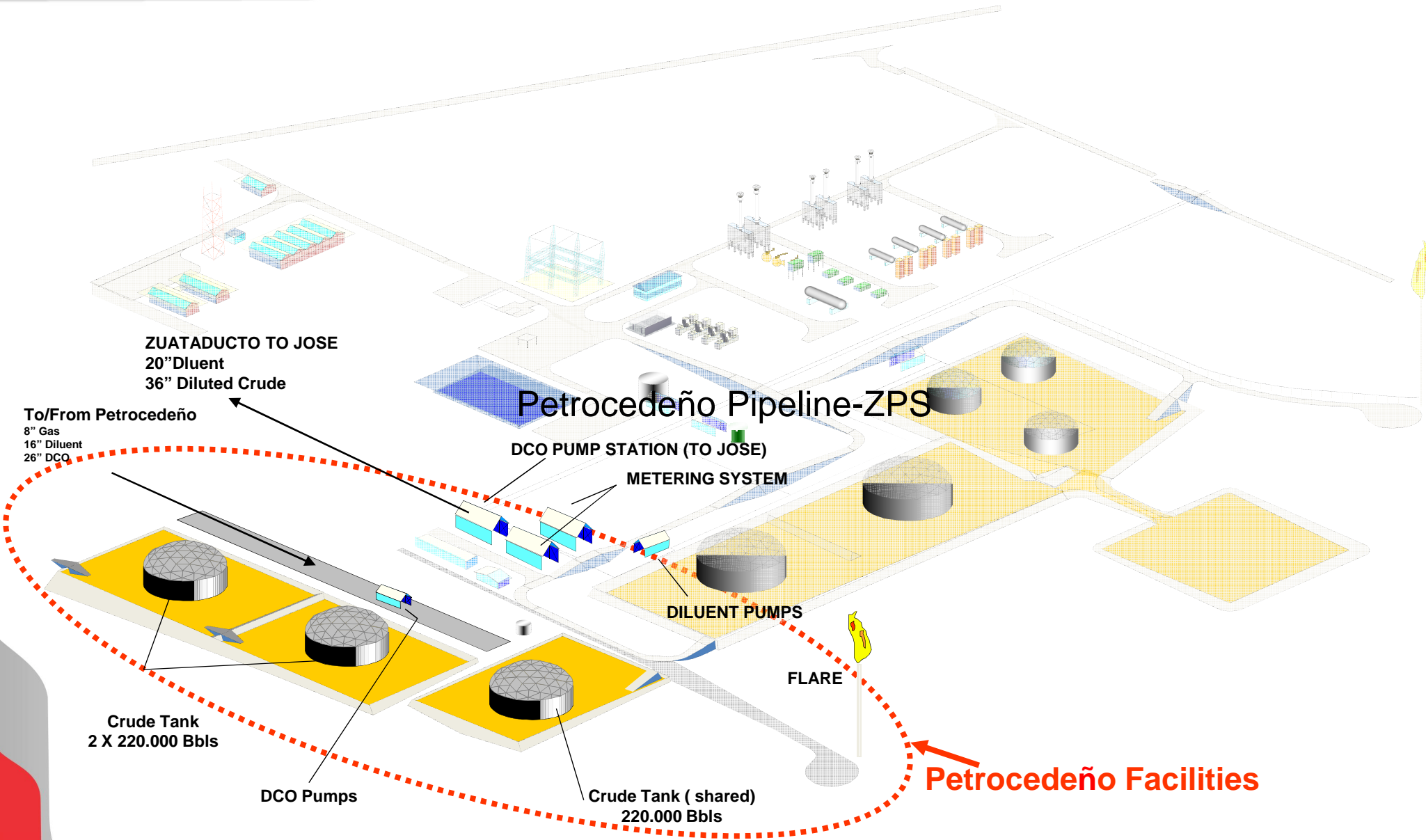




# Petrocedeño Pipelines -ZPS

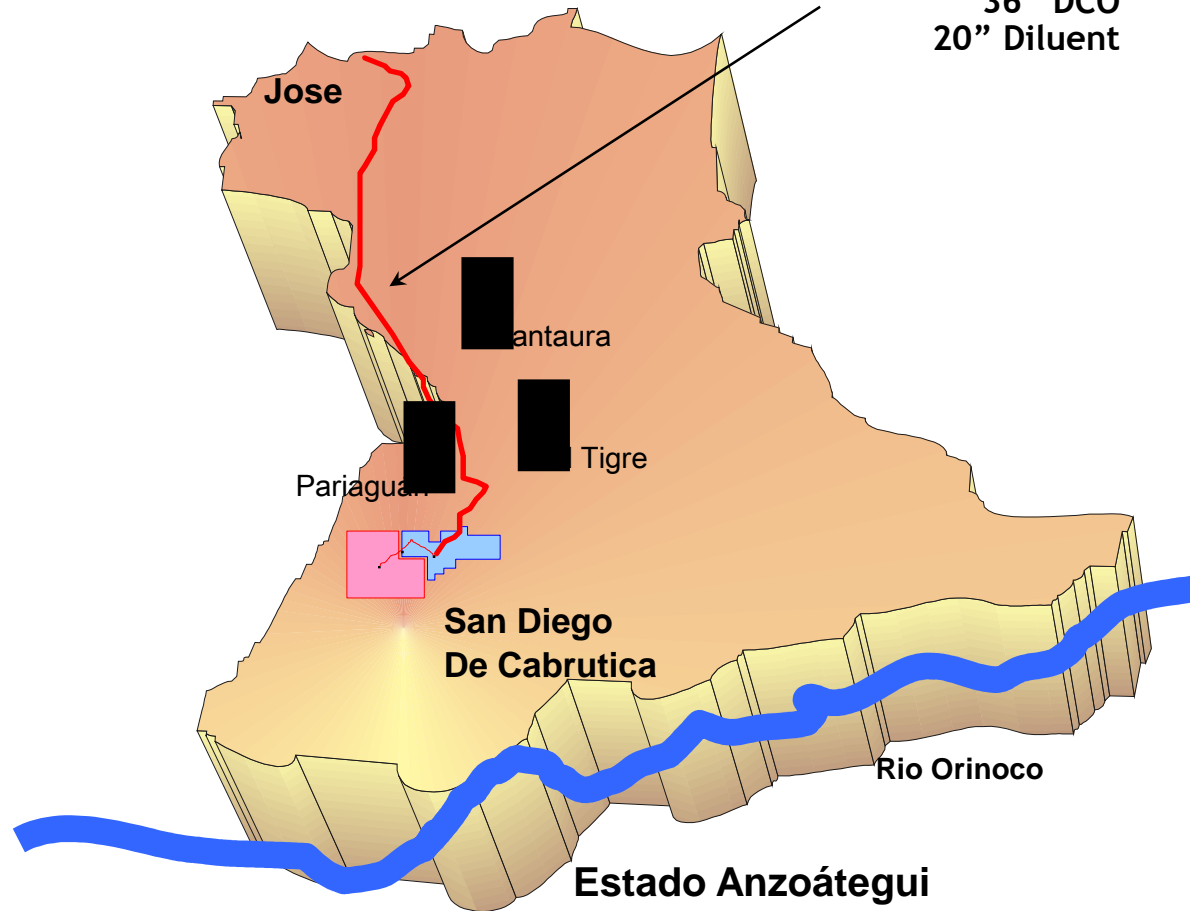
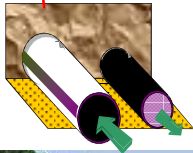
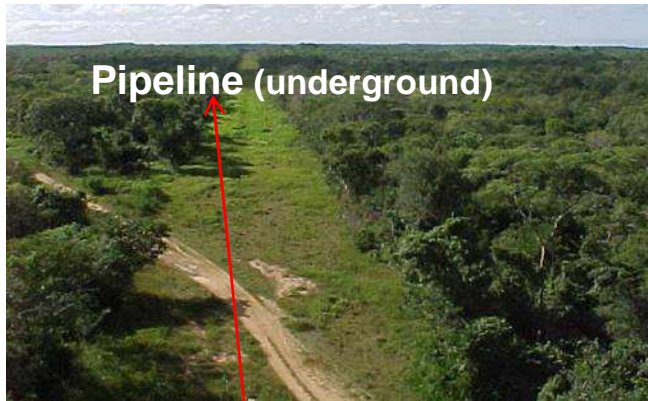


# Zuata Pump Station



# Pipeline ZPS-Jose

210 km  
19 Valve Station  
36" DCO  
20" Diluent

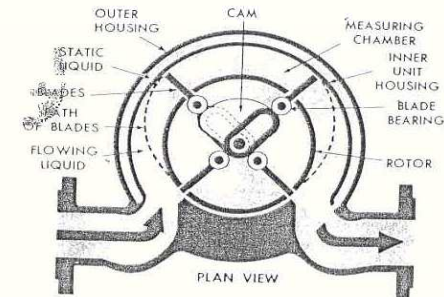
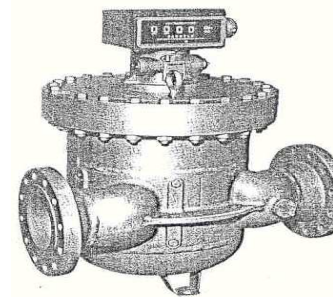
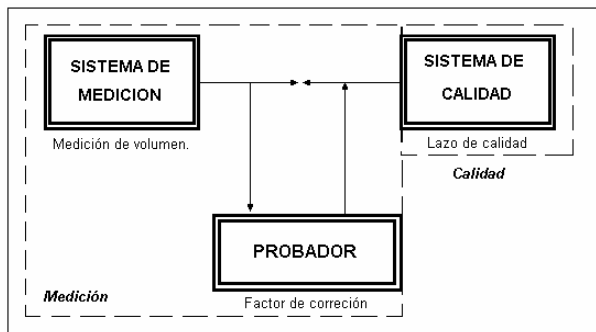


## Diluted Crude Measurement

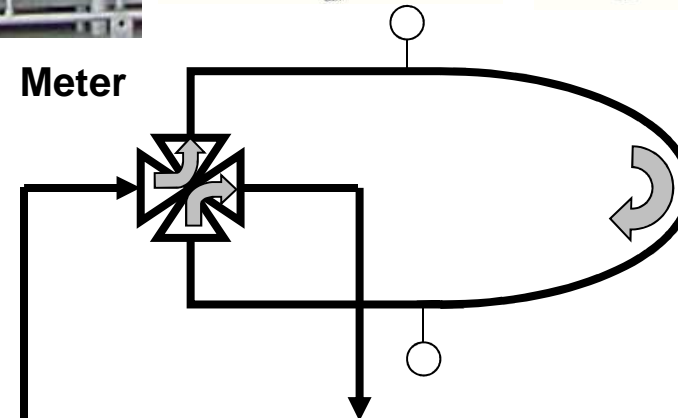
- A Skid double leg measurement of 10 ", with a total capacity of 1495 m<sup>3</sup> / h (225,600 B / D) and 112,800 B / D each branch. 603-MET-601.
- A Skid double leg measurement of 12 ", with a total capacity of 2289 m<sup>3</sup> / h (345,600 B / D) and 172,600 B / D each branch. 603-MET-602.
- A measurement Skid 12 "with a capacity of 1145 m<sup>3</sup> / h (172.800B / D) 603-MET-606.
- A known volume tester (23.69584 Bls according last calibration), to calibration of the measurement skids. 603-MET-607.

NOTE: Each measurement Skid is equipped with a positive displacement meter to measure flow rate, suction filter, block valves for manual and motorized valves alignment tests and a quality system.

