

EOGEPL/CBM-RG (E)/CA/2023/4687
June 14th, 2023

The Additional PCCF and Nodal Officer, FC Act
4th Floor,
Department of Forest
Aranya Bhawan, Salt Lake
Kolkata – 700098

Sub: Submission of “plan for treatment of the effluent water generated due to pumping out of underground water along with methane” in connection with Diversion proposal for 12.5492 Ha of forest land in favour of M/S Essar Oil and Gas Exploration and Production Ltd (Proposal No FP/WB/OTHERS/154900/2022)

Ref No: 2410/ L</2M-63/2022 dated 13.06.2023

Respected Madam,

Please find herewith the plan for treatment of the effluent (Produced) water generated during the production of Coal Bed Methane gas of Raniganj East CBM Block of Essar Oil and Gas Exploration and Production Limited.

We request you to kindly upload the plan online on Parivesh portal for further consideration of the proposal.

Thanking You,
For, Essar Oil and Gas Exploration & Production Ltd


Ranjan Jindal
Chief Finance Officer



Copy forwarded for information:-

1. The Chief Conservator of Forests, South-East Circle, West Bengal
2. The Divisional Forest Officer, Burdwan Forest Division, Burdwan
3. The Divisional Forest Officer, Durgapur Forest Division, Durgapur

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**PRODUCED WATER MANAGEMENT PLAN
FOR
RG (East)-CBM-2001/1 PROJECT, DURGAPUR**



Central Integrated Water Treatment Plant

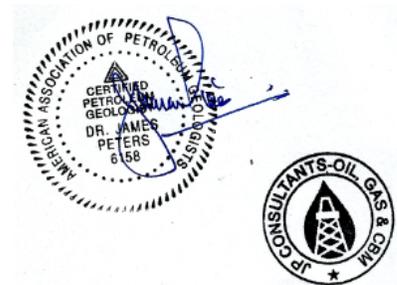
Prepared for Essar Oil & Gas Exploration & Production Ltd., Mumbai

By

JP Consultants, Dehradun

June 8, 2023

**JP Consultants
Independent Consultants
(Oil & Gas and CBM Exploration and Development)
124/5, Lane 9, Street 4, Rajinder Nagar,
Dehradun 248001**





Reference: JPC-EOGEPL/2023/2

June 8th 2023

**PRODUCED WATER MANAGEMENT PLAN FOR RG (East)-CBM-2001/1 PROJECT,
DURGAPUR**

Project: No. JPC- Essar (E&P)/2023/2- Block RG(East)-CBM-2001/1

Subject: Independent Consultancy Services

Comments:

Revision No	Date	Prepared By	Revised By	Approved By	Description
1	06-06-2023	JP	JP	JP	For Circulation to EOGEPL Ltd.

Rev	DD/MM/YYYY	Status	Written	Verified	Approved	Validated
2	08-06-2023	Final	JP	JP	JP	JP Consultant



**Dr James Peters
JP Consultants
June 8, 2023**

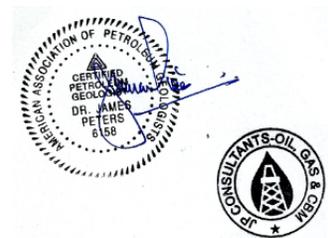


PRODUCED WATER MANAGEMENT PLAN FOR RG (East)-CBM-2001/1 PROJECT, DURGAPUR

Disclaimer

JP Consultant was dependent solely on the data given by EOGEP and has not considered any information in the public domain. JP consultant reviewed all the submitted documents and physically verified all the installed and commissioned facilities of RG(E) CBM block. JP Consultant has reviewed all earlier reports submitted to EOGEP, including “Certification of Production Forecast And Adequacy of Facilities: CBM Block - RG (East)-CBM-2001/1” , submitted to EOGEP on March 30th 2018.

This report is solely written for Essar Oil & Gas Exploration & Production Limited (EOGEP), with its registered office at F20, Balaji Shopping Wide Angle Highway, Nagalpur, Mahesana, GJ 384002, and corporate Office at Essar House – Durgapur, Village & Post Office – Molandighi Block:- Kanksa, Durgapur Sub-Division, Dist. Paschim Bardhaman, Durgapur 713212, West Bengal, India, and therefore, may not be disclosed to or relied upon by any third party without JP Consultant’s prior consent, provided that, this opinion may be disclosed to the Professional Regulators/Advisors or Investors.



