POISONED

Report on the Environmental Sampling around the Coal Mines, Thermal Power Plants and Ash Ponds in Tamnar Block of Raigarh, Chhattisgarh

Community Environmental Monitoring
&
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August 2017

Executive Summary

Sampling and testing of chemicals present in the air, water, soil and sediment of Kosampali, Dongamahua, Kodkel, Kunjemura and Regaon villages in Tamnar Block of Raigarh district in Chhattisgarh was undertaken to investigate the complaints of severe pollution and health problems from the coal mines, thermal power plants and coal ash ponds by the residents of the region.

Total of 4 air samples, 7 water samples, 9 soil samples, 2 fly ash and 6 sediment samples were collected from various locations in the region. Results of analysis indicated that the air, water, soil and sediment in and around Kosampali, Dongamahua, Kodkel, Kunjemura and Regaon were severely contaminated with various toxic heavy metals.

Air samples results indicate the presence of PM2.5 at levels above the Indian, World Health Organization and US EPA regulatory guidelines. Toxic heavy metals like Manganese, Arsenic, Nickel and Silica were also found in the air at levels above the health based guidelines.

Levels of toxic heavy metals such as Aluminum, Arsenic, Boron, Cadmium, Chromium, Manganese, Selenium and Total Dissolved Solids in water were above the Indian drinking water standards or the WHO standards or the Canadian Council of the Ministers for the Environment guidelines. Presence of toxic chemicals in high levels in the waterbodies also indicates a threat to the aquatic life in the region.

Toxic metals like Chromium, Vanadium, Nickel, Zinc, Arsenic, Selemium, Cadmium, Antimony and Lead were found in levels above the health based standards in soil. Similarly the sediment analysis revealed the presence of toxic chemicals like Chromium, Zinc, Arsenic, Cadmium and Lead in levels that could harm the aquatic life.

Nine of the 17 soil and sediment samples are suspected to be heavily contaminated by escaped fly ash. Three of the 17 samples are suspected to be heavily contaminated by escaped coal dust. Five samples are suspected to be impacted by releases from either coal washeries or coal mines. Levels of Chromium, Nickel, Cadmium and Antimony in soil were above the Dutch Intervention levels and would trigger remedial action.

Snapshot of chemicals found and their health effects:

1. A total of 12 toxic metals including Aluminum, Arsenic, Antimony, Boron, Cadmium, Chromium, Lead, Manganese, Nickel, Selenium, Zinc and Vanadium were found in water, soil and sediment samples taken around the region.

2. Out of the 12 toxic metals found, 2 are carcinogens and 2 are probable carcinogens. Arsenic and Cadmium are known carcinogens and Lead and Nickel are probable carcinogens.

3. Many of the metals cause respiratory disorders, shortness of breath, lung damage, reproductive damage, liver and kidney damage, skin rashes, hair loss, brittle bones, nausea, vomiting, diarrhea, stomach pains, muscle and joint pain and weakness etc.

4. Humans and animals in the area are at risk of amplified harm because of the exposure to multiple toxicants and carcinogens all at once. Many of these toxic chemicals adversely affect the same organ (e.g. lungs, kidneys) or have similar impacts (cancer, skin damage, damage to reproductive system). It is clear that there is an increased cumulative threat when the exposure is to many toxic chemicals at the same time.

5. Many chemicals found are known to bio accumulate and move up the food chain.

Based on these findings and observations, local communities demand that the Chhattisgarh Environment Conservation Board and the Chhattisgarh Government should immediately:

