Water Quality Analysis of Village and Monitoring Well around Rembang Steam Power Plant (EIA in Central Java, Indonesia)

Sunik[1*], Very Dermawan[2]

Civil Engineering Department, Widya Karya Catholic University,East Java, Indonesia, www.widyakarya.ac.id,

Water Resources Engineering Department. Brawijaya University,East Java, Indonesia, http://pengairan.ub.ac.id, veryderma@yahoo.com[2]

[*]Corresponding author:sunik146@gmail.com

***Abstract*— Water quality sampling and monitoring of village well as a regular monitoring each quarter in a year for Rembang Steam Power Plant 2 x 315 MW was one part of EIA implementation study. This research aim to analysis the most impact occurrence that forecasted as a hypothetical important impact which is cause environmental change base on water quality sampling and monitoring from operational activity in first quarter (TW 1). Implementation method was used water sampling in 2(two) resident well and 6 (six) monitoring well in Trahan and Leran village, then the water sample was analyze in laboratory refer to the raw quality which has been set. The monitoring result on the residents wells quality was generally known that in the Trahan village residents wells (AB-1) found parameter that exceed quality standard i.e. total dissolved solids (TDS, come from river seepage and rainfall runoff), Chloride and Hardness,the high concentration some parameters, both exceed the quality standard as well as have a high critical level, generally was not caused by the operational activities of Rembang Steam Power Plant. Monitoring result from 6 (six) monitoring wells in location of Rembang Steam Power Plant was found parameters in several point that exceed the quality standard i.e. Turbidity in AB-3, organic chemical substance (KmnO4) in AB-3 and AB-7, TDS in AB-3 (monitoring wells 1), AB-4 (monitoring wells 2), AB-5 (monitoring wells 3) and AB-7 (monitoring well 5), and AB-8 (monitoring wells 6). While the content of heavy metals that detected include arsenic, cadmium, lead, and selenium on AB-3.**

Keywords—water quality sampling, village well and monitoring well, impact, hypothetical important impact

I. INTRODUCTION

Electrical energy has a fundamental role in supporting the development of a region, in term of supporting a wide range of activities in accordance with the functions and roles of the region. Electrical energy is generally used for fulfillment needs of residental, public and social facilities (educations, healths, worships, recreations, etc), industry in a variety of scale, trade and service, and system and infrastucture areas. It can be said that the level of electrical energy sevice in a region will determine the level of development of the region. It mean that if the electrical energy requirements needs can be fulfilled, in term of the capacity and the distribution, the activities in a region which has high level of complexity can run well and fast which later affect the development of the region.

The construction purpose of Rembang Steam Power Plant 2 x 315 MW was to fulfill the needs of electrical energy for various interest of constructions, especially for Java, Madura, and Bali. Rembang Steam Power Plant 2 x 315 MW is an implementation of goverment programs in the intensification, diversication and energy conversion. In this case, the coal potential utility in Indonesia as the source of energy and reduce the dependence on petroleum. Various effects that cause by change enabling environment of Rembang Steam Power Plant 2 x 315 MW activities operasional must be studied and analyzed comprehensive, accurate and precise to anticipate management and monitoring of environment impacts, so the impact which is predicted to arise can be prvented or minimalized earlier. Rembang Steam Power Plant 2 x 315 MW located in the Leran village and Trahan Village; subdistrict Sluke; Rembang district; Central Java Province. Power plant site was located on the North coast of Java Island, located approximately ± 130 km to the East of Semarang city or more precisely at coordinates 6 ° 30 '- 7 ° 00' South latitude and 110 ° 00 '- 111 ° 30' East longitude.

Figure 1. Layout of Rembang Steam Power Plant 2 x 315 MW

Implementation of Environmental Management and Monitoring for Rembang Steam Power Plant 2 x 315 MW First Quarter 2014 held on Month January-March

2014 as regular monitoring agenda which is includes environmental quality sampling (water quality).

II. METHOD

Research was carried out in Trahan village and Leran village. Water sampling was done in 2 (two) resident well and 6 (six) monitoring well then the water sample was analyze in water quality laboratory (PJT 1 laboratory) refer to the raw quality which has been set.

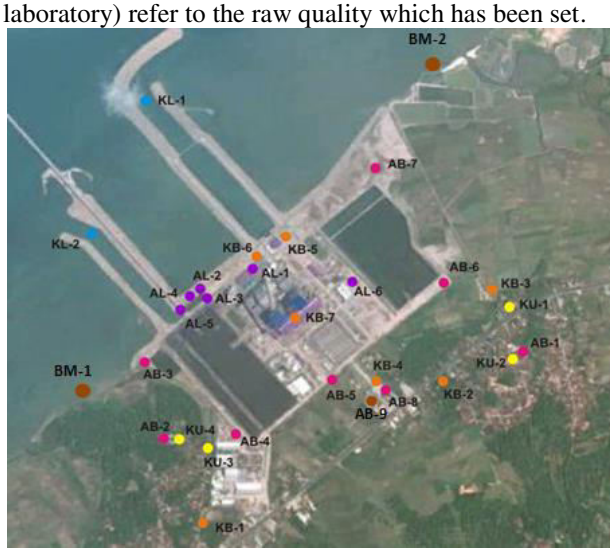


Figure 2. Water sampling for resident and monitoring well in Leran and Trahan village (AB-1 until AB-8)

The method to know water quality decrease was used Implementation (Environmental Management Implementation and Environmental Monitoring Implementation) and Evaluation as follow:

A. *Implementation*

1. Environmental Management Implementation :

(1) Types of managed impact
Types of managed impacts were decreased of water quality (village's wells) and groundwater quality in monitoring wells that caused by Rembang Steam Power Plant 2 x 315 MW operational caused by activities of coal and coal ash storage.

(2) Source of impact
Sources of decreased impact of groundwater quality is the overall activity or activities in operation stage. Activities operation which is give potentially impact of groundwater decreased quality was the activity of hoarding coal and coal ash. It was feared coal leachate seep into the ground so that contaminate village's wells.

(3) Management action
Management action for decrease impact of groundwater quality that has done was the stockpiling of coal at a designated place (coal stock pile and ash pond) which had been coated with geo-membrane and geo-textiles and prevent spills coal off-site from coal stock pile and manufacture leachate drainage which will flow into the coal run-off pond to prevent seepage of leachate coal.

(4) Quality standard reference
Quality standard reference for decreased impact of water quality (village's wells) are standard of surface water quality that refers to the Minister of Health number 416/MEN.KES/PER/IX/1990 about conditions and water quality monitoring.

(5) Management location
Management location for decrease impact of groundwater quality was implemented in Coal Stock Pile area and the area nearby Rembang Steam Power Plant 2 x 315 MW.

(6) Management schedule
Management schedule for decreased impact of groundwater quality was implemented during the operation of generator system for Rembang Steam Power Plant 2 x 315 MW.

2. Environmental Monitoring Implementation

(1) Types of impact monitored
Types of impacts monitored was ground water quality decrease (residents wells and monitoring wells) caused by operational of Rembang Steam Power Plant 2 x 315 MW.

(2) Source of impact
Sources impact of ground water quality decrease (resident wells and monitoring wells) is the overall activity or activities in the operation phase.

Operating activities which potentially impact the groundwater quality deterioration is hoarding of coal and of coal ash. To ascertain whether the condition of the ground water quality has decreased then the water quality monitoring is carried out at several points.

(3) Monitoring location

Monitoring location for decreased impact of water quality (wells) performed at some monitoring points as the table below.