Dr James Peters



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Executive Summary

- ❖ Essar Oil and Gas Exploration & Production Ltd. (EOGEP) has a 100% participating interest in the block RG (EAST)- CBM-2001/1 granted on 29-March-2005 from the Government of West Bengal. The block is located in the south east part of the Raniganj Coal Field and measures about 500 km²
- ❖ EOGEP (Essar Oil and Gas Exploration and Production Limited) is one of the largest E&P companies in India primarily focused in the domain of Unconventional Hydrocarbons (UHC) having a resource base of 12 TCF (Trillion Cubic Feet) CBM and shale gas resources. EOGEP has so far invested in around ₹5,000 Crores in exploration to commercial development of the Raniganj CBM Block. The company is a pioneer of Unconventional HC in India with about 25 years of experience in E&P of CBM. EOGEP is the only E&P player in India to produce over 80 BCF CBM till date. As on date the project is commissioned with 348 wells and a state-of-art indigenous infrastructure facility.
- ❖ To independently evaluate the reasons leading to unavoidable flaring of CBM gas efforts to mitigate this flaring and regularization of flaring under contractual provisions as well as per Industry standards, EOGEP, has approached JP Consultants, Dehradun to submit a report on “Unavoidable Flaring” of CBM Gas in Block RG(East)-CBM-2001/1 and give recommendations for writing off/approve the unavoidable lost flared volume of gas by EOGEP under contractual provisions.
- ❖ Coal bed methane production involves the production of methane gas from coal seams. These coal seams typically contain fresh to brackish water. Water contained in the coal seam must be pumped out to depressurize the well to release the methane that is adsorbed within the coal. This pumped water is called as ‘Produced Water’. A series of production wells are drilled into the coal so that produced water can be pumped to surface to reduce the hydrostatic pressure in the coal seam for the adsorbed gas to be released.
- ❖ Water production from CBM wells typically starts at a high volume, but normally falls dramatically over time as the coal seam becomes depressurized. Once the fluid pressure is lowered in the coal seam, methane gas is released and available for production through the wells. Water produced from CBM wells can vary in quality with Total Dissolved Solids (TDS) concentration (between 1000 ~ 6000 ppm). This water needs to be treated through Reverse Osmosis (RO) for lowering of TDS before discharge.
- ❖ The Raniganj CBM Block presently has 348 wells. The water produced from individual gas producing wells shall be conveyed to the nearest feasible water collection tank in the area where Reverse Osmosis plants are installed and/or planned to reduce TDS. As a part of total Water Management Plan, systems consisting of Zink-Aluminum tanks and pumps are being installed and commissioned at well pads to pump produced water to treatment facility via pipeline network.
- ❖ It is necessary to manage the quality of this water through a combination of treatment before storage, disposal, and use. CBM wells produce large volume of water early in their life, which declines with time. Usually, CBM-produced water is discharged/stored into lined ponds/Storage Tanks for further process. Management of CBM-produced water has challenges. CBM related produced water can be beneficially used but only after treatment to reduce their salinity.
- ❖ As per Oil Drilling and Gas Extraction Industry Standards (no 72) and Environmental (Protection) Rule 1986 the Total Dissolve Solid should not exceed 2100 mg/l which is the major yardstick for CBM related produced water. Also, Environment Clearance No: F. No. J - 11011/491/2011 – IA II (I) Dated 26th February 2013 and Amendment & Extension of Validity Dated 9th May 2019, defines that a production well “will which generates around 50 m³/day which requires to be treated through reverse osmosis (RO) before utilizing for agriculture and



other domestic purpose” EOGEPL treats the produced water through Reverse Osmosis (RO) for lowering of TDS less than 1000 mg/l before discharge.

- ❖ EOGEPL complies with the General Condition clause B (xi) of Environmental Clearance by submitting six monthly reports on the status of the compliance of the produced water management including results of monitored data (both in hard copies as well as by e-mail) to the Regional Office of MOEF, the respective Zonal Office CPCB and the WBPCB. Daily In-house-monitoring and also monitoring through 3rd party NABL accredited laboratory on monthly basis.
- ❖ As per existing system, the additional produced water shall be stored in storage tank at well pad and pumped into the underground PE (Polyethylene) water pipeline (laid along the road) network for further transportation to treatment facility. The treatment facility shall be enhanced according to the additional produced water from planned new wells to be drilled.
- ❖ An Additional 2,700 m³/day of produce water will be expected from proposed additional 54 wells in forest area, considering 50 m³/day/well. The water produced from the well head will be directly pump to the pipeline network or storage tank which shall be installed on the basis of the water pressure of the well and distance of the well pad from nearest RO plant. The proposed well locations in the forest shall also be integrated within existing water network and treatment plant. About 12.5 Km pipeline with 4' diameter will be laid to transport the produced water along the proposed approach road and pipeline of the proposed Forest well pad. No water will be discharge out from the proposed CBM well in Forest land, Hence maintaining a Zero discharge. The capacity of the treatment plant shall be enhanced by 2500 m³/day to cater the additional water from proposed wells. Online pressure monitoring instrument shall be installed at the water headed of the pipeline network to monitoring of the water pressure of the pipeline to check any leakage, chocking, damage etc., and if required immediately control measures to be taken by dedicated water pipeline maintenance team. In the event of any emergency the water produced will be transported through Tanker to the RO plant from Well site to the water Storage tank.
- ❖ Presently the produced water evacuated from the well is routed through the surface facility where the gas & water is separated and sent to separate networks respectively. Water is stored in storage tank and pumped into the underground water network for transportation to treatment facility. Water is collected into raw water pit at treatment facility. The facility location has four pit/storage for raw water, treated water, intermediate storage and reject water separately. All the pits have proper pumping arrangement for the specific purpose of treatment/disposal.
- ❖ Desalination, to bring salts content to acceptable levels for disposal by using the Reverse Osmosis technology. The water is treated in 2 stage to reduce the TDS before discharge. Dolomite dosing, after subjecting the water to RO is used in the permeate water to reduce the Sodium Absorption Ratio (SAR) value before discharge the surface drainage. Regular monitoring through Online TDS, pH and Conductivity meter and monthly Sampling carried out through NABL accredited Laboratory.
- ❖ EOGEPL takes utmost care not to contaminate the ground water because of operations. This is ensured through design as well as regular monitoring. Contamination of ground water is contained by the fact that the targeted seams of Raniganj Formation for production of CBM are at depths varying from less than 1000 meters to greater than 1400 meters, whereas the fresh, potable water is at a depth of about 50 to 100 meters, thereby the large separation is reasons for non-contamination of ground water by the produced water. Besides this large separation, the wells are cased in a manner that the 9 5/8" casing shoe is at about 575 meters, much below the ground water.
- ❖ EOGEPL has taken utmost care and all precautions while planning for its drilling operations In forested areas which come under the shallow, intermediate and deep coal seam areas, much below the groundwater.
- ❖ There is also a naturally occurring thick impermeable layer of (clay and shale) in between the target seams and water table, besides the lowered of 95/8" steel casing and this too will prevent