1. Initiate continuous and long-term monitoring of emissions in the region and publish the results periodically and issue advisories. This should include the comprehensive monitoring of air, soil waterbodies, drinking water and fish in the region.
2. Use the pollution data to apprehend polluters and take corrective remediation action to bring the levels of dust and heavy metals in in residential areas to below detection limits.
3. Commission a Cumulative Environmental and Health Impact Assessment study of the densely industrialized areas of Tamnar block.
4. Commission a study to assess the carrying capacity of the densely industrialized areas of Tamnar block for any further industrialization.
5. Enforce a moratorium on any expansion of coal mines and coal-fired thermal power plants and any other polluting industries in the region pending the findings of the study.
6. Provide for long-term health monitoring by initiating health studies among the residents of villages and workers in and around Tamnar, Chhattisgarh.
7. Set up specialized health care infrastructure operated by the Government health department at polluters' cost to cater to pollution-impacted Tamnar residents and factory workers.
8. Set up an oversight committee comprising of government officials from various departments (including the pollution control board, health and local administration) and local residents from various villages to oversee the time-bound execution and implementation of the above-mentioned recommendations.

Background

Residents of Kosampali, Dongamahua, Kodkel, Kunjemura and Regaon villages in Tamnar Block of Raigarh district in Chhattisgarh have been complaining of severe pollution and pollution related health problems from the coal mines, thermal power plants and coal ash ponds in the region.

Coal mines, thermal power plants and coal ash ponds are known polluting operations. A visual tour of the above mentioned villages confirms the lapses in the implementation of environmental norms by the industries. The regulatory agencies of the State and the Center have failed to ensure that the area is not polluted and the environment and health is not harmed. There is hardly any data presented by the agencies to the general public about the state of the environment in the region. In order to further investigate the nature of contamination and presence of toxins in the environment a comprehensive assessment of air, water, soil, sediment and fly ash was conducted in the month of May 2017.

The following report presents the findings of the environmental sampling and implications of the results on public health and environment in the region.

Samples and Methodology:

Samples of air, water, soil, sediment and fly ash were taken from various locations (See Map and refer to Table 1) in the villages around the coal mines and power plants.

Air samples:

In total 4 air samples were taken. Samples of dust in ambient air were taken from the villages in the vicinity the plant and were analysed for the Particulate Matter 2.5 (PM2.5) levels and the presence of toxic heavy metals in the air.

Sampling locations were spread over the villages of Kosumpali, Sarasmal, Dongamahua and Sakta Sitapur. All samples were from rooftops of houses of residents in the villages next to mines or power plants. All samples were located downwind of the source and samples were taken on days with clear and normal weather and not on heavy/gusty windy days.

The equipment used is a low volume air-sampling device called the MiniVol[1]. All samples were taken continuously over a period of 24-hour. The samples were sent for analysis to the

[1] http://www.airmetrics.com/index.html

Chester LabNet[2], a laboratory based in Oregon, USA. The laboratory tested the samples for $PM_{2.5}$ using the Gravimetry[3] technique and used the X-ray Fluorsescence (XRF) technique to detect the presence of heavy metals. XRF is a United States Environment Protection Agency (US EPA) approved technique.

Water Samples:

Seven water samples were taken from various sites in the villages of Regaon, Kunjemura, Kosampali, Dongamahua, Dhaurabhata and Kodkel. Water samples were collected from streams and irrigational canals that are used by the villages in bathing, cleaning and farming purposes.

Water samples were collected in 250 ml screw top plastic containers from the sites and were analyzed at Speciality Analytical[4], a laboratory based in Oregon. The samples were analyzed for the presence of Selenium, Arsenic, Lead, Manganese, Aluminum, Chromium, Boron and Cadmium [with a detection limit of < 0.1 ppb (0.1 ug/l)]. The samples were also tested for Total Dissolved Solids (TDS).

Soil Samples:

Nine samples of soil were taken from various locations in the villages of Regaon, Kunjemura, Kosampali/ Sarasmal, Dongamahua, Beljor, Kodkel, Daurabhata and Banjikod Mod. 6 out of the 9 samples were from private farm lands in the region. Most of the farmers complained of excessive deposits of fly ash on their crops from the fly ash ponds and power plants. They also complained of water in the irrigation canals of being contaminated from the effluents from the mines and coal washeries. 2 samples were taken from roadsides in areas that witness hundreds of coal trucks plying daily. One sample was collected from the forest region behind Dongamahua Power Plant.