Table 1. Monitoring locations of water quality (water in residents wells and in monitoring wells)

No	Code	Location	Coordinate	Information
1	AB-1	Bp. Kasan's well, Trahan village	BT 111° 28' 53,5" LS 06° 38' 14,5"	Clean Water owned by local residents
2	AB-2	Jami' Baiturahim Mosque well, Leran village	BT 111° 28' 19,0" LS 06° 38' 24,2"	Clean Water owned by local residents
3	AB-3	Monitoring Well 1	BT 111° 28' 15,14" LS 06° 38' 24,2"	Clean water inside Steam Power Plant
4	AB-4	Monitoring Well 2	BT 111° 28' 25,97" LS 06° 38' 23,46"	Clean water inside Steam Power Plant
5	AB-5	Monitoring Well 3	BT 111° 28' 35,02" LS 06° 38' 17,36"	Clean water inside Steam Power Plant
6	AB-6	Monitoring Well 4	BT 111° 28' 46,91" LS 06° 38' 07,74"	Clean water inside Steam Power Plant
7	AB-7	Monitoring Well 5	BT 111° 28' 40,11" LS 06° 38' 55,43"	Clean water inside Steam Power Plant
8	AB-8	Monitoring Well 6	BT 111° 28' 40,45" LS 06° 38' 18,23"	Clean water inside Steam Power Plant

Sources : RKL-RPL dan IPLC

(4) Environmental parameters monitored

Environmental parameters that monitored were physical parameters, chemistry, and biology that refers to the Minister of Health number 416/MEN.KES/PER/IX/1990 about conditions and water quality monitoring.

(5) Monitoring methods

Method of data collection through field observation by sampling water quality (water wells) which then analyzed in the laboratory that has been accredited nationally. Analysis of the data by using the ratio of the required quality standards.

B. *Evaluation*

Evaluation stage consist of trend evaluation and critical level evaluation described in chapter III (result and discussion)

III. RESULTS AND DISCUSSION

A. *Result*

Results of water quality monitoring (resident wells and monitoring wells) at each monitoring location in detail can be seen in the table below:

Table 2. Results of Water Quality Monitoring (Residents Well)

No	Parameter	Unit	Quality Standart	Monitoring Result	
				AB-1	AB-2
1	Temperature	°C	± 3°C	25,0	25,5
2	Field pH	-	6,5 - 9,0	7,4	8,0
3	Turbidity	NTU	25	0,39	0,31
4	Odor	-	Odorless	Odorless	Odorless
5	Taste	-	Tasteless	Tasteless	Tasteless
6	Organic substances (KMnO4)	mg/l	10	3,1	2,1
7	Total Suspended Solids (TSS)	mg/l	-	27,9	13,8
8	Total Dissolved Solids (TDS)	mg/l	1500	2203	1333
9	Fluoride	mg/l	1,5	0,282	0,226
10	Chloride	mg/	600	695	400
11	Nitrate as N	mg/l	10	2,038	1,157
12	Sulfate	mg/l	400	199,6	0,261
13	Hardness as $CaCO_3$	mg/l	500	385	396
14	Nitrite as N	mg/l	1,0	0,030	0,015
15	Detergen	mg/l	0,5	0,054	0,039
16	Cyanide	mg/l	0,1	Tt	Tt
17	Oils and fats	mg/l	-	< 1,9	< 1,9
18	Color	TCU	50	< 0,258	< 0,258
19	arsenic	mg/l	0,05	Tt	Tt
20	Cadmium	mg/l	0,005	Tt	Tt
21	Copper	mg/l	-	Tt	Tt
22	Total Chromium	mg/l	-	Tt	Tt
23	Iron	mg/	1	Tt	Tt
24	Mercury	mg/l	0,001	Tt	Tt
25	Manganese	mg/l	0,5	Tt	Tt
26	Lead	mg/l	0,05	Tt	Tt
27	Selenium	mg/l	0,01	Tt	Tt
28	Zinc	mg/l	15	Tt	< 0,0064

Information :

- *The quality standard in accordance with Ministry of Health Regulation number416/MEN.KES/PER/IX/1990 about condition and water quality monitoring*
- DL = Detection Limit

Table 3. Results of Water Quality Monitoring (Residents Well)

No	Parameter	Unit	Quality Standart	Monitoring Result					
				AB-3	AB-4	AB-5	AB-6	AB-7	AB-8
1	Temperature	°C	± 3°C	28,9	29,1	28,0	30,0	30,0	27,5
2	Field pH	-	6,5 - 9,0	7,5	7,3	7,5	7,7	7,4	7,4
3	Kekeruhan	NTU	25	8,64	1,32	3,38	37,5	3,68	4,47
4	Odor	-	Odorless	Odorless	Odorless	Odorless	Odorless	Smelling (scale 5)	Odorless
5	Taste	-	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless
6	Organic substances (KMnO4)	mg/l	10	24,5	2,3	4,1	6,1	6,1	1,8
7	TSS	mg/l	-	18,3	17,5	23,7	39,8	31,8	42,5
8	TDS	mg/l	1500	8927	521,0	2222	565,0	456,3	3063
9	Fluoride	mg/l	1,5	< 0,016	0,052	0,142	0,436	0,167	0,055
10	Chloride	mg/	600	4820	620	940	225	950	50,5
11	Nitrate as N	mg/l	10	1,278	0,921	0,692	1,064	1,283	1,039
12	Sulfate	mg/l	400	813,5	131,7	119,8	28,40	623,0	1131
13	Hardness as $CaCO_3$	mg/l	500	343	283	213	142	566	264
14	Nitrite as N	mg/l	1,0	0,001	0,014	0,004	0,010	0,518	0,198
15	Detergen	mg/l	0,5	0,092	0,034	0,039	0,062	0,038	0,039
16	Cyanide	mg/l	0,1	Tt	Tt	Tt	Tt	Tt	Tt
17	Oils and fats	mg/l	-	< 1,9	< 1,9	< 1,9	< 1,9	< 1,9	3,5
18	Color	TCU	50	0,513	0,279	< 0,258	< 0,258	0,978	0,266
19	Arsenic	mg/l	0,05	Tt	Tt	Tt	Tt	Tt	Tt
20	Cadmium	mg/l	0,005	Tt	Tt	Tt	Tt	Tt	Tt
21	Copper	mg/l	-	Tt	Tt	Tt	Tt	Tt	Tt
22	Total Chromium	mg/l	-	Tt	Tt	Tt	Tt	Tt	Tt
23	Iron	mg/	1	Tt	Tt	Tt	Tt	Tt	Tt
24	Mercury	mg/l	0,001	Tt	Tt	Tt	Tt	Tt	Tt
25	Manganese	mg/l	0,5	Tt	Tt	Tt	Tt	Tt	Tt
26	Lead	mg/l	0,05	Tt	Tt	Tt	Tt	Tt	Tt

Source : Primary Data Monitoring Results Water Quality PJT I Malan3.1 g, 2014

B. *Trend Evaluation*

Trend evaluation was shown in Table and Figure as follow.