### Diluted Crude meters ( positive displacement)



### Tester Meter



## Diluent Measurement

- A pig (tool) receiver 623-PR-651

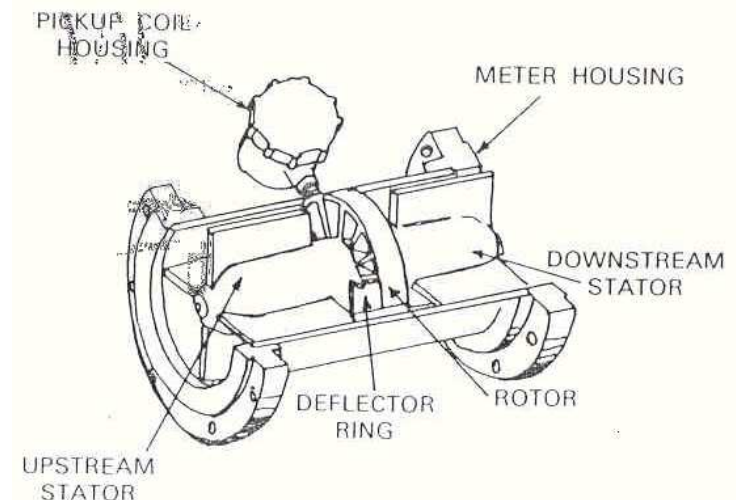
Three metering skid s( diameter 6 “), with a capacity of 636 m<sup>3</sup> / h (96,000 B / D) c / u, 603-MET-651, 603-MET-652, 603-MET-656.

A known volume tester (23.88298 BIs as last calibration), calibration of the meters. 603-MET-657.

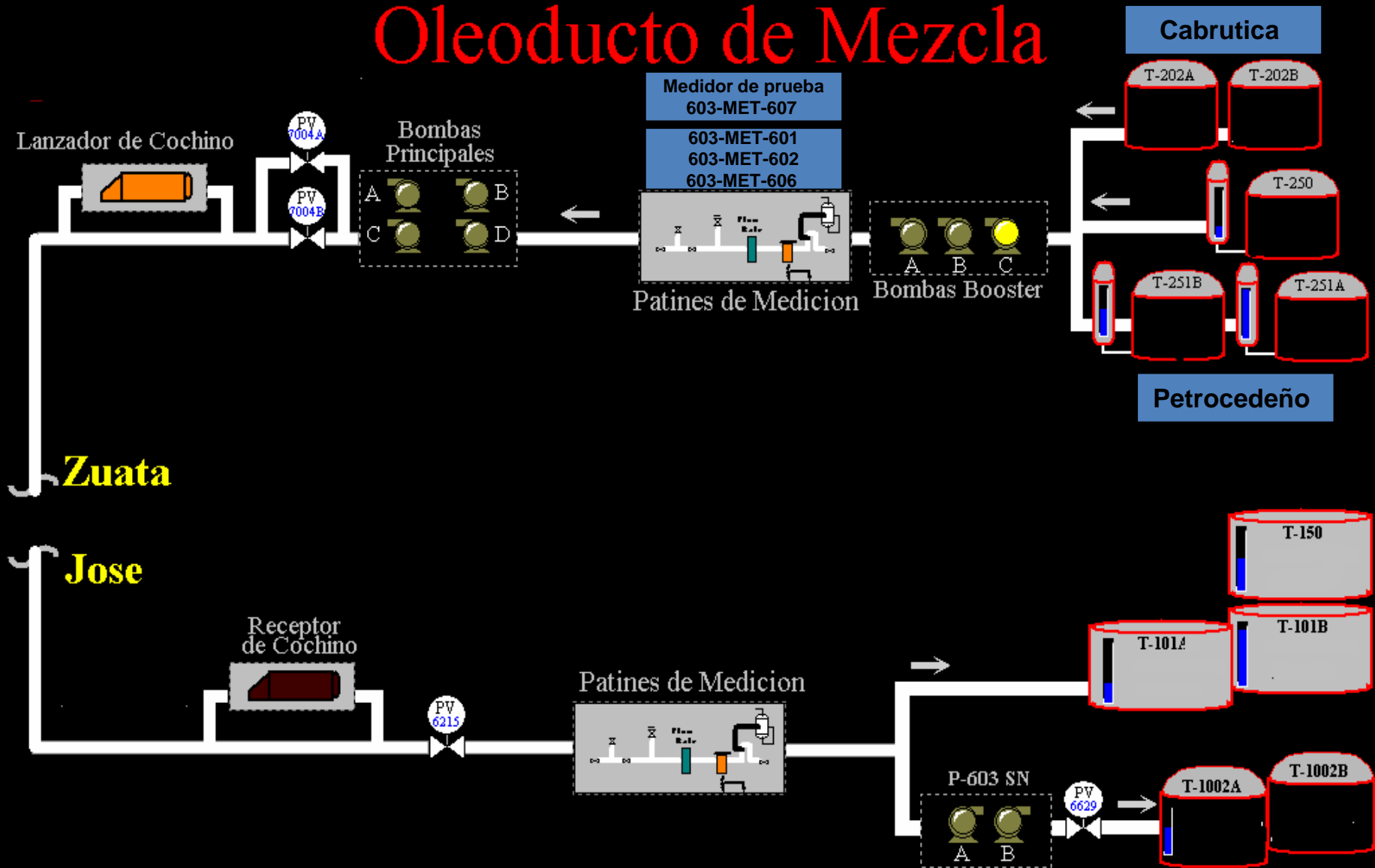
NOTE: Each measurement Skid is equipped with a turbine to measure flow rate, suction filter, block valves for manual and motorized valves alignment tests and a quality system.



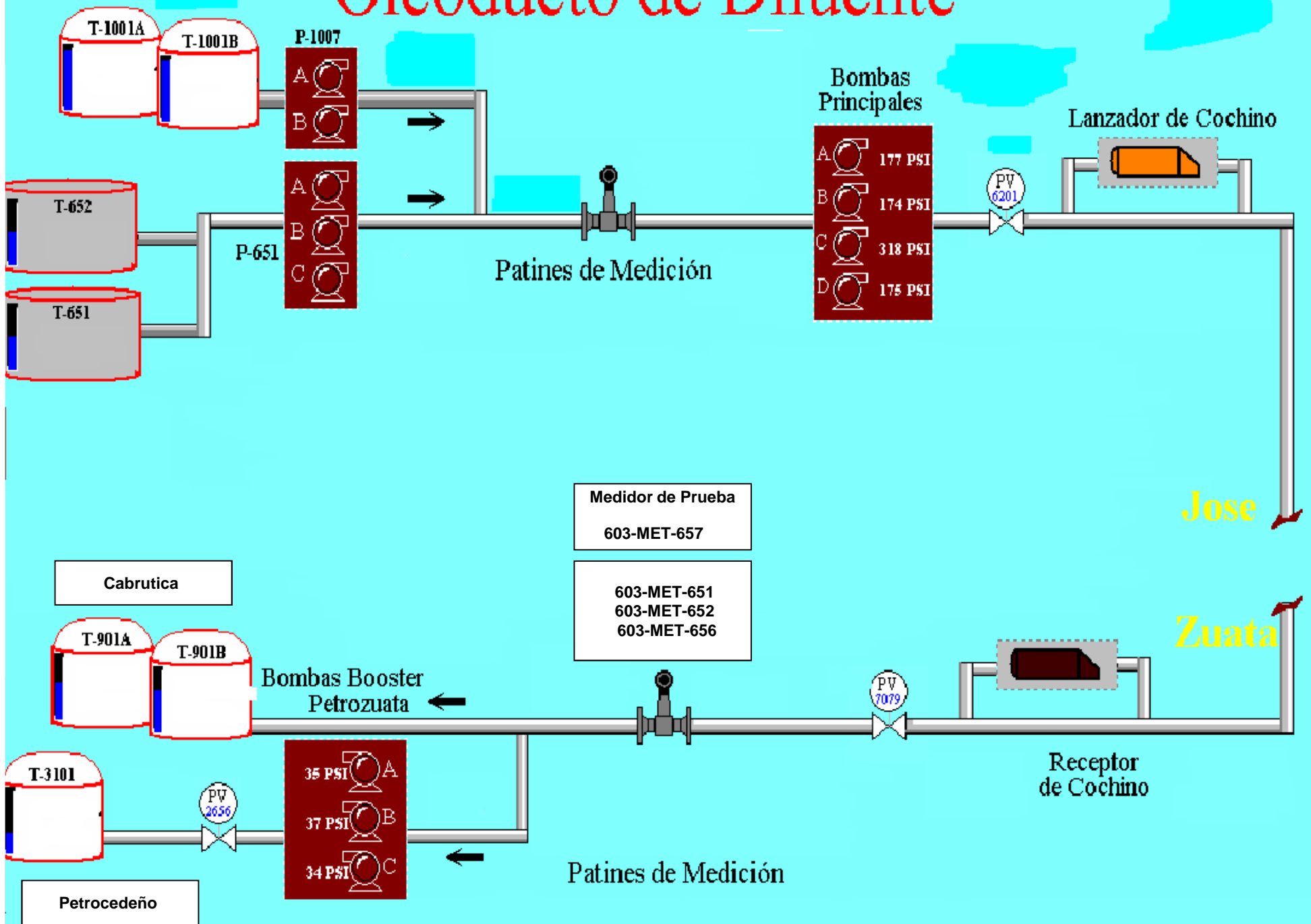
### Meter



# Oleoducto de Mezcla



# Oleoducto de Diluyente



# Metering System Quality System

In this system the values of API gravity and % BSW are shown online.

## Automatic sampler



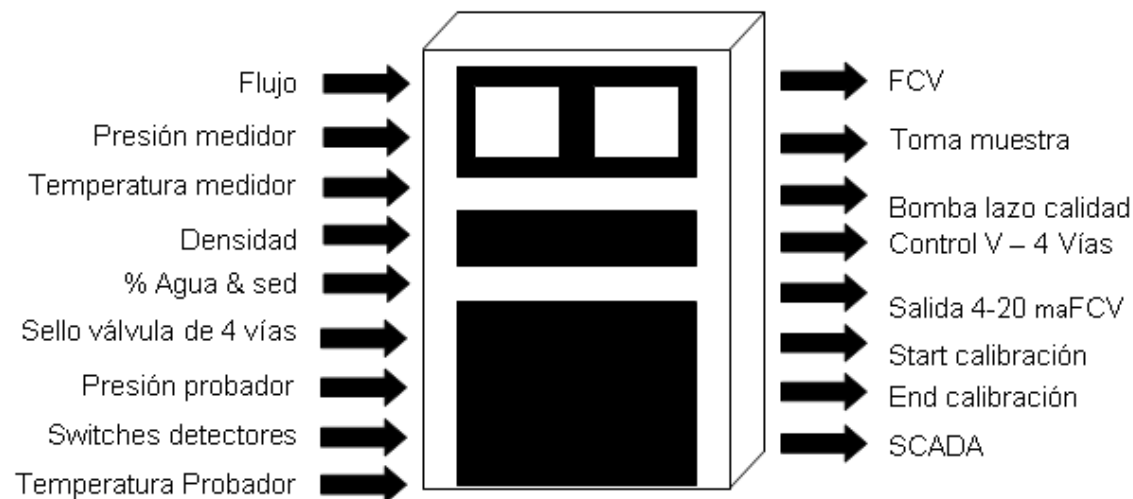
## °API and % BSW analyzers



## Flow Computer

It is a microprocessor-based computer that has all the formulas and algorithms needed to calculate volume compensation for temperature and pressure. Takes data from the meter and flow tester, besides the signs of the temperature and pressure transmitters in the line, calculates the correction amount for standard values.

Controls the bypass valves to test the meters, takes samples, loops pumps quality, flow control valves, emission test reports and batch order, etc.