Fly Ash Samples:

One sample of fly ash was taken from Regaon and Kosampali each. Most common complaint about fly ash was that it was being indiscriminately dumped in the public and private lands, farms and forest thus contaminating the region. Fly ash samples too were analyzed along with the soil samples.

Sediment Samples:

Six samples of sediment were taken from various locations in Regaon, Kosampali/ Sarasmal, Dongamahua, Kodkel and Beljor villages. 5 out of 6 sediments were collected from local

[2] http://www.chesterlab.net/index.php

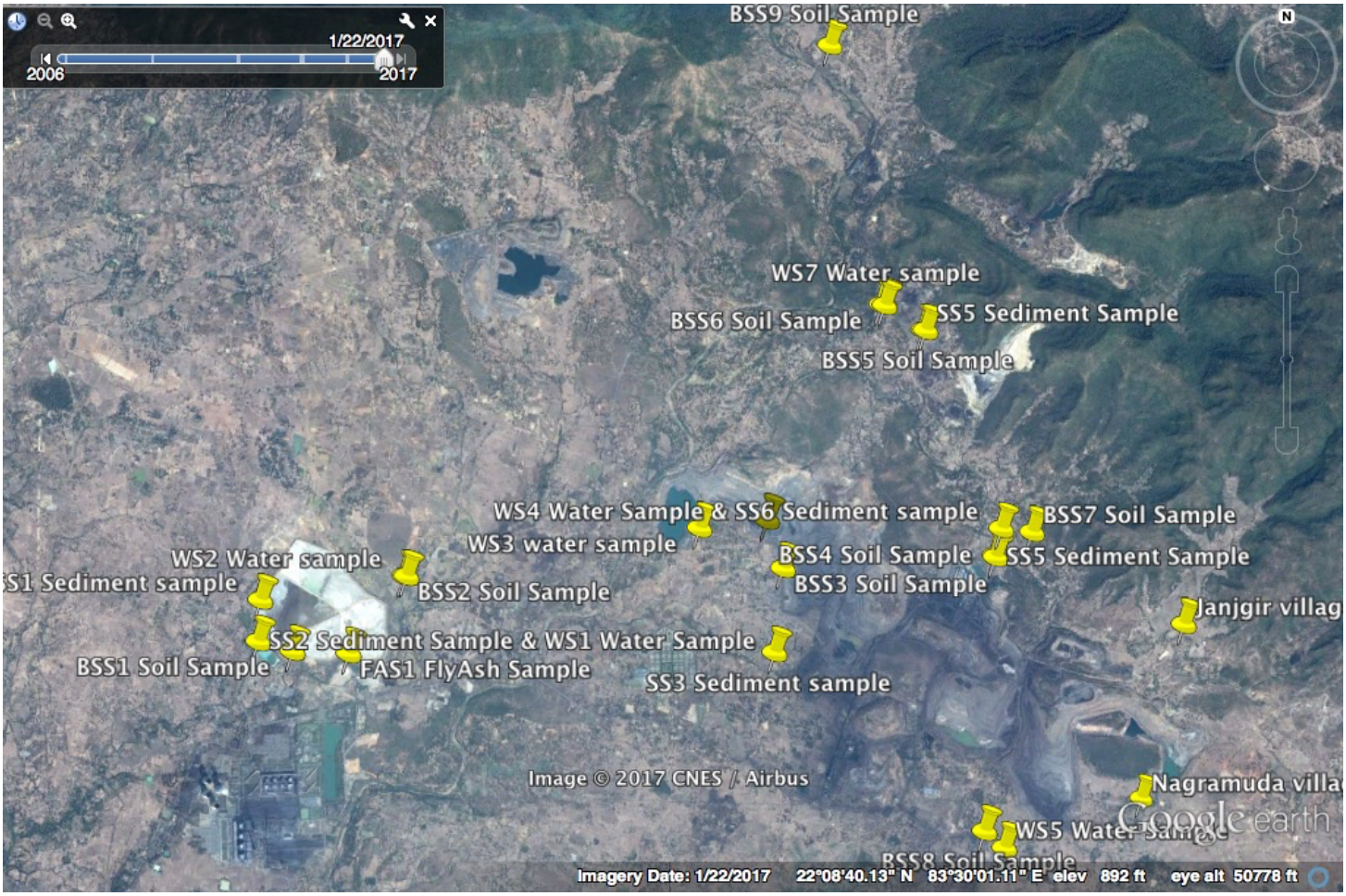
[3] http://www.chesterlab.net/service.php#gra