Table 4. Changes in Water Quality (Villager's Well) in AB-1 (Mr. Kasan's Well,Trahan Village)

No	Parameter	Unit	Quality Standard	Detection Limit	Changes in Water Quality Monitoring (Villager's Well) in AB-1								
					TW-1 2012	TW-2 2012	TW-3 2012	TW-4 2012	TW-1 2013	TW-2 2013	TW-3 2013	TW-4 2013	TW-1 2014
1	pH	-	6,5 - 9,0	0,01	6,9	6,0	6,4	5,8	7	7,00	7,5	7,5	7,4
2	Temperature	°C	± 3°C	0,1	28	28	28	28	28,5	31,0	29,0	27,1	25,0
3	Nitrate	mg/l	10	0,0019	7,086	8,466	45,37	14,781	18,946	9,9796	7,3742	8,531	2,038
4	Nitrite	mg/l	1,0	0,0021	0,027	0,002	0,036	0,021	0,01	2,2078	0,0033	0,111	0,030

Source : Results of Analysis, 2014
Explanation:
- Quality standard based on Permenkes No. 419/MEN.KES/PER/IX/1990
- AB-1 = Mr. Kasan's Well, Trahan Village

Table 5. Changes in Water Quality (Inhabitant's Well) in AB-2 (The well of Jami' Baiturahim Mosque)

No	Parameter	Unit	Quality Standard	Detection Limit	Changes in Water Quality Monitoring (Villager's Well) in AB-2								
					TW-1 2012	TW-2 2012	TW-3 2012	TW-4 2012	TW-1 2013	TW-2 2013	TW-3 2013	TW-4 2013	TW-1 2014
1	pH	-	6,5 - 9,0	0,01	6,9	6,0	7,2	6,4	7	7,00	7,5	7,8	8,0
2	Temperature	°C	± 3°C	0,1	28	28	27	28	28	31,0	29,0	30,1	25,5
3	Nitrate	mg/l	10	0,0019	2,358	6,459	38,903	11,761	19,248	4,8811	7,4573	7,678	1,157
4	Nitrite	mg/l	1,0	0,0021	0,020	0,022	0,038	0,072	<0,0009	0,0328	0,0819	0,003	0,015

Source : Results of Analysis, 2014
Explanation
r. Quality standard based on Permenkes No.419/MEN.KES/PER/IX/1990
s. AB-2 = The well of Jami' Baiturahim Mosque, Leran Village

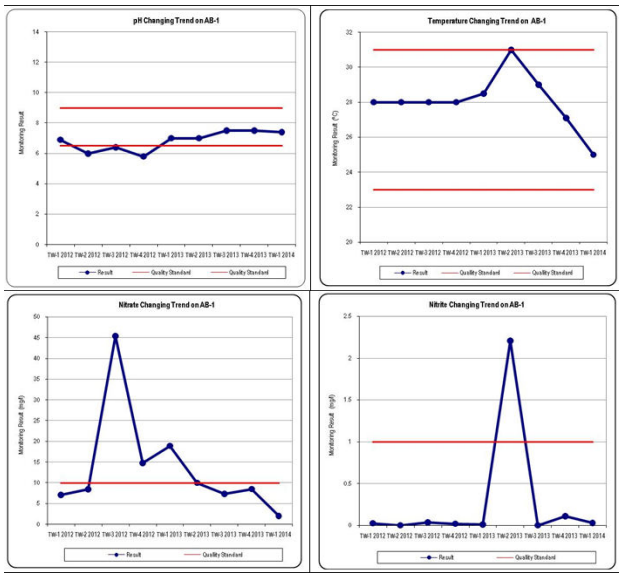


Figure 3. Diagram of Water Quality Change (resident's well) in AB-1

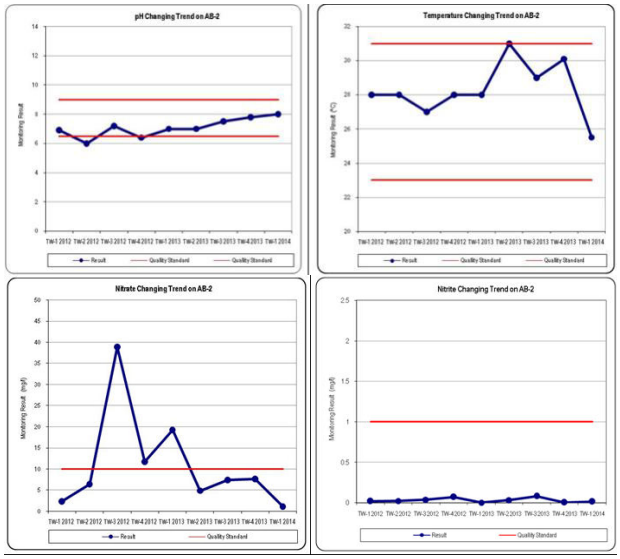


Figure 4. Diagram of Water Quality Change (resident's wells) in AB-2

Table 6. Recapitulation on statistical result of water quality change (resident's wells)

No	Parameter	Evaluation of Preference (Linear Regression)	
		AB-1	AB-2
1	Ph	Linear Regression Equation: y = 0.17x + 6.01 R^2 = 0.51 Which : y = pH x = time of measurement	Linear Regression Equation: y = 0.18x + 6.17 R^2 = 0.62 Which : y = pH x = time of measurement
2	Temperature	Linear Regression Equation: y = -0.16x + 28.88 R^2 = 0.08 Which : y = temperature x = time of measurement	Linear Regression Equation: y = 0.05x + 28.01 R^2 = 0.01 Which : y = temperature x = time of measurement
3	Nitrate	Linear Regression Equation: y = -1.680x + 22.018 R^2 = 0.128 Which : y = Nitrate x = time of measurement	Linear Regression Equation: y = -1.182x + 17.010 R^2 = 0.076 Which : y = Nitrate x = time of measurement
4	Nitrite	Linear Regression Equation: y = 0.041x + 0.067 R^2 = 0.024 Which : y = Nitrite x = time of measurement	Linear Regressions Equation: y = -0.000x + 0.034 R^2 = 0.002 Which : y = Nitrite x = time of measurement

Source: Result of Data Analysis, 2014

Explanation:

- AB-1 = Mr. Kasan's Well, Trahan Village
- AB-2 =Jami' Baiturahim Mosque's Well, Leran Village

Evaluation of Preference from some water quality parameter on monitoring well located in the Steam Power Plant is shown in tables and figures below.

Table 7. Water Quality Change (Monitoring Well) in AB-3/SP1

No	Parameter	Unit	Quality Standard	Detecting Limit	Monitoring Result				
					TW-4 2012	TW-2 2013	TW-3 2013	TW-4 2013	TW-1 2014
1	Dissolved Solid Substance	mg/l	1500	1	-	5170	8760	-	8927
2	Iron	mg/l	1	0,0037	-	< LD	0,0514	-	Tt
3	Manganese	mg/l	0,5	0,0491	-	2,9134	< LD	-	Tt
4	Nitrate as N	mg/l	10	0,0019	-	3,6434	3,9862	-	1,278
5	Nitrite as N	mg/l	1,0	0,0021	-	0,0064	< LD	-	0,001
6	pH	-	6,5 - 9	0,01	-	7,50	8,00	-	7,5

Source: Result of Data Analysis, 2014

Explanation:

- Quality Standard based on Permenkes No.416/MEN.KES/PER/IX/1990
- AB-3 = Monitoring Well 1 (Ground Water in the Steam Power Plant)
- LD = Detecting Limit