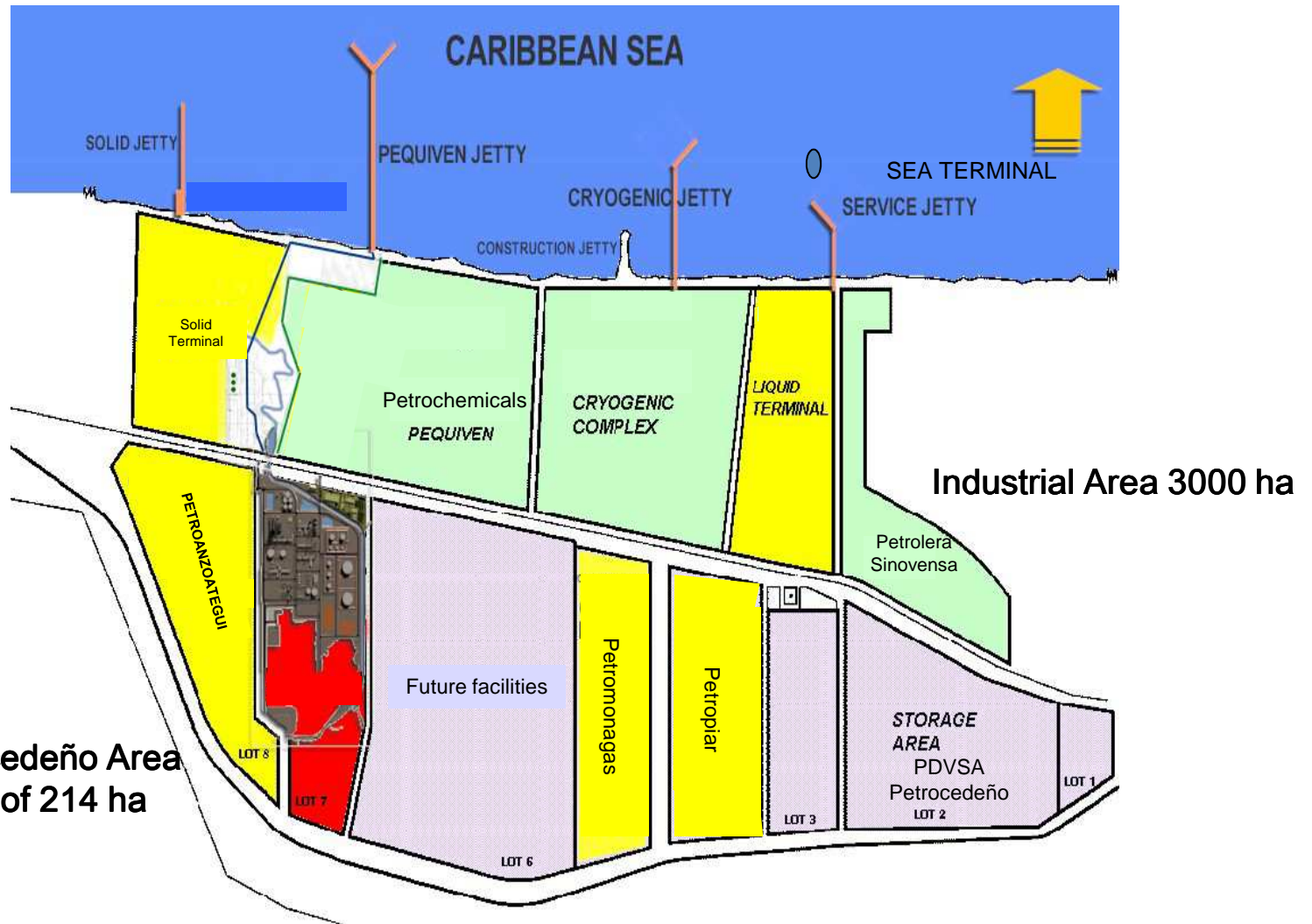


# Upgrader

# Pipeline System



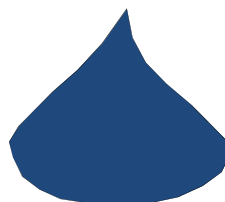
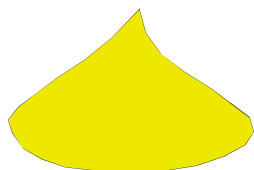
# José Antonio Anzoátegui Industrial Complex



**Petrocedeno Area**  
164 of 214 ha

# Extra Heavy Oil Upgraders in Venezuela

	PDVSA Petrocedeño	PDVSA Petromonagas	PDVSA Petroanzoátegui	PDVSA Petropiar
Main Processing Units	Coker HDT, MHC	Coker	Coker	Coker HDT, HCK
Production Volume	180 MBPD	108 MBPD	102 MBPD	180 MBPD
Upgraded Crude Specification	30°-32° API Light Crude Low Sulfur	16° API Heavy Crude High Sulfur	20° API Heavy Crude High Sulfur	26° API Med Crude. Med.Sulfur
Refinery modifications	No	Yes	Yes	Yes
Reference Crude	Cusiana or Forcados	Maya be compared	Maya	WTI



# Upgrader in North Anzoátegui



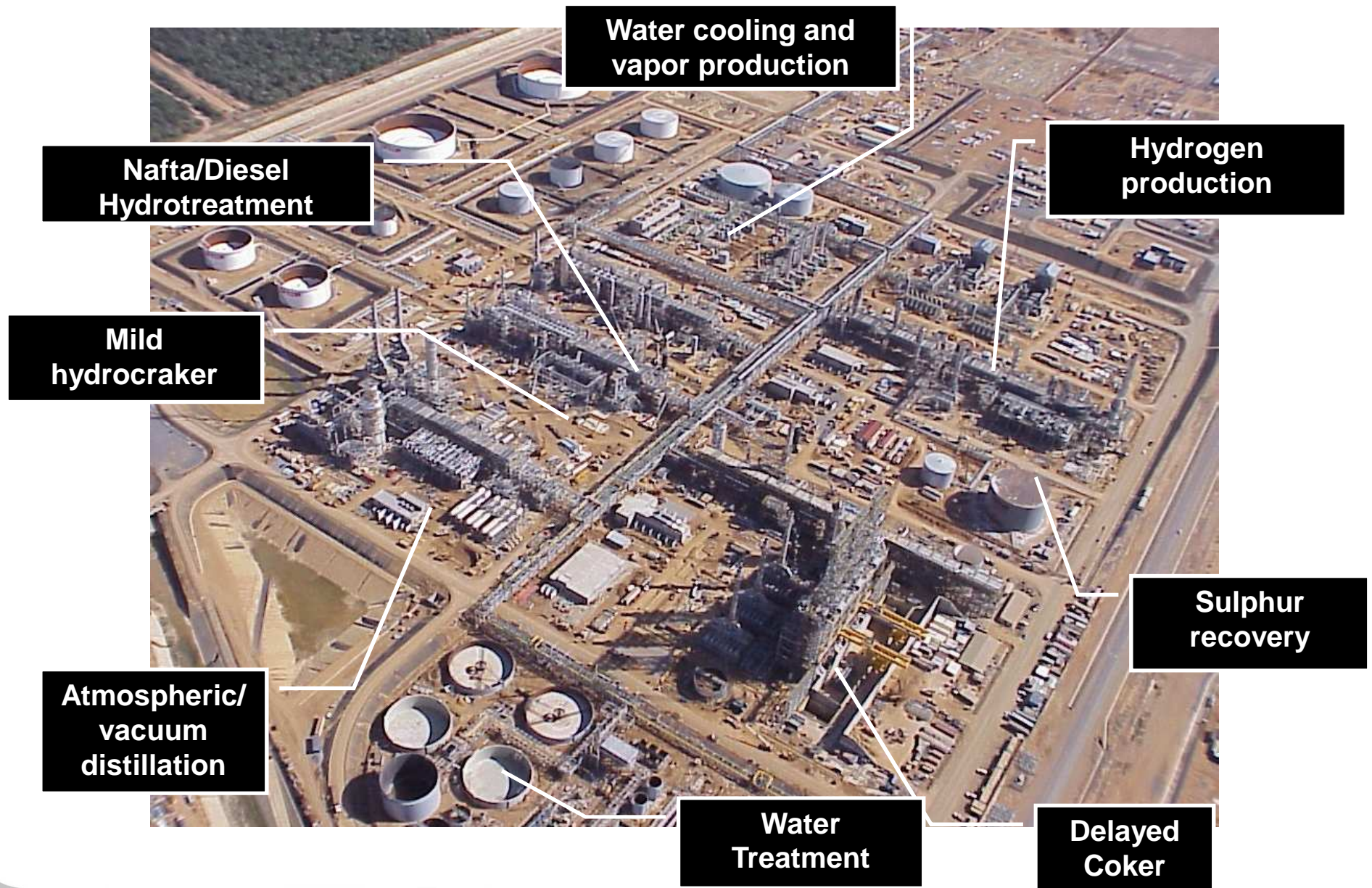
# Upgrader in North Anzoátegui



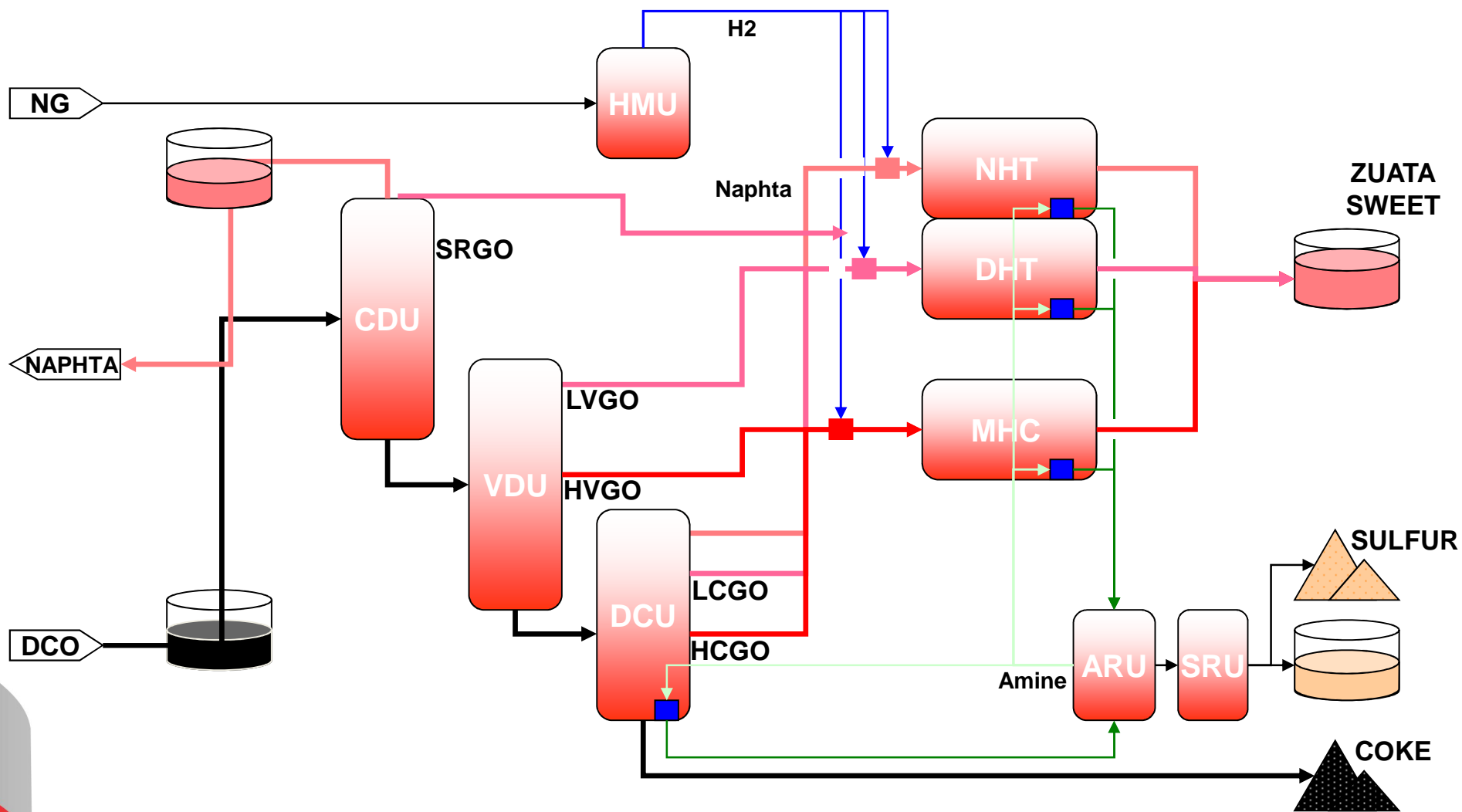
# Solids Handling Facilities



# Plant Area



# Process Scheme



# Upgrader Facts – Installed Capacities After Major Turnaround 2004

## UNITS

- EHO Crude gravity: 8.5°API
- DCO Crude: 17°API
- CDU: 284,000 B/D
- VDU: 180,000 B/D
- COKER: 106.400 B/D
- NDHT: 110,000 B/D
- MHC: 75,000 B/D