any channel or connection between the two. Because of these precautions SWID has already approved the production operation of EOG EPL, as these operations shall not contaminate or hamper the groundwater resource.

- ❖ Finally, the produced CBM water from wells are treated at facilities and the processed water is further disposed as per law of land. EOG EPL has started production since 2010 and has already ~350 wells in the non-forest land for last 10 years without impacting the groundwater and the same standards are expected for the forest land too.



(Dr James Peters)
JP Consultants

1. Introduction

Essar Oil and Gas Exploration & Production Ltd. (EOGEPL) has a 100% participating interest in the Raniganj block, RG (East)-CBM-2001/1 awarded to it under the CBM-I round of bid by the Ministry of Petroleum and Natural Gas (MoPNG), Government of India. The CBM Contract with the Government was signed on 26th July 2002. The Petroleum Exploration License (PEL) was granted on 29th March 2005 from The West Bengal Government. The block is located in the southeastern part of the Raniganj Coal Field and measures 500 Km² (Fig.-1).

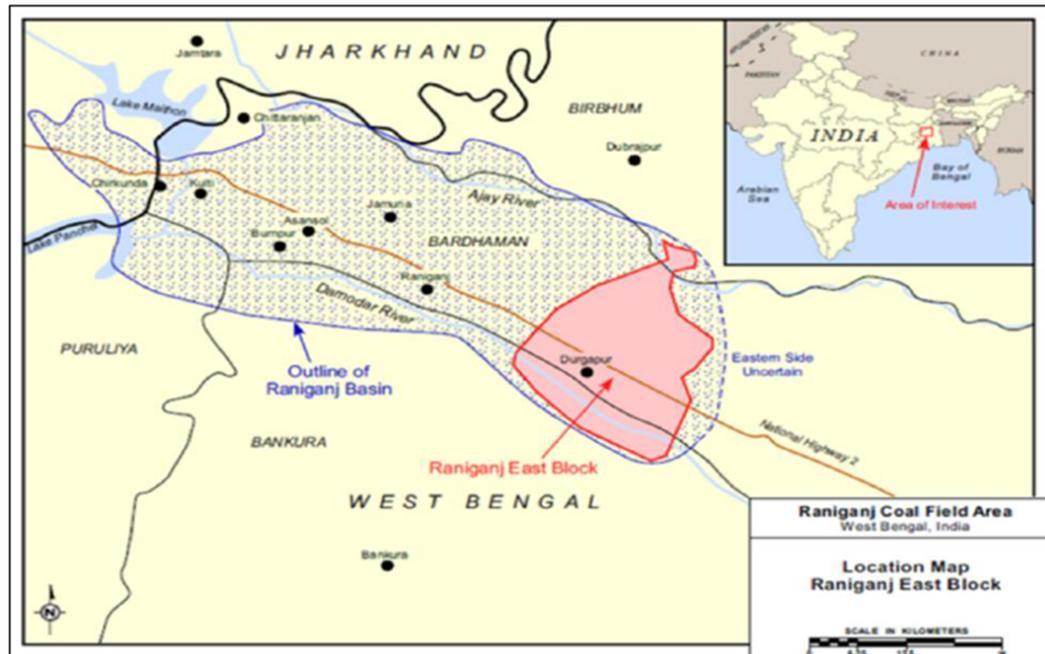


Figure 1 Location of the Block RG (East)-CBM-2001/1

EOGEPL (Essar Oil and Gas Exploration and Production Limited) is one of the largest E&P companies in India primarily focused in the domain of Unconventional Hydrocarbons (UHC) having a resource base of 12 TCF (Trillion Cubic Feet) CBM and shale gas resources. EOGEPL has so far invested in around ₹5,000 Crores in exploration to commercial development of the Raniganj CBM Block. The company is a pioneer of Unconventional HC in India with about 25 years of experience in E&P of CBM. EOGEPL is the only E&P player in India to produce over 80 BCF CBM till date. As on date the project is commissioned with 348 wells and a state-of-art indigenous infrastructure facility.