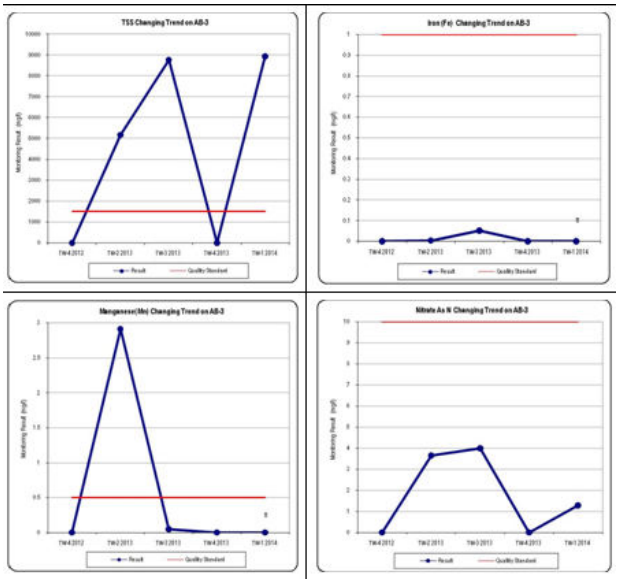


Figure 5. Diagram of water quality change (monitoring well) in AB-3

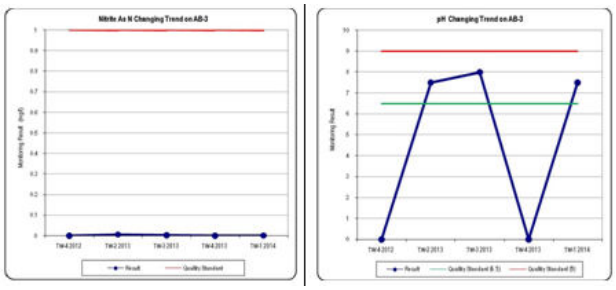


Figure 5. Diagram of water quality change (monitoring well) in AB-3 (continue)

Table 8. Water Quality Change (Monitoring well) in AB-4/SP2

No	Parameter	Unit	Quality Standard	Detecting Limit	Monitoring Result				
					TW-4 2012	TW-2 2013	TW-3 2013	TW-4 2013	TW-1 2014
1	Dissolved Solid Substance	mg/l	1500	1	38	1308	1082	2800	521
2	Iron	mg/l	1	0,0037	0,028	< LD	0,0179	<LD	Tt
3	Manganese	mg/l	0,5	0,0491	<0,010	0,0516	< LD	Tt	Tt
4	Nitrate as N	mg/l	10	0,0019	0,207	0,9062	0,9380	0.718	0,921
5	Nitrite as N	mg/l	1,0	0,0021	0,421	< LD	0,0023	<LD	0,014
6	pH	-	6,5 - 9	0,01	7,9	7,5	8,00	8.3	7,3

Source: Result of Data Analysis, 2014

Explanation:

- Quality Standard is based on Permenkes No.416/MEN.KES/PER/IX/1990
- AB-4 = Monitoring Well 2 (Ground Water in Steam Power Plant)
- LD = Detecting Limit

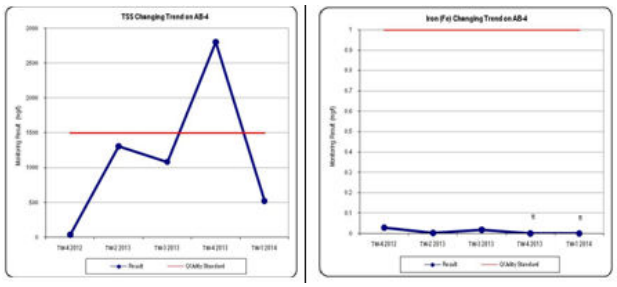


Figure 6. Diagram of water quality change (monitoring well) in AB-4

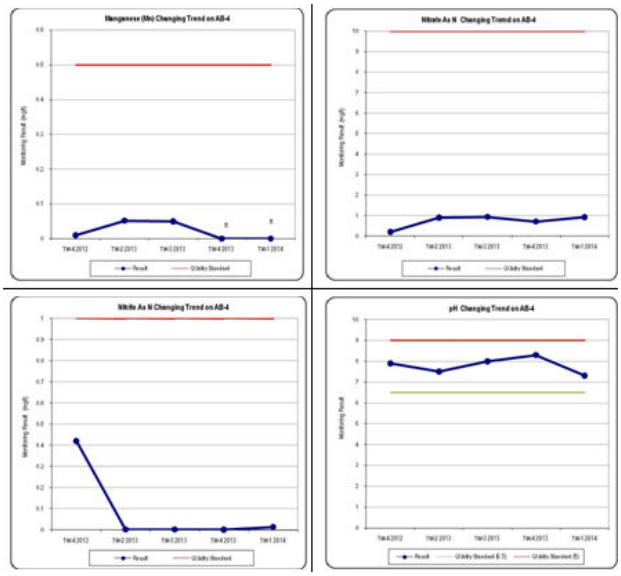


Figure 6. Diagram of water quality change (monitoring well) in AB-4 (continue)

Tabel 9. Water quality change (monitoring well) in AB-5/SP3

No	Parameter	Unit	Quality Standard	Detecting Limit	Monitoring Result				
					TW-4 2012	TW-2 2013	TW-3 2013	TW-4 2013	TW-1 2014
1	Dissolved Solid Substance	mg/l	1500	1	10	805	1495	1360	2222
2	Iron	mg/l	1	0,0037	<0,010	< LD	0,0167	0	Tt
3	Manganese	mg/l	0,5	0,0491	0,010	< LD	< LD	tt	Tt
4	Nitrate as N	mg/l	10	0,0019	3,040	2,7661	1,8484	2.664	0,692
5	Nitrite as N	mg/l	1,0	0,0021	0,062	0,0084	< LD	0.007	0,004
6	pH	-	6,5 - 9	0,01	8,5	7	7,5	7.2	7,5

Source: Result of Data Analysis, 2014

Explanation:

- Quality Standard is based on Permenkes No.416/MEN.KES/PER/IX/1990
- AB-5 = Monitoring Well 3 (Ground Water in Steam Power Plant)
- LD = Detecting Limit

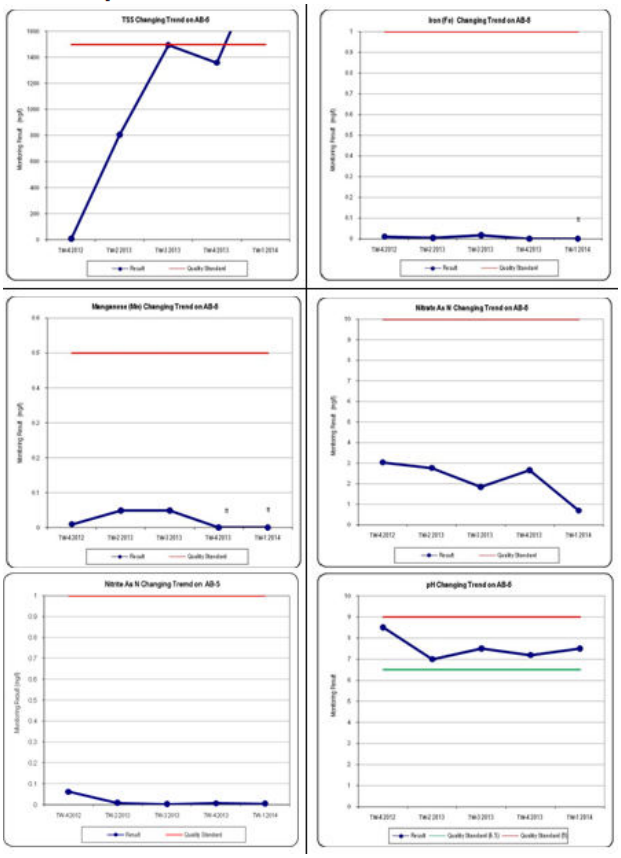


Figure 7. Diagram of water quality change (monitoring well) in AB-5

Tabel 10. Water quality change (monitoring well) in AB-6/SP4

No	Parameter	Unit	Quality Standard	Detecting Limit	Monitoring Result				
					TW-4 2012	TW-2 2013	TW-3 2013	TW-4 2013	TW-1 2014
1	Dissolved Solid Substance	mg/l	1500	1	124	973	1199	937.8	565
2	Iron	mg/l	1	0,0037	0,044	< LD	0,0171	0	Tt
3	Manganese	mg/l	0,5	0,0491	0,025	< LD	< LD	0	Tt
4	Nitrate as N	mg/l	10	0,0019	1,445	4,4345	2,8211	3.708	1,064
5	Nitrite as N	mg/l	1,0	0,0021	0,004	0,0118	< LD	0	0,010
6	pH	-	6,5 - 9	0,01	7,8	7	7	7.8	7,7