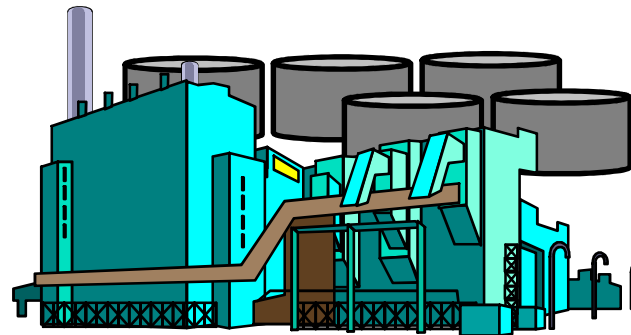
## PRODUCTS

- Crude gravity: 32 API
- Crude: 180,000 B/D
- Coke: 6,000 T/D
- Sulfur: 900 T/D



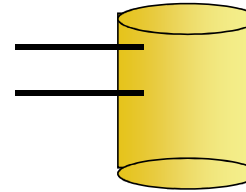
# Upgrader

## *Process Units of Upgrader - Licenses*



- \* Atmospheric/Vacuum Distillation
- \* Delayed Coker
- \* Hidroprocessing Units (NDHT/MHC)
- \* Sulphur/Amines/Sour Water/Tail Gas
- \* Hydrogen Manufacturing
- \* Industrial Services
- \* Common Technology
- \* Foster Wheeler
- \* French Institute of Petroleum, IFP
- \* TPA-Kvaerner
- \* KRUPP-UHDE
- \* Common Technology

# Zuata Sweet



- First light and low sulphur crude from Venezuela
- Compatible with environmental conditions
- High technical / High Refining value

# Low Sulphur Upgraded Crude Quality

<u>LSSC</u>	<u>METHOD</u>	
API Gravity 60°F	ASTM D1298-90	30-32
Sulfur, wt %	ASTM D5453-93	≤0.13
Metals, ppm wt	IFP 9422	<u>1</u>
Viscosity CTS @ 50°C		4.7
Inflammation, °C	ASTM D 93	19-23
Composition, wt % (Estimated)	ASTM D2887-97	
– Liquefied Gas		1
– Nafta (C5 - 165°C)		10
– Medium Distillates (165 - 385°C)		58
– Vacuum gas Oil (385°C +)		31
Production, millions barrels per year		62
– Low sulfur synthetic crude (LSSC)		≤ 90%
– Med sulfur synthetic crude (MSSC)		≤ 10 %

(\* ) Estimated Quality: 17 API, 3.3 % Sulfur



**Thanks for your  
Attention**

# Surface Facilities

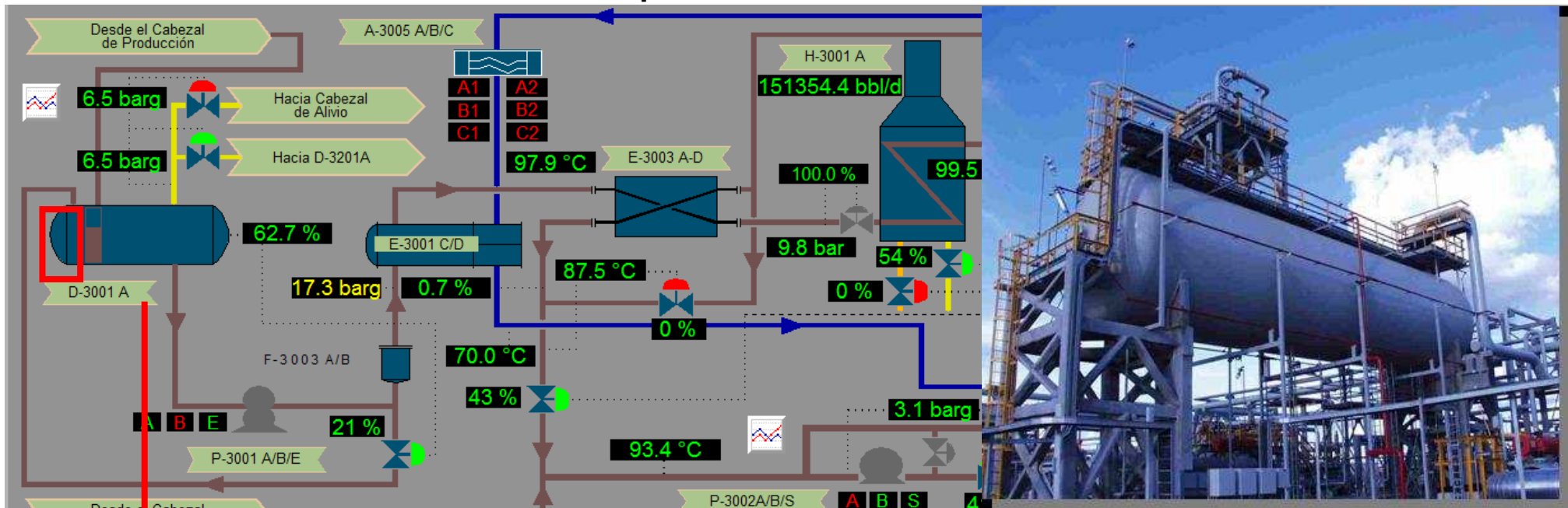
## Back up slide



# PRODUCTION PROCESS

## 3. Oil + Water + Gas Produced to the D-3001A/B

### 3.1. Free Gas collected in D-3213 separator



## Primary Separation

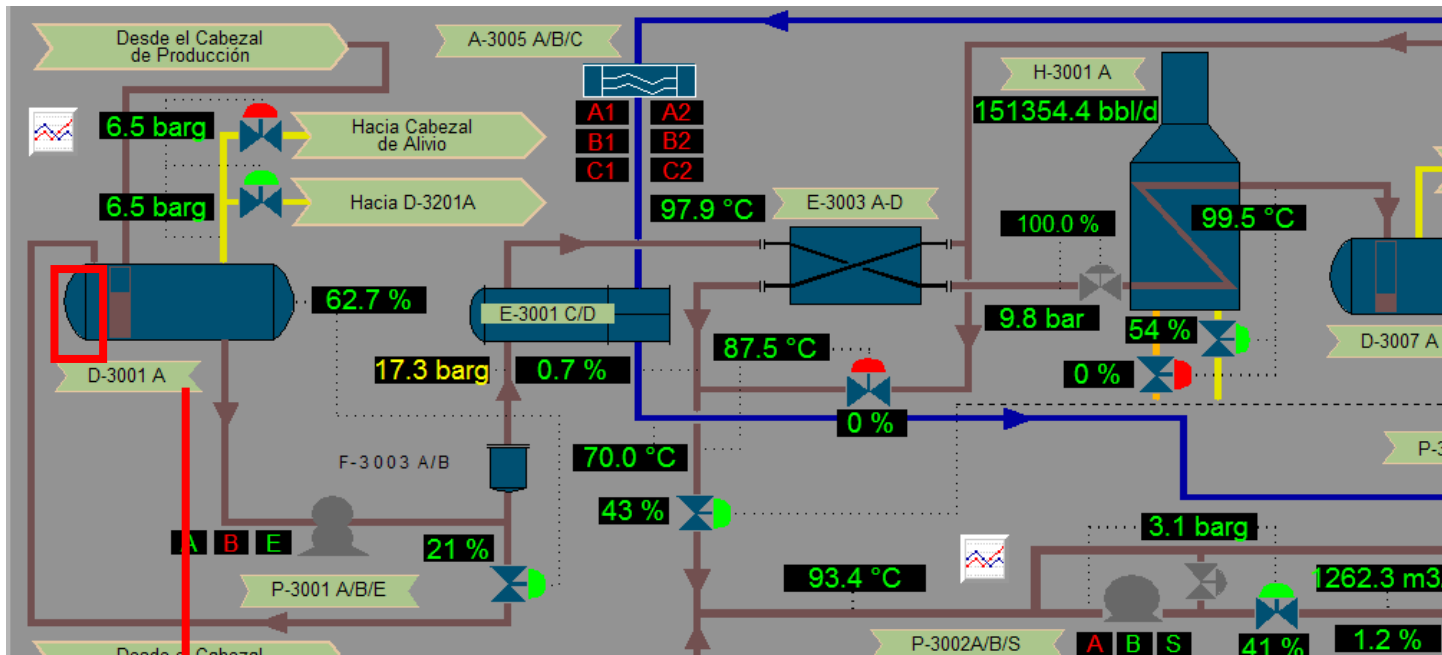
- Free gas is separated into the Gas System
- Oil + Water is pumped through P-3001 A/B/C/D/E/F