Coal bed Methane (CBM) is predominantly methane (95-98%) which is inherently generated during the coalification process. This gas occurs as adsorbed gas on the coal surface and when commercially produced it can be ultimately used as fuel for power plant, feed stock for fertilizer, petrochemical plants and other industries, CBM can be piped for domestic and industrial supplies, CBM can also be used as transportation fuel in the form of CNG

Coal bed methane production involves the production of methane gas from coal seams. These coal seams typically contain fresh to brackish water. Water contained in the coal seam must be pumped out to depressurize the well to release the methane that is adsorbed within the coal (Figure-2). This pumped water is called as 'Produced Water'. A series of production wells are drilled into the coal so that produced water can be pumped to surface to reduce the hydrostatic pressure in the coal seam for the adsorbed gas to be released.

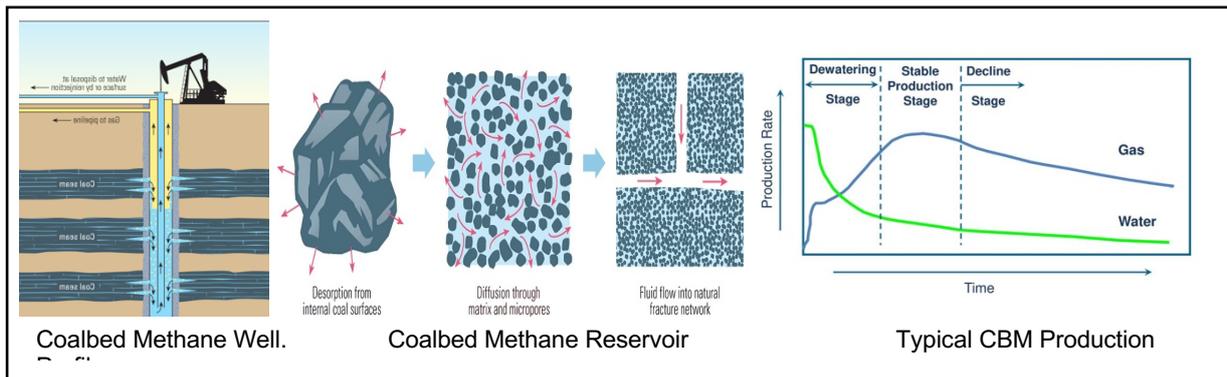


Figure 2: Production of CBM wells & Wells Characteristics

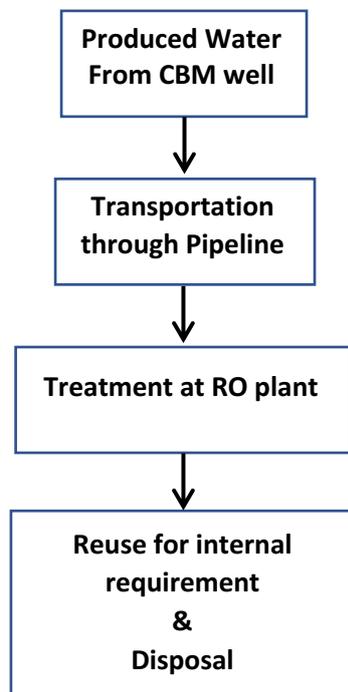
Water production from CBM wells typically starts at a high volume, but normally falls dramatically over time as the coal seam becomes depressurized. Once the fluid pressure is lowered in the coal seam, methane gas is released and available for production through the wells. Water produced from CBM wells can vary in quality with Total Dissolved Solids (TDS) concentration (between 1000 ~ 6000 ppm). This water needs to be treated through Reverse Osmosis (RO) for lowering of TDS before discharge.

The Raniganj CBM Block presently has 348 wells. The water produced from individual gas producing wells shall be conveyed to the nearest feasible water collection tank in the area where Reverse Osmosis plants are installed and/or planned to reduce TDS. As a part of total Water Management Plan, systems consisting of Zink-Aluminum tanks and pumps are being installed and commissioned at well pads to pump produced water to treatment facility via pipeline network.

2. Management of Produced Water

Initial Production of CBM is associated with evacuation of large quantity of connate water to reduce hydrostatic pressure on coal seams. Produced water quality and quantity vary widely, and it is necessary to manage the quality of this water through a combination of treatment before storage, disposal, and use. CBM wells produce large volume of water early in their life, which declines with time. Usually, CBM-produced water is discharged/stored into lined ponds/Storage Tanks for further process. Management of CBM-produced water has challenges. CBM related produced water can be beneficially used but only after treatment to reduce their salinity.