Source: Result of Data Analysis, 2014

Explanation:

- Quality Standard is based on Permenkes No.416/MEN.KES/PER/IX/1990
- AB-6 = Monitoring Well 4 (Ground Water in Steam Power Plant)
- LD = Detecting Limit

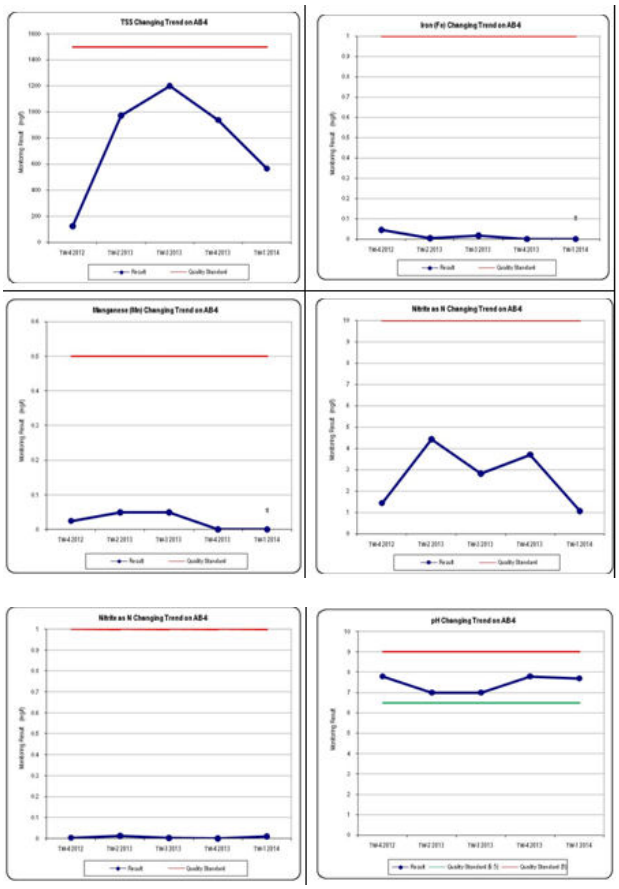


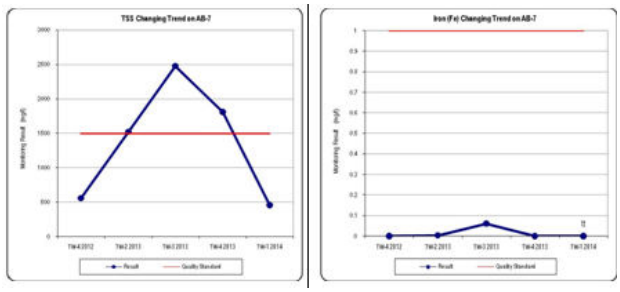
Figure 8. Diagram of Water Quality Change (Monitoring Well) in AB-6

Tabel 11. Water Quality Change (Monitoring Well) in AB-7/SP5

No	Parameter	Unit	Quality Standard	Detecting Limit	Monitoring Result				
					TW-4 2012	TW-2 2013	TW-3 2013	TW-4 2013	TW-1 2014
1	Dissolved Solid Substance	mg/l	1500	1	558	1523	2480	1811	456,3
2	Iron	mg/l	1	0,0037	<0,010	< LD	0,0610	0	Tt
3	Manganese	mg/l	0,5	0,0491	0,056	< LD	0,1216	tt	Tt
4	Nitrate as N	mg/l	10	0,0019	0,790	2,9448	2,3808	2.716	1,283
5	Nitrite as N	mg/l	1,0	0,0021	0,454	0,0048	0,0094	0.007	0,518
6	pH	-	6,5 - 9	0,01	7,5	7	7,5	7.9	7,4

Source: Result of Data Analysis, 2014
Explanation:

- Quality Standard is based on Permenkes No.416/MEN.KES/PER/IX/1990
- AB-7 = Monitoring Well 5 (Ground Water in Steam Power Plant)
- LD = Detecting Limit



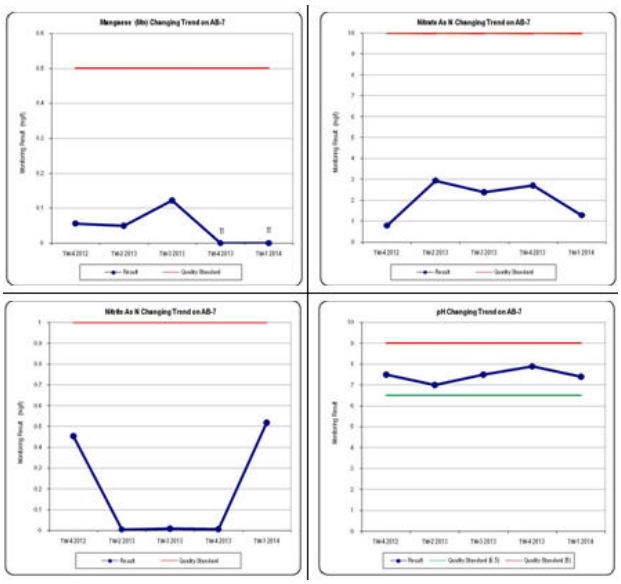


Figure 9. Diagram of water quality change (monitoring well) in AB-7

Table 12. Water quality changes (observation well) in AB-8/SP6

No	Parameter	Unit	Quality Standard	Detecting Limit	Monitoring Result				
					TW-4 2012	TW-2 2013	TW-3 2013	TW-4 2013	TW-1 2014
1	Dissolved Solid Substance	mg/l	1500	1	60	446	525	594.5	3053
2	Iron	mg/l	1	0,0037	0,039	<LD	0,0145	0	Tt
3	Manganese	mg/l	0,5	0,0491	0,012	<LD	< LD	0	Tt
4	Nitrate as N	mg/l	10	0,0019	0,500	1,2052	1,4894	3.73	1,039
5	Nitrite as N	mg/l	1,0	0,0021	0,003	<LD	< LD	0.013	0,198
6	pH	-	6,5 - 9	0,01	8,3	7	7,5	7.8	7,4

Source: Result of Data Analysis, 2014
Explanation:

- Quality Standard is based on Permenkes No.416/MEN.KES/PER/IX/1990
- AB-8 = Monitoring Well 6 (Ground Water in Steam Power Plant)
- LD = Detecting Limit