**Operating Conditions:**  
Pressure: 4-8 BARG  
Temp.: 30-50 ° C

# PRODUCTION PROCESS

## 4. Oil + Water + Gas Produced to the D-3001 A/B

### 4.1. Free Gas collected in D-3213 separator



**Operating Conditions**  
 Pressure: 13-18 BARG  
 Temp.: 30-50 ° C

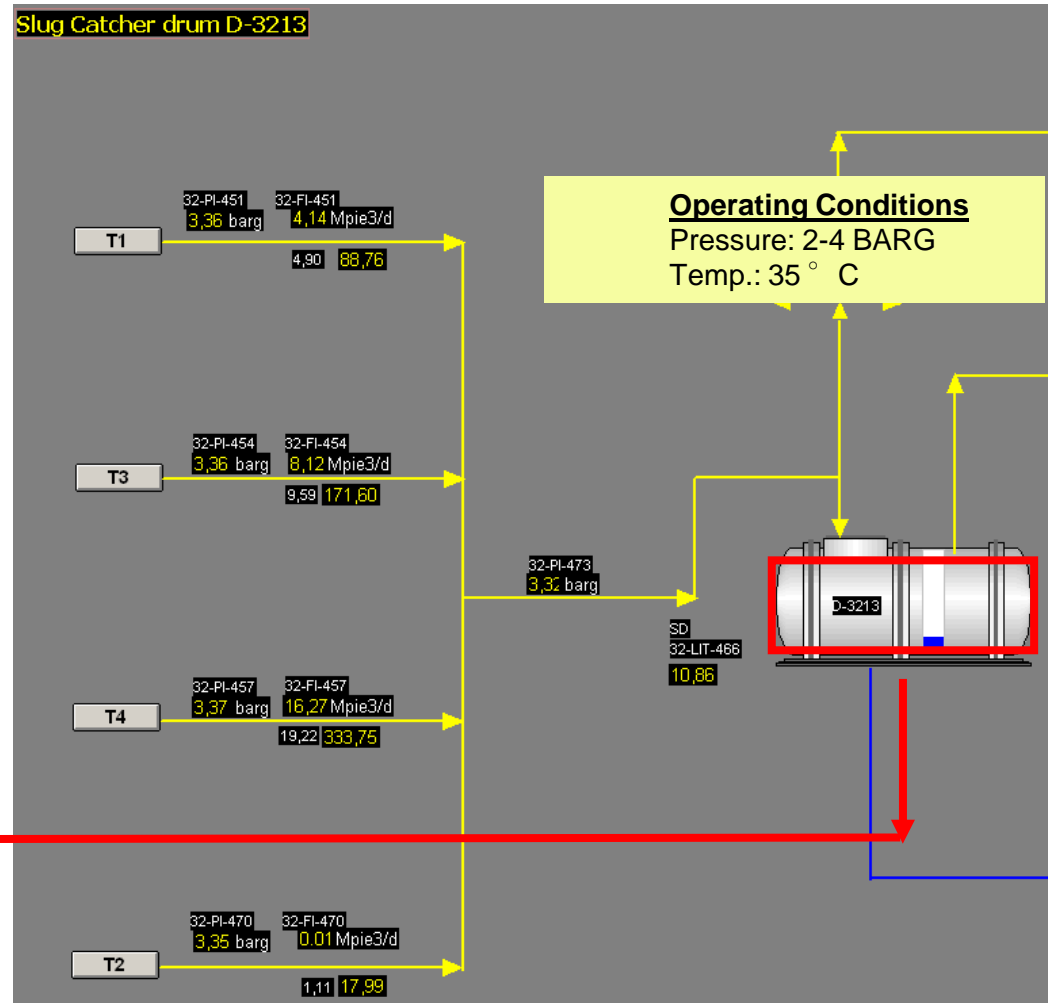
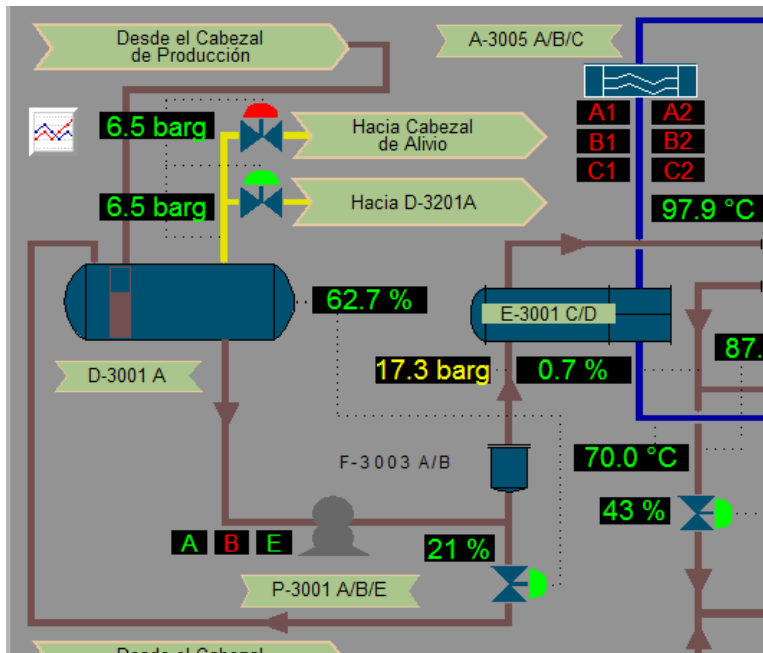
### Primary Separation

- Free gas is separated into the Gas System
- Oil + Water is pumped through P-3001 A/B/C/D/E/F

# PRODUCTION PROCESS

## 5. Oil + Water + Gas Produced to the D-3001A/B

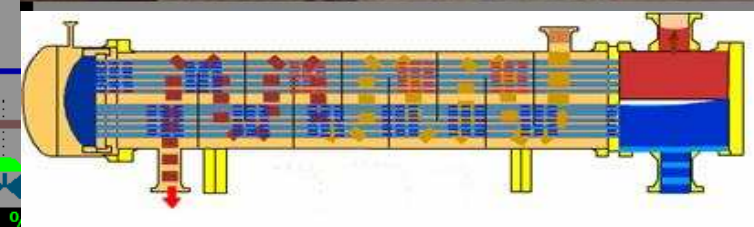
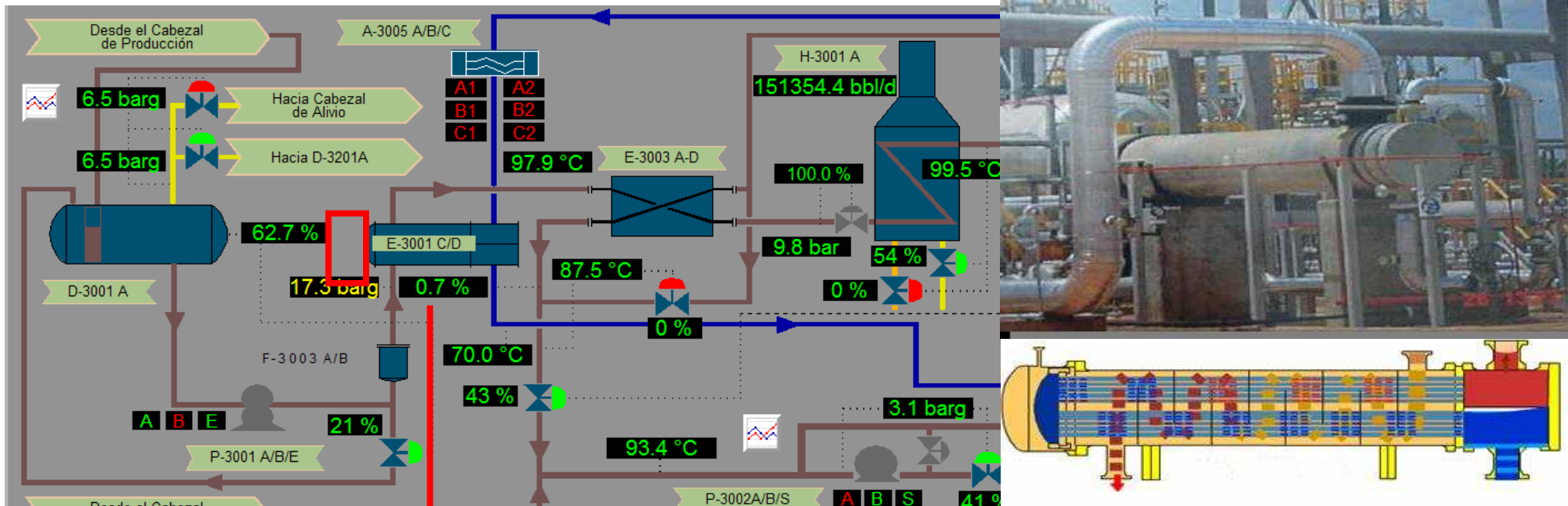
### 5.1. Free Gas collected in D-3213 separator



- Free gas is separated
- Condensates into Water Plant

# PRODUCTION PROCESS

## 6. Exchangers E-3001 C / D / E / F



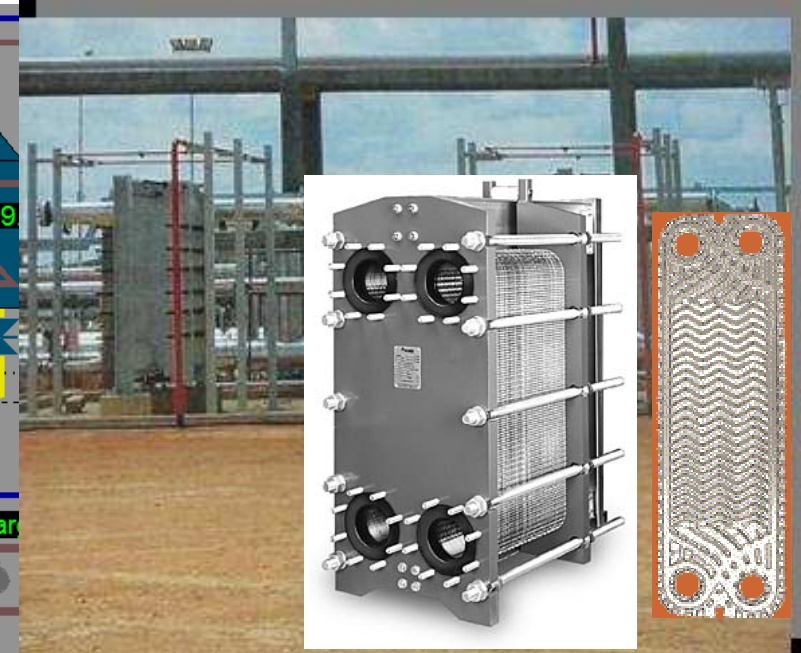
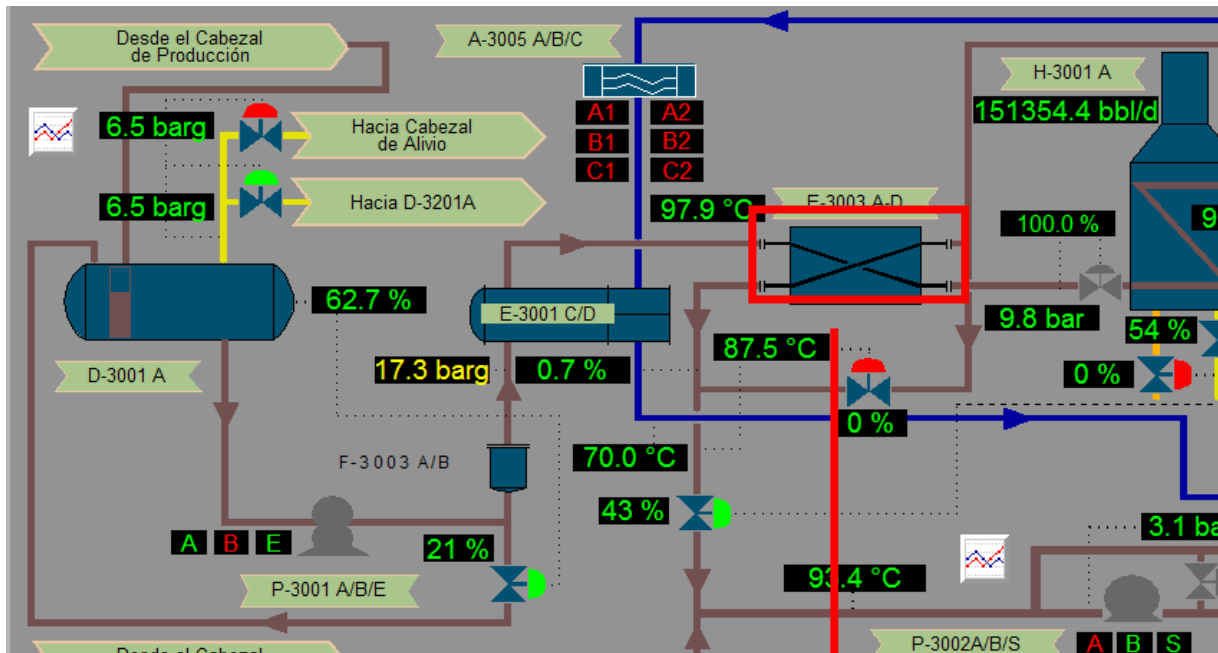
**Operating Conditions :**  
 Heating stage 40->50° C  
 Cooling water 100->75 ° C