A typical flow-chart for managing the produced water within environmental permissible limits is given below:



3. Statutory Environmental Compliance for Produced Water

- As per **Oil Drilling and Gas Extraction Industry Standards** (no 72) and **Environmental (Protection) Rule 1986** states that the **Total Dissolve Solid should not exceed 2100 mg/l** which is the major yardstick for CBM related produced water and therefore need to be complied with.
- **Environmental Clearance:** As per Clause no: 3.0 of Environment Clearance No: F. No. J - 11011/491/2011 – IA II (I) Dated 26th February 2013 and Amendment & Extension of Validity Dated 9th May 2019, defines that a production well “will be generated around 50 m³/day which requires to be treated through reverse osmosis (RO) before utilizing for agriculture and other domestic purpose”
 - ✓ EOGPEL treated the produced water through Reverse Osmosis (RO) for lowering of TDS less than 1000 mg/l before discharge.
- **General Condition clause B (xi) of Environmental Clearance** “The project proponent shall also submit six monthly reports on the status of the compliance of the stipulated environmental conditions including results of monitored data (both in hard copies as well as by e-mail) to the Regional Office of MOEF, the respective Zonal Office CPCB and the WBPCB. The Regional Office of this Ministry / CPCB/ WBPCB shall monitor the stipulated conditions.”
 - ✓ EOGPEL complies with the above by submitting six monthly reports on the status of the compliance of the produced water management including results of monitored data (both in hard copies as well as by e-mail) to the Regional Office of MOEF, the respective Zonal Office CPCB and the WBPCB. Daily In-house-monitoring and also monitoring through 3rd party NABL accredited laboratory on monthly basis.

3.1 Current Scenario:

EOGPEL CBM Raniganj Block presently has 348 wells and water is produced @7500 m³/ day. Total Dissolved Solids (TDS) concentration for produced water varies between 1000 ~ 6,000 ppm. **Total treatment capacity of the water treatment plant is 8100 m³/ day installed in the location below** and as shown in Figure-3

Sl. No.	Location	Treatment Capacity(m ³ /day)
1	GGs-1	1400
2	EDD-50	1400
3	EDN-99	1300
4	EDH-64	4000



Figure-3. Central Integrated Water Treatment Plant

As per existing system, the additional produced water shall be stored in storage tank at well pad and pumped into the underground PE (Polyethylene) water pipeline (laid along the road) network for further transportation to treatment facility. The treatment facility shall be enhanced according to the additional produced water from planned new wells to be drilled.

3.2 Planning for produced water treatment of proposed 54 CBM wells of 16 Well pads

Additional 2,700 m³/day of produce water will be expected from proposed additional 54 wells in forest area, considering 50 m³/day/well.

- The water produced from the well head will be directly pump to the pipeline network or storage tank which shall be installed on the basis of the water pressure of the well and distance of the well pad from nearest RO plant.
- The proposed well locations in the forest shall be integrated within existing water network and treatment plant.
- Around 12.5 Km pipeline with 4' diameter will be laid to transport the produced water along the proposed approach road and pipeline of the proposed Forest well pad.
- Those proposed pipeline shall be interconnected with the existing water pipeline network.

- No water will be discharge out from the proposed CBM well in Forest land, Hence, maintaining a Zero discharge.
- The capacity of the treatment plant shall be enhanced by 2500 m³/day to cater the additional water from proposed wells.
- Online pressure monitoring instrument to be installed at the water headed of the pipeline network to monitoring of the water pressure of the pipeline to check any leakage, chocking, damage etc., and if required immediately control measures to be taken by dedicated water pipeline maintenance team.
- In the event of any emergency the water produced will be transported through Tanker to the RO plant from Well site to the water Storage tank.

4. Details of Water Treatment Facilities

4.1 Produced Water Storage at each Well Pad

Presently the produced water evacuated from the well is routed through the surface facility where the gas & water is separated and sent to the separate networks respectively. Water is stored in storage tank and pumped into the underground water network for transportation to treatment facility (Figure-4).



Figure-4 Water Storage & Pumping System at Well Pad

4.2 Transportation of Produced Water

Produced water is transported through underground PE pipeline network from each well pad to treatment facility for further treatment/ process. The line pressure is maintained through pumping from well sites.

4.3 Collection / Treatment of Produced water

Water is collected into raw water pit at treatment facility. The facility location has four pit/storage for raw water, treated water, intermediate storage and reject water separately. All the pits have proper pumping arrangement for the specific purpose of treatment/disposal.

5. Treatment Process

5.1 Reverse Osmosis & Two Stage Treatment

The produced water is high on dissolved solids content (water analysis report attached). It must be desalinated to bring salts content to acceptable levels for disposal. The technology used is the Reverse Osmosis process. Water is passed through Fiber glass thin film composite membranes with pore size of 0.0001 micron at high pressure. The process removes 95-99% of dissolved ions. Salts left behind in the permeate (purified water) are well within the acceptable levels for most disposal systems including WBPCB norms for disposal of various categories. The produced water passes through the pre filtration unit followed by the micron cartridge filter and next the water passes through a high-pressure pump to RO membranes. The water is treated in 2 stage to reduce the TDS before discharge (Figure-5).