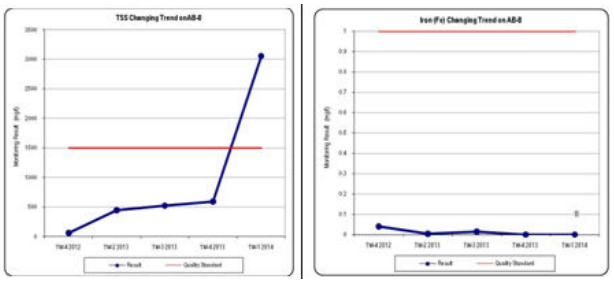


Figure 10. Diagram of water quality change (monitoring well) in AB-8

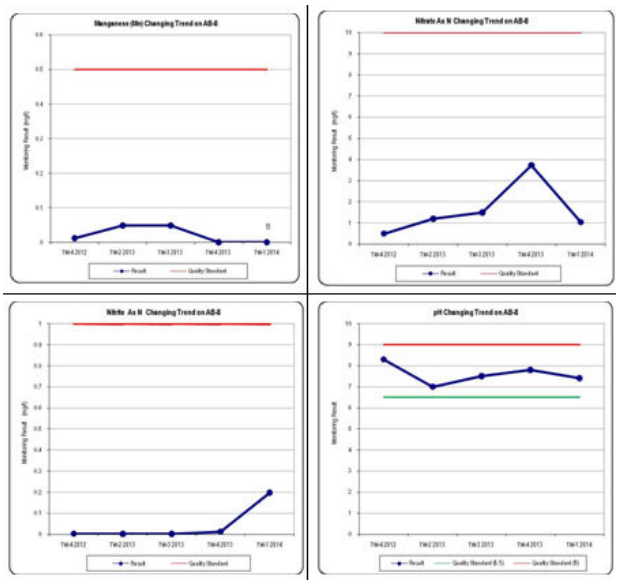


Figure 10. Diagram of water quality change (monitoring well) in AB-8 (continue)

C. *Critical Level Evaluation*

Parameter of critical level for water quality (resident's wells) in the location AB-1 and AB-2 in some parameters have high critical level and some have exceeded the critical point (above the quality standards). Likewise, water quality (monitoring well's water) in some locations (AB-3 to AB-8) in some parameters have high critical level and some has exceeded critical level (above the quality standards). The evaluation result of the critical level of water quality (people's wells and monitoring well) for some parameters in every location is presented in the following table.

Table 13. Percentage and category of Critical Water of Water's Quality (Soil Water) at AB-1, AB-2, AB-3, and AB-4

No	Parameter	AB-1		AB-2		AB-3		AB-4	
		%	Category	%	Category	%	Category	%	Category
1	Dissolved solid substance	146.87	> BML	88.87	High	595.13	> BML	34.73	Sedang
2	Turbidity	1.56	Low	1.24	Low	34.56	Medium	5.28	Low
3	Iron	2.05*	Low	2.05*	Low	2.05*	Low	2.05*	Low
4	Fluoride	18.80	Low	17.73	Low	1.07	Low	3.47	Low
5	Hardness	77.00	High	79.20	High	68.60	High	56.60	Medium
6	Chloride	115.83	> BML	66.67	Medium	803.33	> BML	103.33	> BML
7	Manganese	2.18*	Low	2.18*	Low	2.18*	Low	2.18*	Low
8	Nitrate as N	20.38	Low	11.57	Low	12.78	Low	9.21	Low
9	Nitrite as N	3.00	Low	1.50	Low	0.10	Low	1.40	Low
10	Zinc	0.04*	Low	0.04*	Low	0.04*	Low	0.04*	Low
11	Cyanide	1.00*	Low	1.00*	Low	1.00*	Low	1.00*	Low
12	Sulfate	49.90	Medium	0.07	Low	203.38	> BML	32.93	Low
13	Lead	8.80*	Low	8.80*	Low	8.80*	Low	8.80*	Low
14	Organic substance ($KmnO_4$)	31.00	Low	21.00	Low	245.00	> BML	23.00	Low
15	Detergent	10.80	Low	7.80	Low	18.40	Low	6.80	Low

Source : Result of Analysis, 2014
Explanation :
- * < LD (less than detection limit)
- AB-1 = Bp. Kasan's well, Ds. Trahan (people's clean water)
- AB-2 = Masjid Jami' Baiturahim's well, Ds. Leran (people's clean water)
- AB-3*) = Monitoring Well 1 Clean Water (In the PLTU's location), monitoring is done in dry condition
- AB-4 = Monitoring Well 2 Clean Water (In the PLTU's location)

Table 14. Percentage and Category of Critical Level of Water's Quality (Soil Water) at AB-5, AB-6, AB-7, and AB-8

No	Parameter	AB-5		AB-6		AB-7		AB-8	
		%	Category	%	Category	%	Category	%	Category
1	Dissolved solid substance	148.13	> BML	37.67	Medium	30.42	Low	203.53	> BML
2	Turbidity	13.52	Low	150.00	> BML	14.72	Low	17.88	Low
3	Iron	2.05*	Low	2.05*	Low	2.05*	Low	2.05*	Low
4	Fluoride	9.47	Low	29.07	Low	11.13	Low	3.67	Low
5	Hardness	42.60	Medium	28.40	Low	113.20	> BML	52.80	Medium
6	Chloride	156.67	> BML	37.50	Medium	158.33	> BML	8.42	Low
7	Manganese	2.18*	Low	2.18*	Low	2.18*	Low	2.18*	Low
8	Nitrate as N	6.92	Low	10.64	Low	12.83	Low	10.39	Low
9	Nitrite as N	0.40	Low	1.00	Low	51.80	Medium	19.80	Low
10	Zinc	0.04*	Low	0.04*	Low	0.04*	Low	0.04*	Low
11	Cyanide	1.00*	Low	1.00*	Low	1.00*	Low	1.00*	Low
12	Sulfate	29.95	Low	7.10	Low	155.75	> BML	282.75	> BML
13	Lead	8.80*	Low	8.80*	Low	8.80*	Low	8.80*	Low
14	Organic substance ($KmnO_4$)	41.00	Medium	61.00	Medium	61.00	Medium	18.00	Low
15	Detergent	7.80	Low	12.40	Low	7.60	Low	7.80	Low

Source : Result of Analysis, 2014
Explanation :
- * < LD (less than detection limit)
- AB-5 = Monitoring Well 3 Clean WAter (In the PLTU's location)
- AB-6 = Monitoring Well 4 Clean Water (In the PLTU's location)
- AB-7 = Monitoring Well 5 Clean Water (In the PLTU's location)
- AB-8 = Monitoring Well 6 Clean Water (In the PLTU's location)

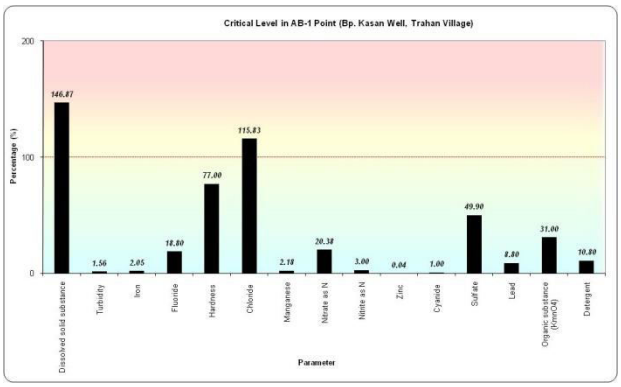


Figure 11. Graph of critical level for clean water quality at point AB-1 (Bp. Kasan's well, Trahan village for people's clean water)

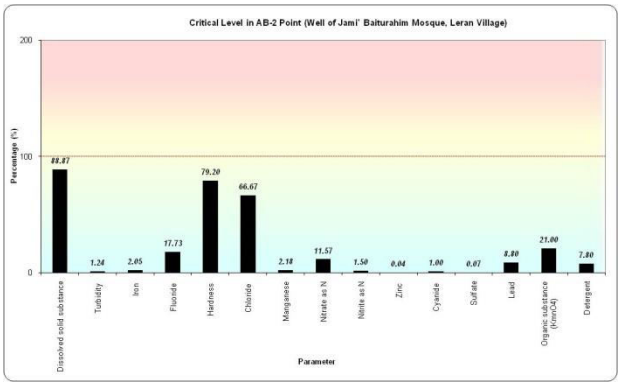


Figure 12. Graph of critical level for clean water quality at point AB-2 (Jami' Baiturahim's Mosque well, Leran village for people's clean water)