[4] http://www.specialtyanalytical.com

canals. Water from these canals is used for bathing, cleaning and agricultural purposes. One sample was taken from the channel of water seeping out of the fly ash pond.

Twenty grams of soil, fly ash and sediment samples from the respective sites were collected in screw top plastic bottles. The samples were sent for analysis to the Chester LabNet[5], a laboratory based in Oregon, USA. The laboratory resuspended soil on to 47 mm oil-coated Teflon and tested for Particulate Mass using the Gravimetry[6] technique and used the X-ray Fluorsescence (XRF) technique to detect the presence of heavy metals.

Map 1: Overall location of samples



[5] http://www.chesterlab.net/index.php

[6] http://www.chesterlab.net/service.php#gra

Table 1: Description of Sampling location

S No	Date	Sample Id and Type	Description of Sampling location
1	18.05.2017	AS1 (Air)	Sample taken from the top of the house of Mr Ramsay Yadav in the village Kosampali on the eastern side of the coal mines.
2	19.05.2017	AS2 (Air)	Sample taken from the top of the house of Mr Nehru Agriya in the village Sarasmal on the eastern side of the coal mines.
3	20.05.2017	AS3 (Air)	Sample taken from the top of the house of Mr Jaybandhu Patel in the village next to Dongamahua Captive Power Plant in village Dongamahua.
4	24.05.2017	AS4 (Air)	Sample taken from the top of the house of Mr Narayan Sidar in the village Sakta Sitapur about 4 kilometers from the coal mines and power plants.
5	29.05.2017	SS1 (Sediment)	Sample taken in Regaon village of the sediment from the water streams that leak out of the JPL's ash pond. Several streams of the water were seen leaking out of the pond through various channels. Sample was taken in the presence of the village head Pralhad Kumar Sidar.
6	29.05.2017	SS2 (Sediment)	Sample taken from across the road from the JPL's flyash dump in Regaon. There is a water stream flowing out from the ash pond through the agricultural field. Water was greyish in colour.
7	29.05.2017	WS1 (Water)	Sample taken from across the road from the JPL's flyash dump in Regaon. There is a water stream flowing out from the ash pond through the agricultural field. Water was greyish in colour. Water from this stream meets the local canal and eventually the Kelo river. Water is used for agricultural purposes and for bathing by the villagers. Sample was taken in the presence of the village head Pralhad Kumar Sidar.
8	29.05.2017	FAS1 (Flyash)	The local residents complain that flyash from the JPL power plant is dumped all around the village illegally. This location from where the sample was taken is a plot of government land allotted for the *Awas Yojna* (low cost public housing). This land is located across the road from JPL power plant and between the plant and its ash pond.
9	29.05.2017	BSS1 (Soil)	The sample was taken from a private land owned by Mr Satyavadi Gupta, about 100 mts south from the JPL flyash pond. The field and crop was covered with flyash at the time of the sampling.
10	29.05.2017	WS2 (Water)	Sample was taken from Nishad pond at Kunjemura village. Villagers often complaint of ash deposit on the water. Water from this pond is used for drinking and washing purposes. The pond is located about 400 mt North of JPL's flyash pond. Sample was taken in the presence of BDC Ms. Vidyavati Sidar.