### First step Pre-heat Stage

- Improves oil viscosity at 50C
- Cooling of produced water at 75C

# PRODUCTION PROCESS

## 7. Exchangers E-3003 A/B/C/D/E/F/G/H



### Second step Pre-heat Stage

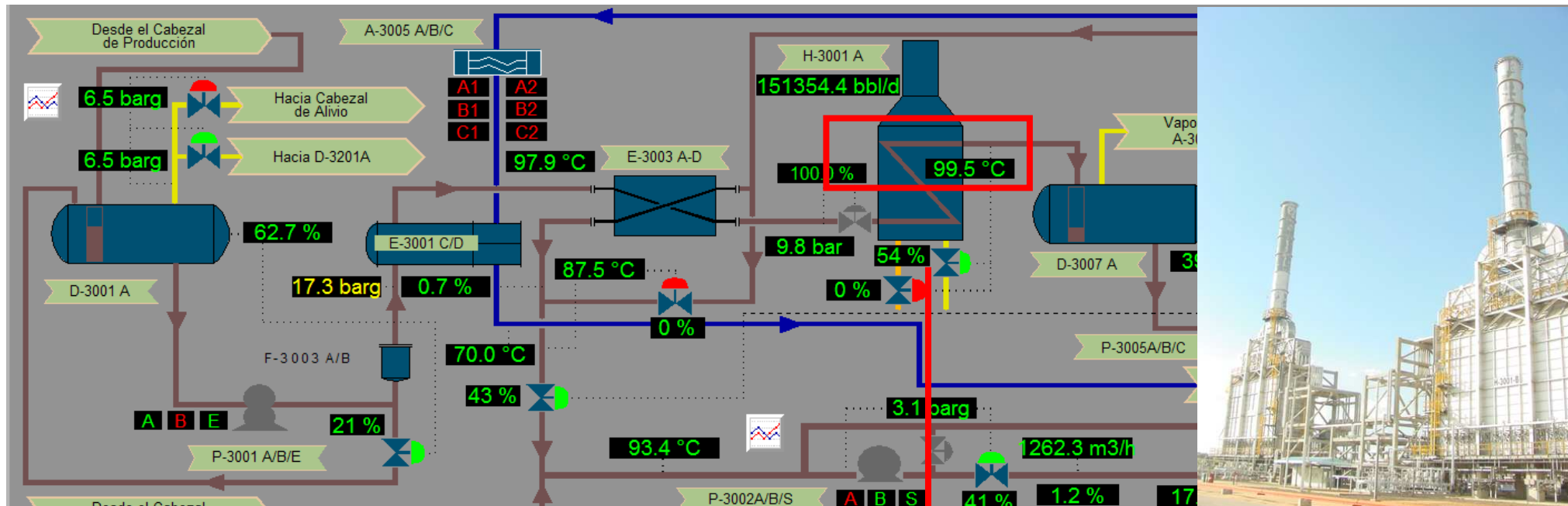
- Improves oil viscosity at 50C
- Cooling of diluted crude oil to export at 100C

#### Operating Conditions:

Heating stage of crude:  
50->65 ° C  
Cooling stage of crude:  
120->100 ° C

# PRODUCTION PROCESS

## 8. Heating furnace H-3001A / B



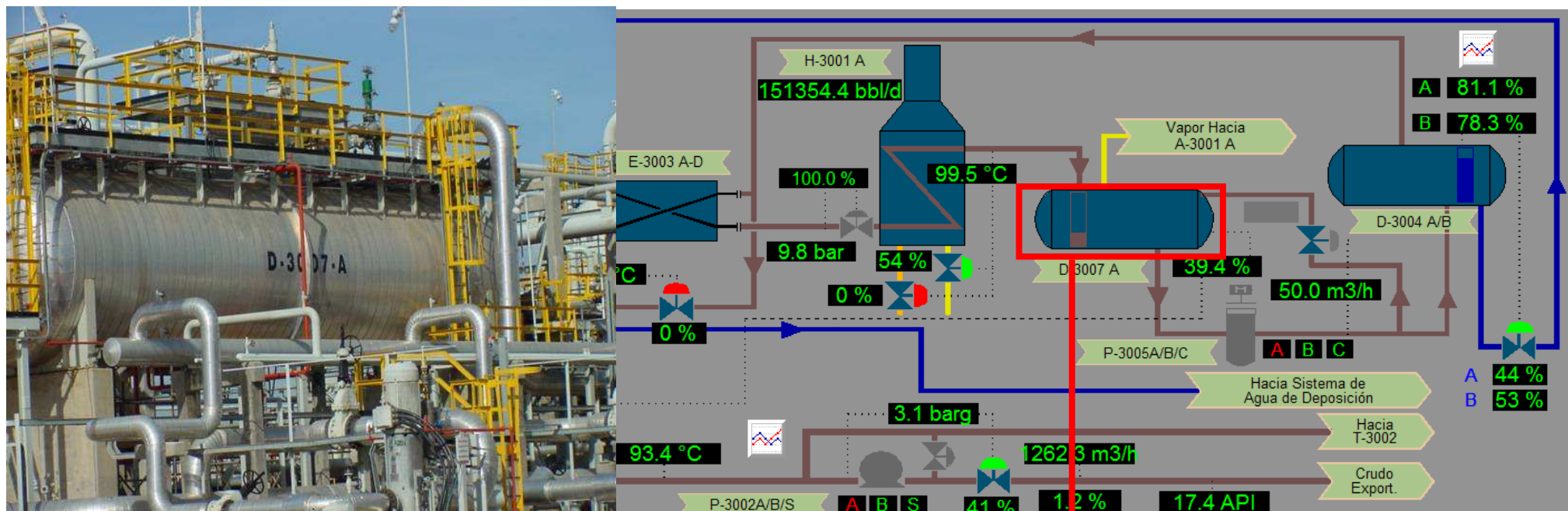
**Operating Conditions:**  
 Pressure: 7-10 BARG  
 Inlet Temp. : 50-65 ° C  
 Outlet Temp: 95-120 ° C

### Heating Process

- Improved oil viscosity at 120C
- It favors the separation of gas in solution
- It favors emulsified water separation

# PRODUCTION PROCESS

## 9. High Temperature Separator D-3007A/B (HTS)



### High Temperature Separation

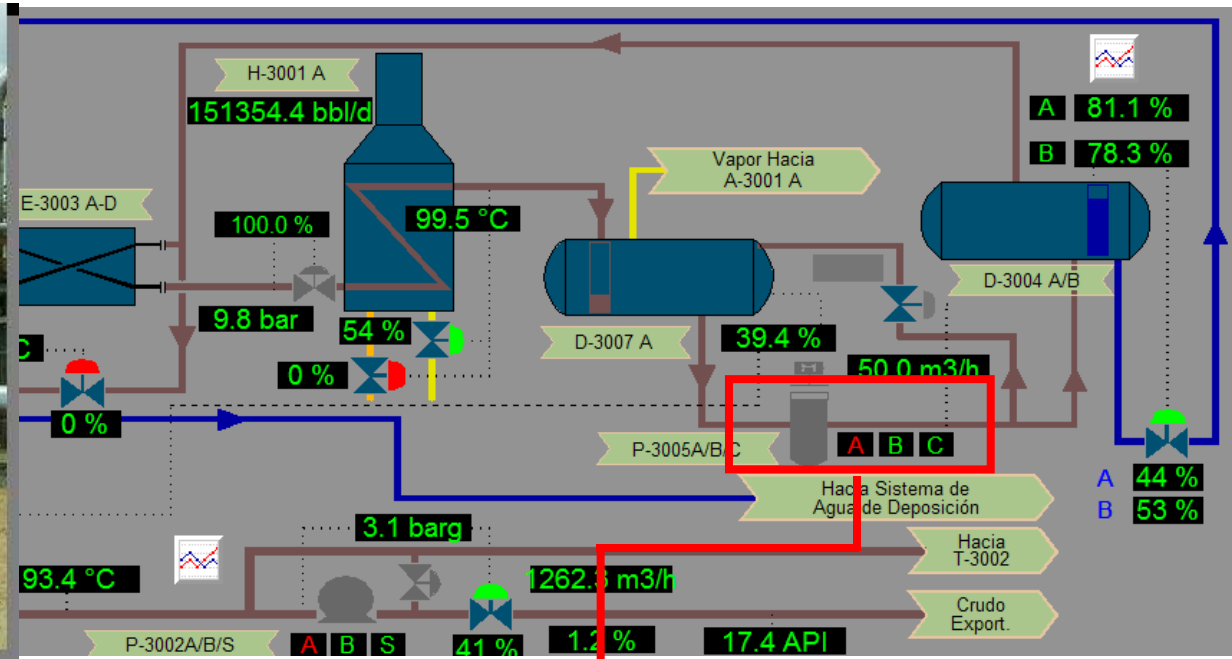
- Separation of solution gas
- Improvement the Crude stabilization to be sent to the dehydration process through P-3005A/B/C/D/E/F

#### Operating Conditions:

Pressure: 4-5 BARG  
Temp.: 95-120 ° C

# PRODUCTION PROCESS

## 10. High Temperature Separator D-3007A/B (HTS)



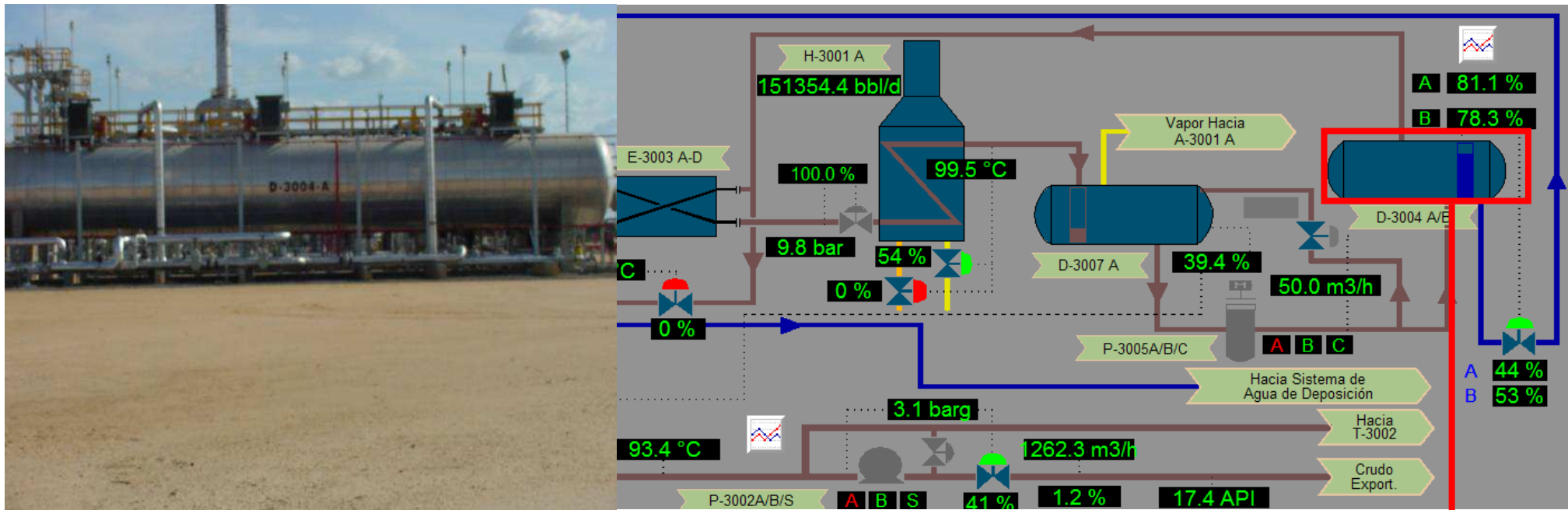
### High Temperature Separation

- Separation of solution gas
- Improvement the Crude stabilization to be sent to the dehydration process through P-3005A/B/C/D/E/F