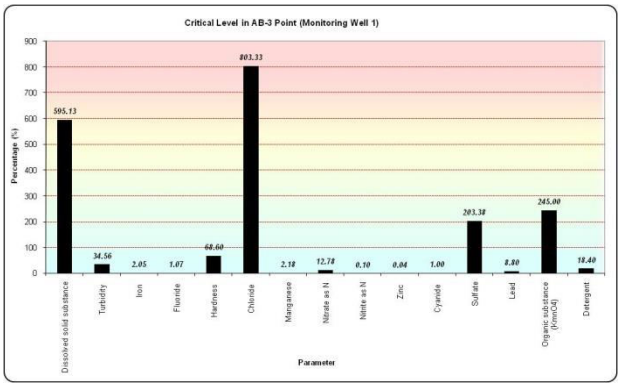


Figure 13. Graph of critical level of clean water quality at point AB-3 (monitoring well 1 of clean water in the Steam Power Plant location)

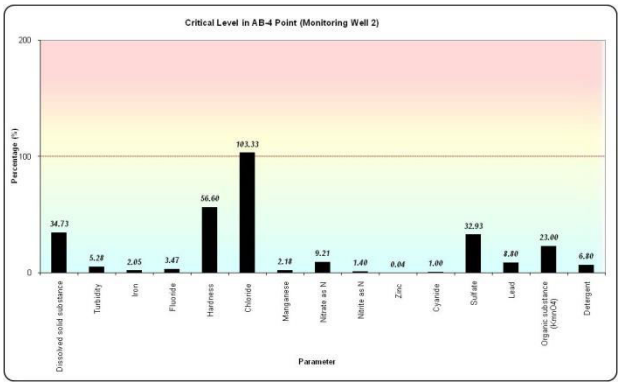


Figure 14. Graph of critical level of clean water quality at point AB-4 (monitoring well 2 of clean water in the Steam Power Plant location)

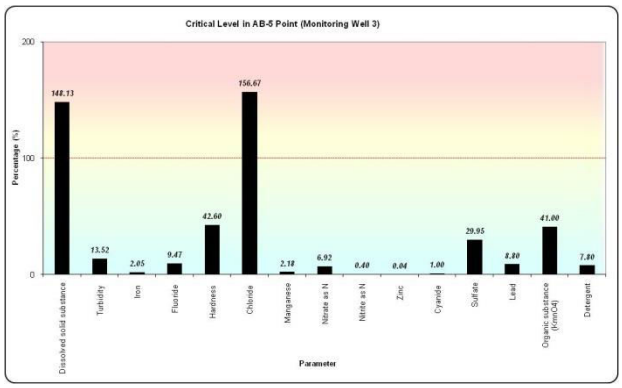


Figure 15. Graph of critical level for clean water quality at point AB-5 (monitoring well 3 of clean water in the Steam Power Plant location)

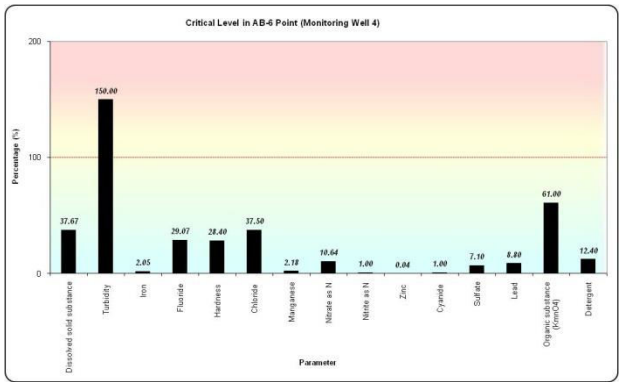


Figure 16. Graph of critical level for clean water quality at point AB-6 (monitoring well 4 of clean water in the Steam Power Plant location)

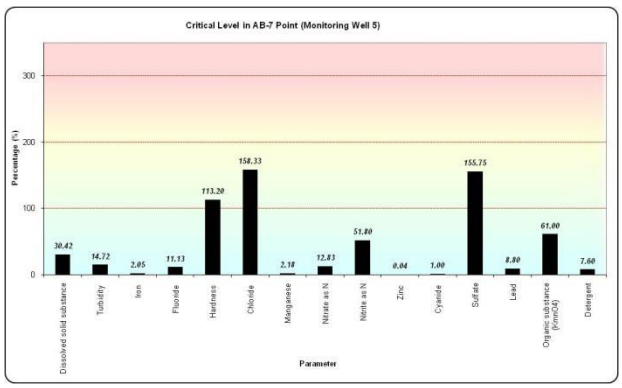


Figure 17. Graph of critical level forclean water quality at point AB-7 (monitoring well 5 of clean water in the Steam Power Plant location)

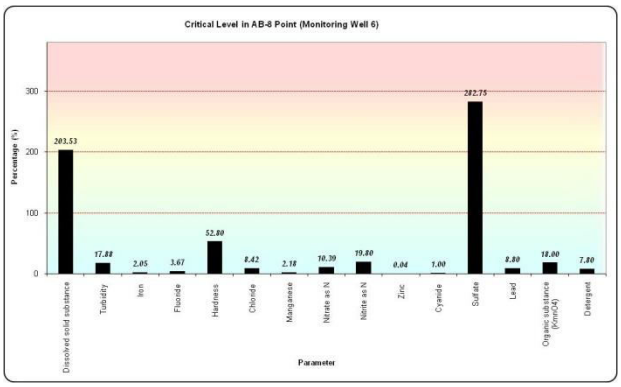


Figure 18. Graph of critical level for clean water quality at point AB-8 (monitoring well 6 of clean water in the Steam Power Plant location)

D. *Discussion*

Base on parameters of resident and monitoring well exceeding the quality standard, it can be described as follow:

1. Turbidity in AB-6
   The location with turbidity level above the standard was in AB-6 (monitoring well 4). The high turbidity was related with the high Total Dissolved Solid (TDS), which affected the water clarity level. Clean water was needed to produce human consumption and industrial needs. Water turbidity was caused by suspensed substance (organic and inorganic compounds), colored organic compound, plankton and microscopic organisms. These factors were predicted cause the high turbidity in AB-6.
2. Chemical organic substance ($KmnO_4$) in AB-3
   Organic content shows the bacteria content. High organic substances will increase microorganism population in the water. The organic substance is easily decomposed by the bacteria using dissolved oxygen. High organic substance showed that the water has been polluted by human or animal feces, or other causes. The higher the organic substances in the water, the more obvious the water has been polluted. High organic substance in AB-3 (monitoring well 1) possibly caused by the organic material which come in the monitoring well 1.
3. Total Dissolved Solid (TDS) in AB-1, AB-3, AB-5, and AB-8
   The monitoring location with TDS which exceeding the standard were in AB-1 (Trahan village's resident well), AB-3 (monitoring well 1), AB-5 (monitoring well 3), and AB-8 (monitoring well 6). The high concentration of TDS was caused by water intrusion from environmental activities around the locations. For AB-1, high TDS mainly predicted came from the river intrusion and rainwater runoff. AB-1 was located close to a small river, in the back of Mr. Kasan's house. For AB-3, AB- 5, and AB-8 (monitoring wells in Steam Power Plant), high TDS can be caused by the water infiltration from the rainwater runoff. High TDS can also indicate that the water is hard. The TDS level became high value if , water hardness became high too.
4. Chloride in AB-1, AB-3, AB-4, AB-5, and AB-7

Chlorine was often used in processing of clean water and water waste as disinfectant and oxidator. Besides, seawater also contains a lot of salt compound. The high concentration of chloride existing in AB-1 (well possessed by the society of Trahan village), AB-3 (monitoring well 1), AB-4 (monitoring well 2), AB-5 (monitoring well 3), and AB-7 (observation) which is located in seashore happened as there was an intrusion of seawater and the condition of land which formed from backfilled soil. It was also caused by sedimentation from seawater which made the amount of salt remaining was still high.