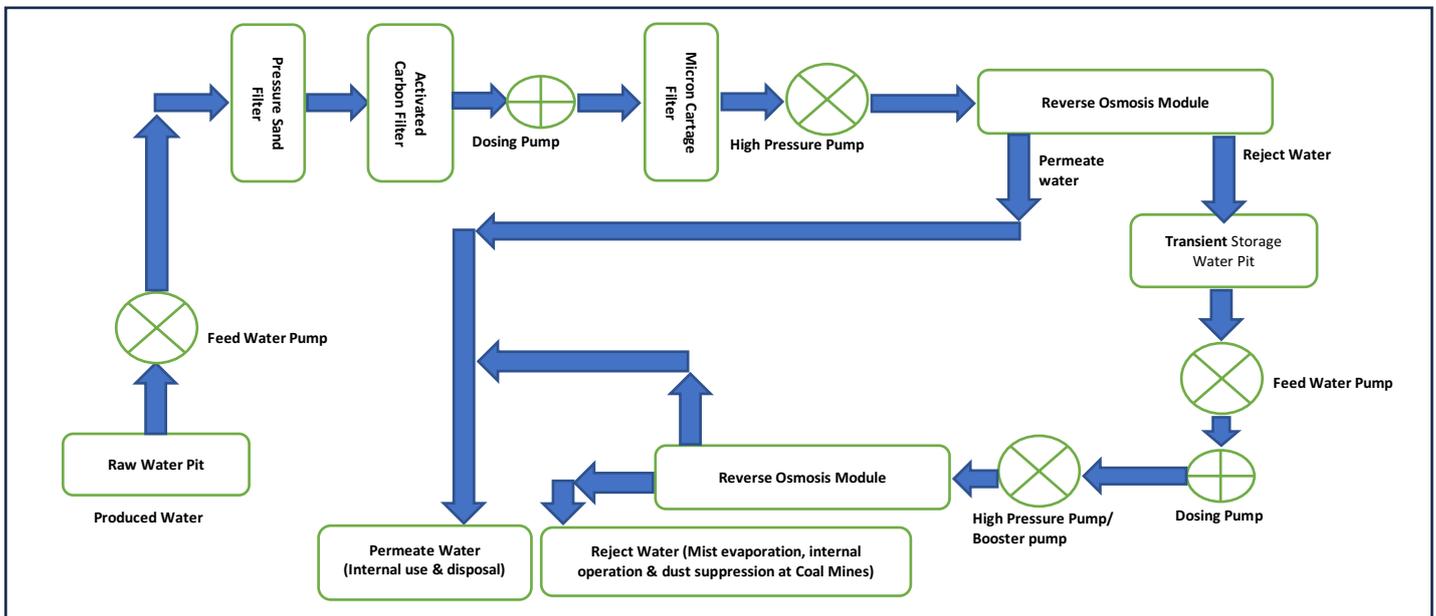


Figure-5 Two Stage Water Treatment of Produced Water

5.2 Dolomite Dosing:

Dolomite dosing, after subjecting the water to RO is used in the permeate water to reduce the Sodium Absorption Ratio (SAR) value before discharge the surface drainage (Figure-6).

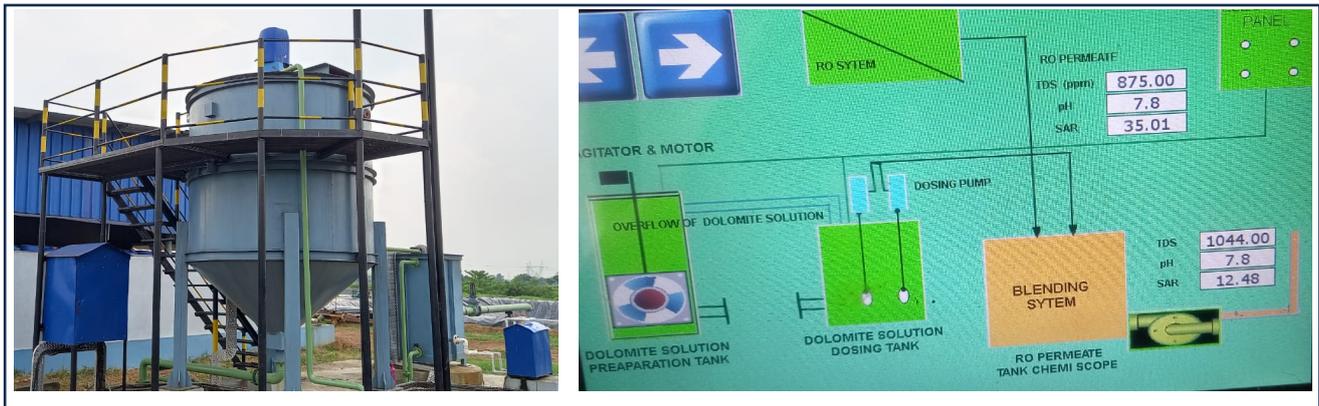


Figure-6 Dolomite Dosing System

5.3 Water Sampling and Monitoring

Regular monitoring through Online TDS, pH and Conductivity meter and monthly Sampling carried out through NABL accredited Laboratory (Figure-7).



Figure-7 Online Monitoring System

6. Protection of Ground Water Resources

Resources such as water have become more critical and valuable to a company's operations and local population than previously assumed. It is a key business risk that needs to be managed effectively. As far as possible, EOGEP L designs and runs its operations in ways that help reduce water use.

EOGEP L takes utmost care not to contaminate the ground water because of operations. This is ensured through design as well as regular monitoring (report attached). Contamination of ground water is contained by the fact that the targeted seams of Raniganj Formation for production of CBM are either

1. In the shallower part of the block, which occur at a depth of <1000m,
2. In the intermediate the coal occurrence is between 1000m to <1400m.
3. Or in the deeper area, coal seams are at a depth of >1400m.