**Operating Conditions:**  
Pressure: 9-11 BARG  
Temp.: 95-120 ° C

# PRODUCTION PROCESS

## 11. Electrostatic Dehydrators D-3004A/B/C/D



**Operating Conditions:**

Pressure: 9-11 BARG  
Temp.: 95-120 ° C  
Voltage: 15 mv-18mV

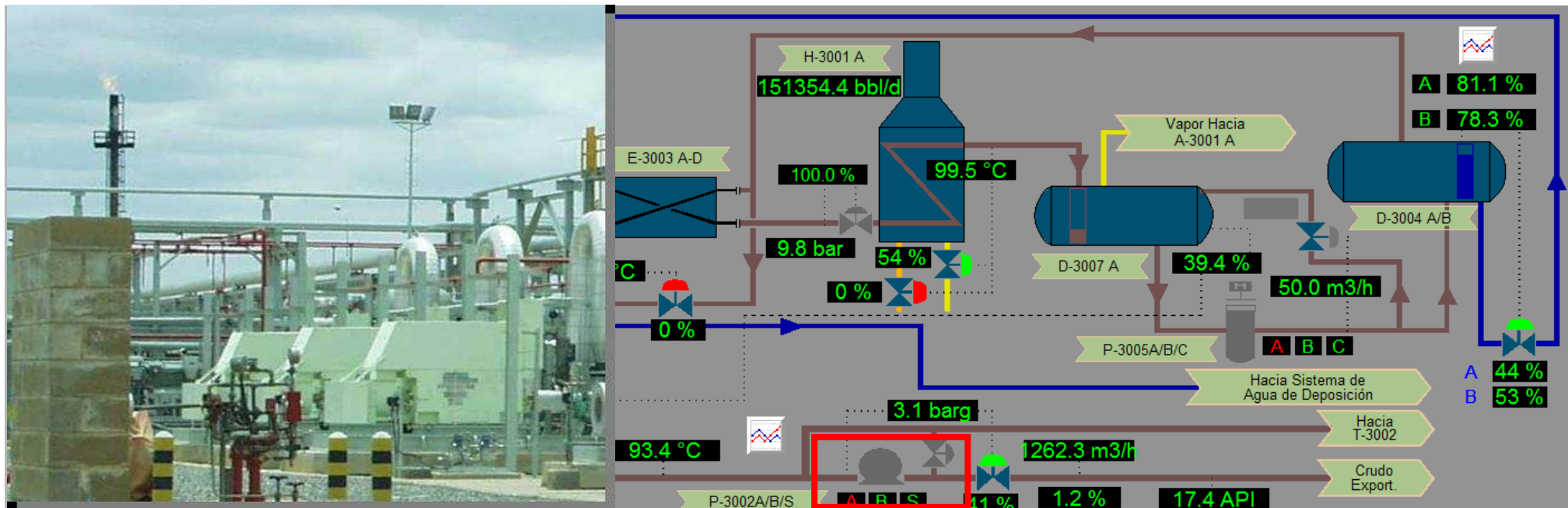
### Dehydration

Separation of free and emulsified water

- Coalescence by applying an electrostatic potential and chemical demulsifier

# PRODUCTION PROCESS

## 12. Export / Storage of DCO through the P-3002A/B/S



**Operating Conditions :**  
Pressure: 18-21 BARG  
Temp.: 90-103 ° C

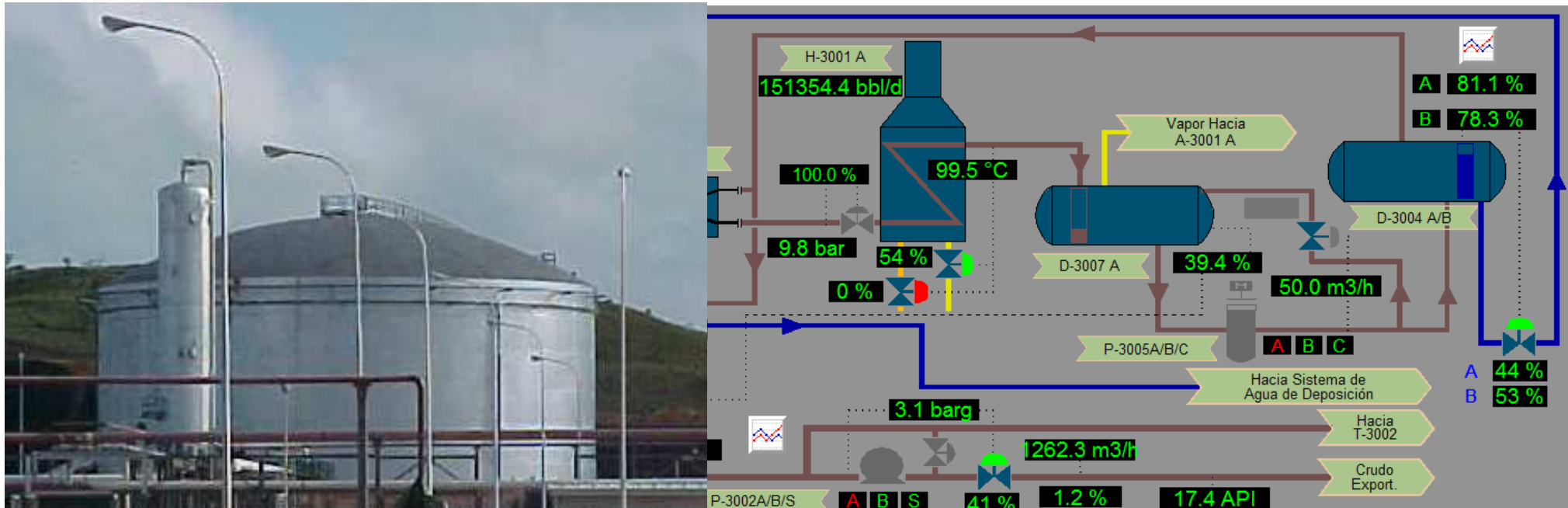
### Export and Storage

Diluted crude pumping through the P-3002 to the Zuata Pump Station (ZPS)

Possibility of storage in the T-3002 when the product is out of specification or any operational requirement

# PRODUCTION PROCESS

## 13. Export / Storage of DCO through the P-3002A/B/S



### Export and Storage

Diluted crude pumping through the P-3002 to the Zuata Pump Station (ZPS)

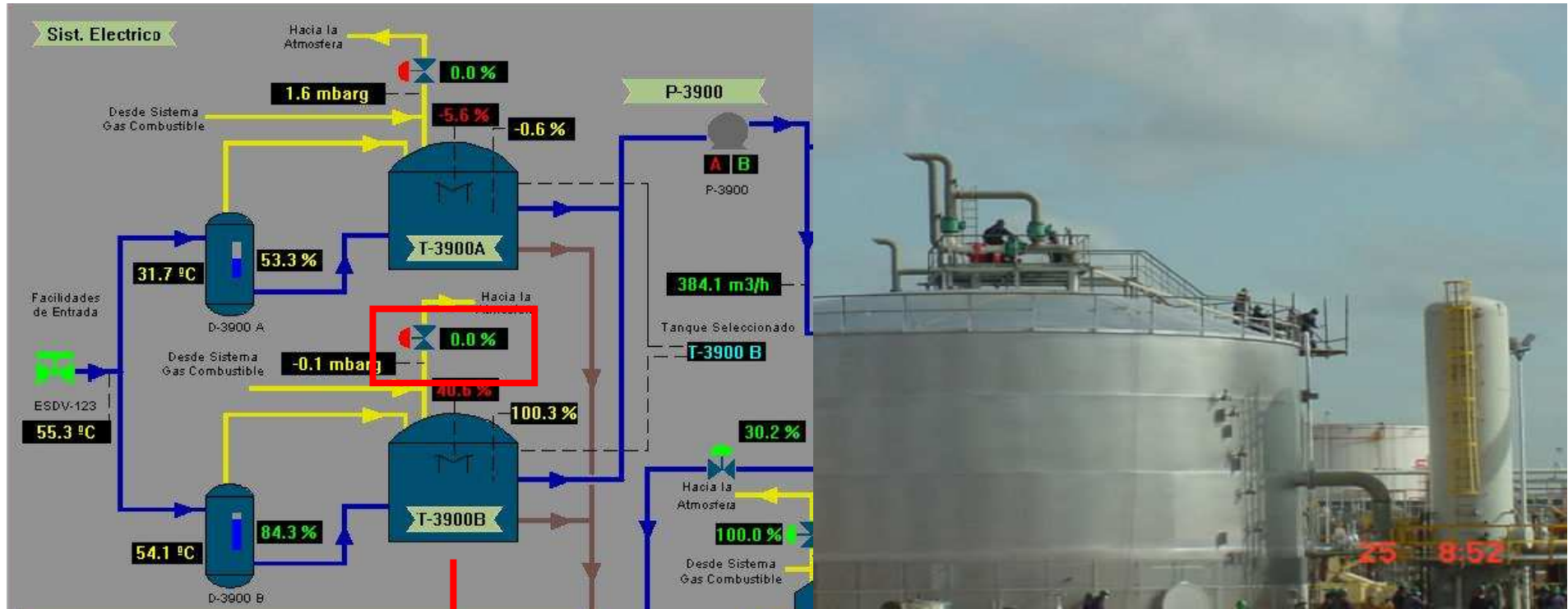
Possibility of storage in the T-3002 when the product is out of specification or any operational requirement

#### Condiciones de Operación:

Volumen: 110.000 BBL  
 Diámetro 36.58 Mts.  
 Altura: 17.08 Mts.  
 Temp: 90-103 ° C.  
 Presión: 40(-2.5) mBarg.

# PRODUCTION PROCESS

## 14. Water produced in to the T-3900A/B



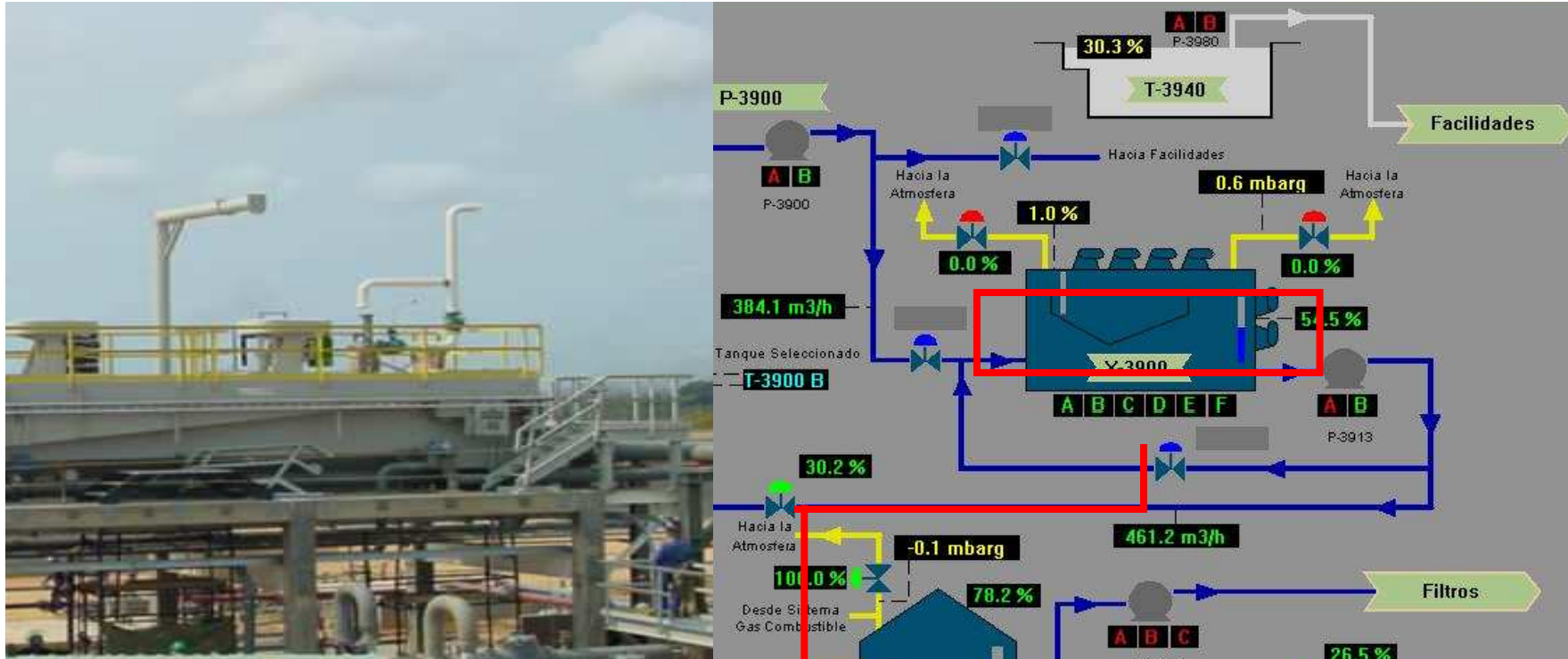
- Crude oil separation by overflow which is sent to export
- Solids settling for removal by drainage
- Water separated through the P-3900A / B to Wemco X-3900 unit