5. Sulphat in AB-3, AB-7, and AB-8
   The sulphat concentration which exceeding the quality standard were existed in AB-3 (monitoring well 1), AB-7 (monitoring well 5), and AB-8 (monitoring well 6). The high parameter of sulphat in several monitoring wells inside the area of Steam Power Plant was thought as effect of land condition around the area which came from sedimentation process of seawater and several part of it wasformed from backfilled soil, which made salt amount of remaining was still high.
6. The Hardness of $CaCO_3$ in AB-1 and AB-2
   The high level of hardness in AB-1 (well possessed by people of Trahan village) and AB-2 (well possessed by people of Leran village) was possible due to its local geology condition. The structure of rocks in that place was limestone, which could cause the level of water hardness become relatively high. Hardness also had close correlation with TDS, which made the higher the TDS, the higher the hardness. From the result of the observation done on TDS parameter in location of AB-1 and AB-2, it showed that the result had been high and above the limit of standard quality, which caused the hardness on those two locations had been above the limit of standard quality of clean water recommended.

Advanced Treatment

Some advanced treatment that is advisable to do for the pioneer (or become a responsibility of the pioneer):

1. Executing maintenance on the effect that is thought will influence the condition of ground water in the area of operational activity of PLTU Rembang, according to the guide of environment's management.

Environmental treatment which are advisable to do for the society:

1. Executing process of sedimentation using filtration for solid sedimentation dissolved to the water from well which has been cooked first to fulfill the need of clean water for drinking
2. Keeping the environment's cleanliness and sanitation, especially in providing clean water for drinking through the cooperation of Local Government.

Parameter with high critical level

1. The dissolved solid (TDS) in the AB-2
   The high critical level of dissolved solid for citizens' clean water in the AB-2 area (Baiturrahim mosque's well, Leran village), it is assumed because the water intrusion from the activities surrounding. The high TDS was predicted to happen because there is rain water intrusion which brings solid materials, such as soil.
2. The hardness in the AB-1, AB-2, and AB-3
   The high critical level of the hardness parameter in the AB-1 (Mr. Karsan's well, Trahan village), AB-2 (well of Baiturrahim mosque, Leran village), and AB-3 (monitoring well 1) was predicted cause by intrusion from sea water and soil condition which is contain the cretaceous rocks. The water hardness content of certain minerals in the water such as ion calcium (Ca), and magnesium (Mg) in the form of sulphuriccarbonate. Hard water can affect the segmentation of mineral which bung up the pipeline and spigot.

Prevention/Anticipation

1. Process of segmentation should be done through filtering, in order to sediment as dissolved solid of well water and boil the water before used in order to fill the needs of clean water.
2. Implement the procedure of Steam Power Plant based on the SOP.

IV. CONCLUSION

Base on description before, the conclusion is:

1. Water quality (residents' wells)
   The observation result on the residents' wells quality was generally known that in the Trahan village residents' wells (AB-1) and AB-2 (Leran village) exceeding parameters were found, that is total dissolved solid (TDS), Chloride, and Hardness of the water. These things were predicted to be occurred because TDS was predicted to come from river water's seepage and rainwater runoff, Chloride was predicted to come from the location that is close with sea and the use of disinfectant, the water hardness was predicted to come from the geology condition of the location. The high concentration of some parameters, both exceeding the standard and having high critical level, generally was not caused by the operational activities of Rembang Steam Power Plant.
2. Water quality (monitoring well)
   Result obtained from observation in six locations of monitoring wells in Rembang Steam Power Plant, some parameters which exceeding the standard were found in some spots as Turbidity in AB-6, Organic Chemical Substance (KmnO4) in AB-3, TDS in AB-3 (Monitoring Well 1), AB-5 (Monitoring Well 3), and AB-8 (Monitoring Well 6), Chloride in AB-3 (Monitoring Well 1), AB-4 (Monitoring Well 2), AB-5 (Monitoring Well 3), and AB-7 (Monitoring Well

5), and also Sulfate in AB-3 (Monitoring Well 1), AB-7 (Monitoring Well 5), and AB-8 (Monitoring Well 6). The causes of the high parameter concentration are: the water turbidity was predicted to happen because of the high TDS that influence the water clarity level, Organic substances because there were some organic material which come from the intrusion to the monitoring well's water, TDS was predicted to come from rainfall run-off intrusion, Chloride was predicted to occur because of the sea water intrusion and the soil condition which once a backfill soil, and sedimentation from the sea that resulted in the high level of salt remaining, Sulfate was predicted to come from the soil condition surround the location is originally from sea sedimentation process and the Steam Power Plant location which partly from former backfill soil, thus the salt remaining is still high.

Some of the parameters which had high critical level and potential to exceed the standard are the water hardness in AB-3 (monitoring well 1) in 68.60%.

Based on the observations that have been done, some advices had been made with the aim to have a better maintenance in the future and can be practically applied, particularly to reduce and prevent the environmental impacts that caused by Rembang Steam Power Plant 2 x 315 MW operational activities. The recommendation are in form of advanced treatment (which has not been summarized in Environmental Management Plan) toward the environment components which already exceeding the standard, and prevention or anticipation for the high critical level environment components as:

1. A sample test for the water quality that goes to the water area should be conducted for checking the nitrate, and to make sure that the nitrate increasing is caused from the other activities such as farming, fishery, and residents' domestic activities, not because of Power Plant activity..
2. Open the information access to the residents to accept suggestions and input related with the operational activities of Rembang Steam Power Plant which affected to the society, and then respond it quickly and accurately.

Prevention/Anticipation

Some of the parameters which have been monitored and resulted in exceeding the standard and have high critical level which happened outside Rembang Steam Power Plant area, and not because of Power Plant operational activities, some things were recommended as follows:

1. To conduct precipitation process toward filtration for precipitation of dissolved solid to the well water and the water that has to be boiled first in order to be able to use as drink water/clean water necessity.
2. To keep the environment and sanitary cleanliness, especially for the clean water supply, by doing cooperation with government district in the area.

IV. REFERENCES

[1] Anonym, ”Implementation of Environmental Management and Monitoring Report of Rembang Steam Power Plant 2 x 315 MW”, First quarter report, January – March 2014, Environmental Centre Research, Brawijaya University.

[2] Environmental State Minister regulation of Indonesia Republic number 05 (2012) about type of business plan and/or activity that require Environmental Impact Assesment (EIA) analysis.

[3] Environmental State Minister regulation of Indonesia Republic number 16 (2012) about document guideline of environmental.

[4] Government regulation of Indonesia Republic number 27 (2012) about environmental permit.

[5] Health Minister regulation number 416/MEN.KES/PER/IX/1990 about conditions and water quality monitoring.

[6] Law of Indonesia Republic number 32 (2009) about protection and management of environmental.

[7] Water Quality Laboratory result number 0415-0422 S/LKA MLG/II/2014 about water quality result for resident well and monitoring well in Leran and Trahan village,2014, Jasa Tirta 1,Malang, East Java.