While the Ground Water aquifers/ water table is normally at a depth of only 50-100 meters. The separation of the ground water table and shallowest coal seam area is > 600 meters. Besides this large separation, the wells are cased in a manner that the 9 5/8" casing shoe is at about 575 meters.

(Figure-8A & 8B)

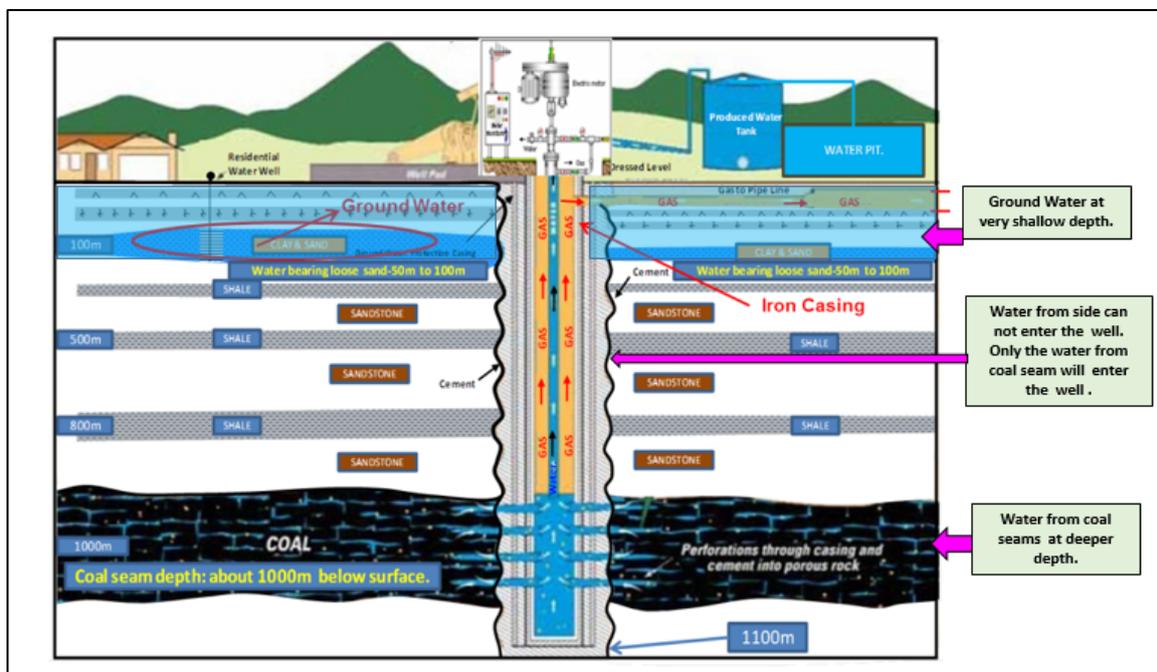


Figure 8A Generalized Schematic diagram Showing Separation of Target Coal Seam with Water Table

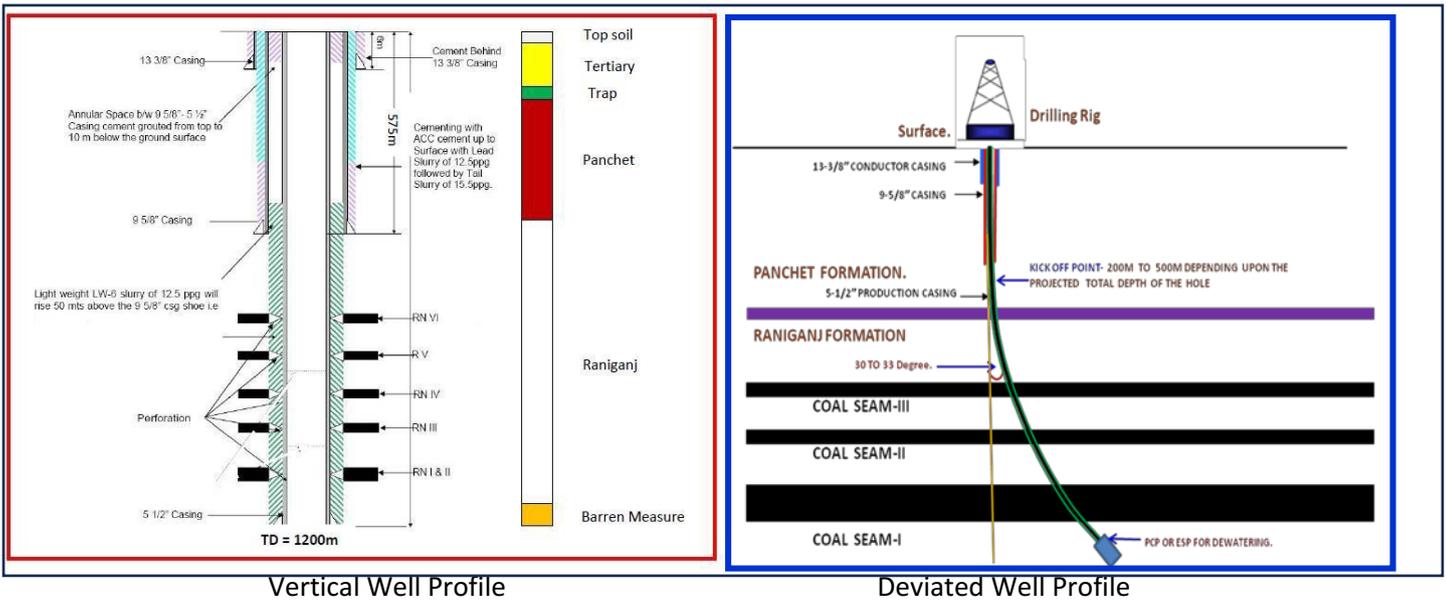


Figure-8B. Separation of Target Coal from Water Table in shallow area, with well profiles in Block RG (East)-CBM-2001/1