### Operating Conditions

Volume: 13.000 BBL  
 Diam. 17.5 Mts.  
 H: 9.1Mts.  
 Pressure: 0.0175 BARG  
 Temp.: 70-80 ° C

# PRODUCTION PROCESS

## 15. Water produced in to the Wemco unit (X-3900)

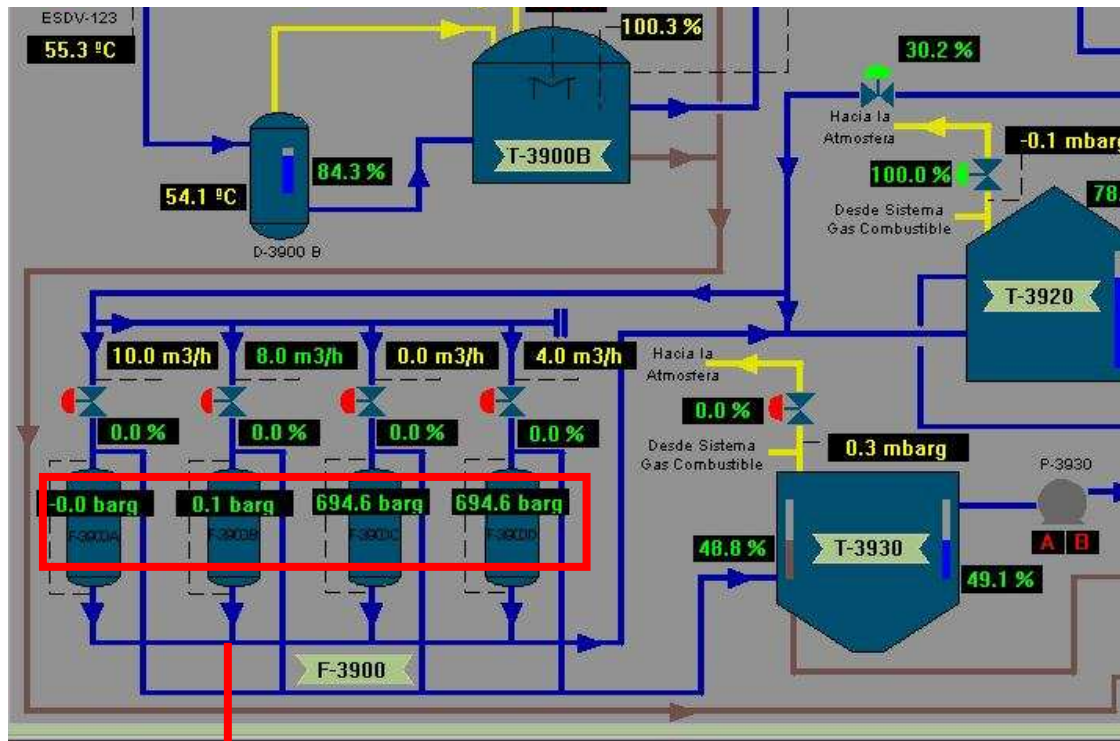


**Operating Conditions**  
Pressure: 0.043 BARG  
Temp.: 70-80 ° C

- Crude oil separation induced by gas which is recovered by the decantation unit T-3930  
Solids settling for removal by drainage
- Water separated through the P-3913A / B to F-3900ABCD (Filtration)

# PRODUCTION PROCESS

## 16. Produced water in the Filtration System F-3900A/B/C/D



- Removal of oil and solids traces
- Water is send to the injection tank

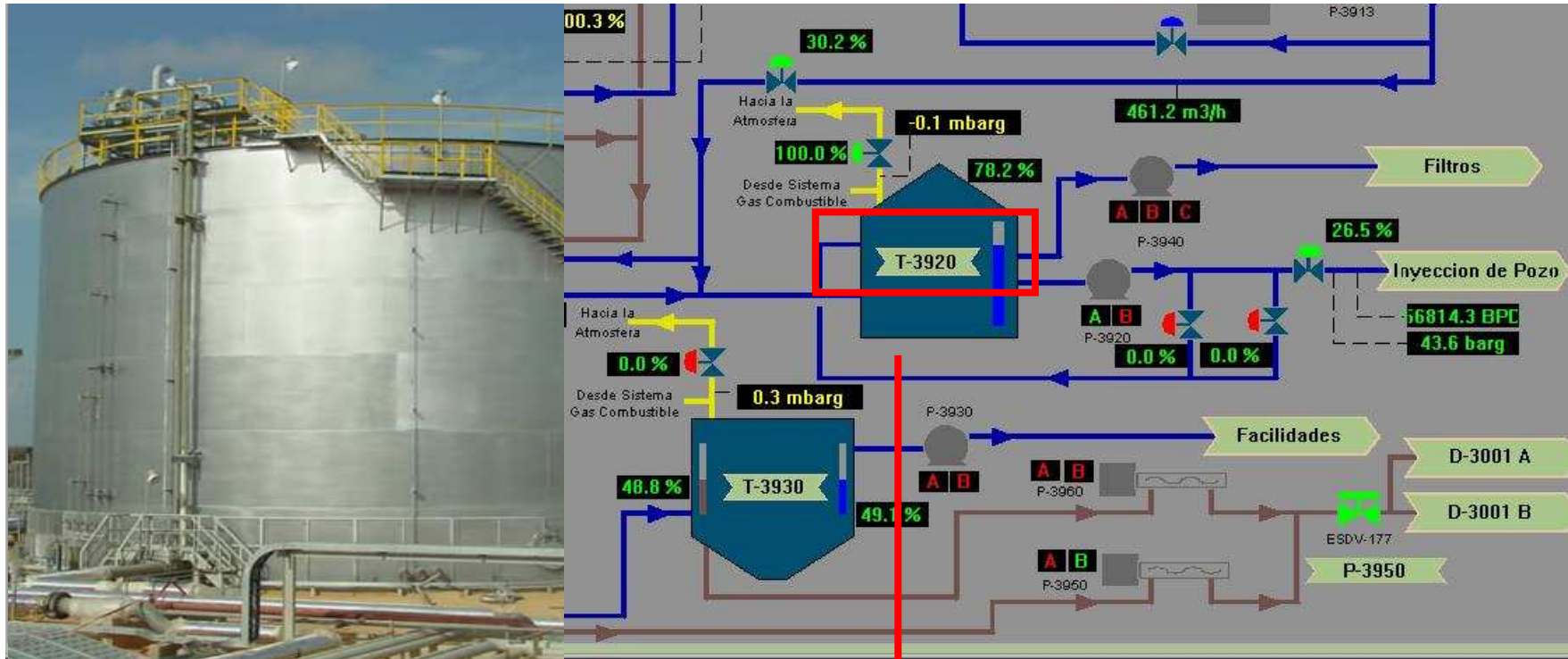
### Operating Conditions

Pressure: 7.42 BARG

Temp.: 70-80 ° C

# PRODUCTION PROCESS

## 17. Produced water Tank T-3920 ( injection)

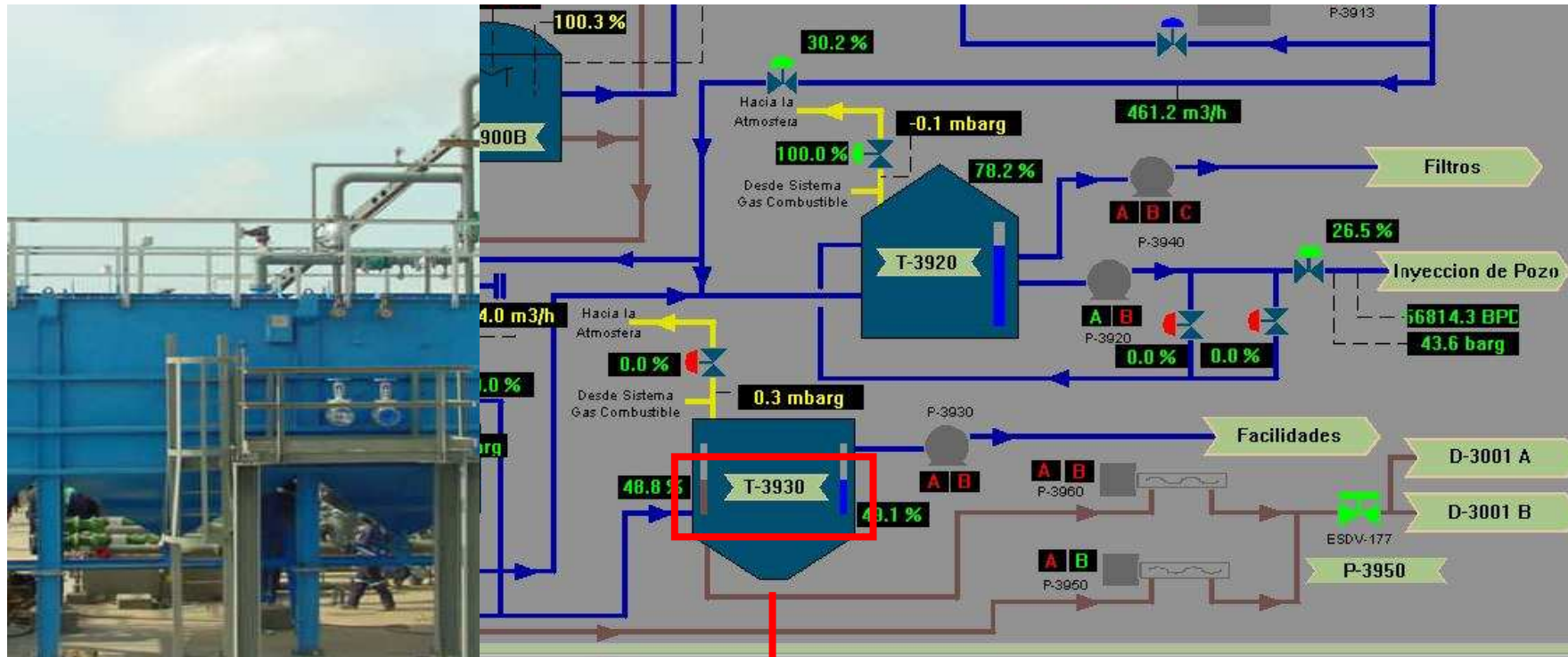


**Operating Conditions**  
 Volume: 35.000 BBL  
 Diam. 22.5 Mts.  
 H: 14 Mts.  
 Pressure: 0.015 BARG  
 Temp.: 70-80 ° C

- Water Storage Tank ( in specification),  
to be injected into the OX01/FX01/FX02/FX04 wells

# PRODUCTION PROCESS

## 18. Oil / Water recovered from Wemco unit for final separation process



- Unit with high residence time to break oil-water emulsions, recovering the water and oil, to be send to water treatment plant or export

**Operating Conditions:**

Volume: 600 BBL  
Pressure: 0.015 BARG  
Temp.: 70-80 ° C