EOGEPL has taken care and all precautions while planning for its drilling operations In forested areas which come under the shallow, intermediate and deep coal seam area (Figure-9)

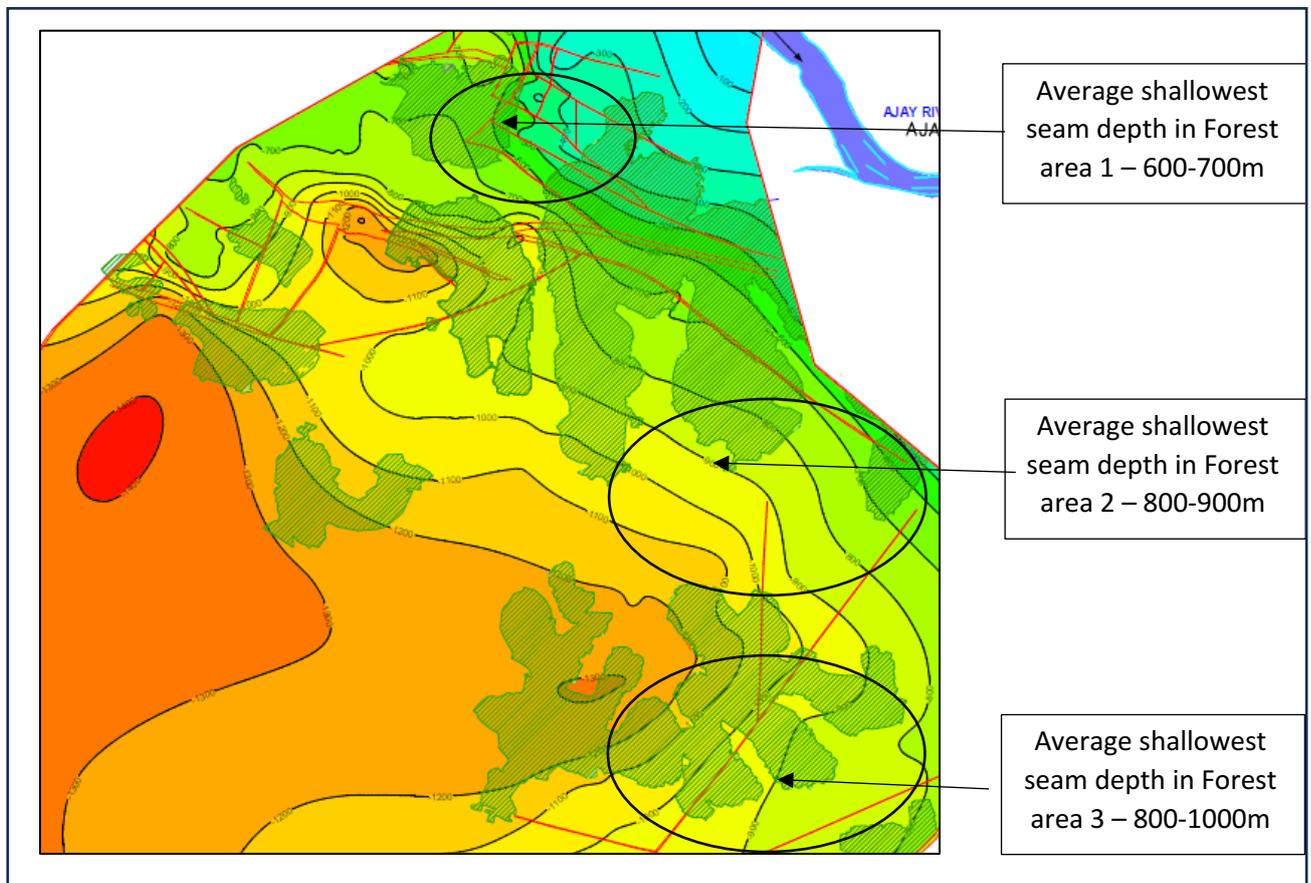


Figure 9: Shallowest Coal Seam Floor Depth

There is also a naturally occurring thick impermeable layer of (clay and shale) in between the target seams and water table, besides the lowered of 95/8" steel casing and will prevent any channel or connection between the two. Because of these precautions SWID has already approved the production operation of EOGEP, as these operations shall not contaminate or hamper the groundwater resource. Finally, the produced CBM water from wells are treated at facilities and the processed water is further disposed as per law of land.

EOGEP has started production since 2010 and has already ~350 producing wells in the non-forest land for last 10 years without impacting the groundwater and the same is expected for the forest land too.