S No	Date	Sample Id and Type	Description of Sampling location
11	29.05.2017	BSS2 (Soil)	The sample was taken from a private land owned by Mr Shivcharan Nishad, about 350 mts North from the JPL flyash pond. The field and crop was covered with flyash at the time of the sampling. Sample was taken in the presence of BDC Ms. Vidyavati Sidar.
12	29.05.2017	WS3 (Water)	Water sample from village pond in Kosumpali adjacent to JPL coal mine. Water from mine is directly emptied in the pond. Water is used for bathing, washing and cleaning purposes. Residents complain of itchiness in skin after using the water.
13	29.05.2017	FAS2 (Flyash)	Flyash sample taken from Kosumpali village. Flyash generated at Tamnar Power Plant in regularly dumped in the area.
14	29.05.2017	BSS3 (Soil)	Sample was taken from a private land owned by aunt of Mr Kanhai Patel. The soil in the land is black in colour and looks like coal dust. The land is barely 50 mts from the coal mine. Farming has been abandoned in the land due to crop faliures.
15	29.05.2017	SS3 (Sediment)	Sediment taken from the banks of Karra nala in Kosampali/ Sarsmal village. This is a local canal that carries water from the Jindal CHP coal washery. The water is used for irrigation purposes and this canal later joins river Kelo.
16	29.05.2017	SS4 (Sediment)	Sample taken from the banks of Bendra nala, a canal that flows from Dongamauha Captive Power Plant. The water is used for irrigation, washing and cleaning purposes and this canal later meets Kelo river. Sample was taken in the presence of Mr. Dileep Sidar.
17	29.05.2017	BSS4 (Soil)	Soil sample taken from forest behind DCPP. As the sample was being taken, flakes of flyash were noticed falling over the region. Sample was taken in the presence of Mr. Dileep Sidar.
18	29.05.2017	SS5 (Sediment)	Sample taken from a local canal that receives water from Jindal Coal washery in village Kodkel. The water from the canal is used for irrigation purposes.
19	29.05.2017	BSS5 (Soil)	The sample was taken from a private land owned by Mr Chaitram Patel in Kodkel village. The land uses water from the local canal to grow paddy.
20	29.05.2017	BSS6 (Soil)	The sample was taken from a private land in Kodkel village. The land uses water from the local canal to grow paddy.
21	30.05.2017	WS4 (Water)	Taken from Bendra Nala behind DCPP at the confluence of effluent channel from the power plant and mines. There was an oily film on the water at the spot and sharp oil like stench.
22	30.05.2017	SS6 (Sediment)	Taken from Bendra Nala behind DCPP at the confluence of effluent channel from the power plant and mines. There was an oily film on the water at the spot and sharp oil like stench.

S No	Date	Sample Id and Type	Description of Sampling location
23	30.05.2017	BSS7 (Soil)	The sample was taken from a private land owned by Mr. Vijay Ram Bhoihar in Beljhor village. The land uses water from the local canal to grow vegetables. The land is located right behind DCPP and is mostly covered with flyash from the plant.
24	30.05.2017	BSS8 (Soil)	Soil sample taken from the entrance of Dhaurabhata primary school. The place is next to the road that sees several hundreds of truck carrying coal daily. The entire place was covered in coal dust.
25	30.05.2017	WS5 (Water)	Sample taken from local pond (Dongri talab) in Dhaurabhata village, the pond in an abandoned mine.The water is red in colour and used for bathing and cleaning purposes.
26	30.05.2017	BSS9 (Soil)	Soil sample taken from road side at Banjkhod Mod. Several hundreds of truck carrying coal form Hindalco mines ply on the road daily. The entire place was covered in coal dust.
27	30.05.2017	WS6 (Water)	Sample taken from a local canal that receives water from Hindalco underground mine in village Kodkel. The water from the canal is used for irrigation purposes. The water was black in colour and local residents use this water for washing and bathing purposes. The residents were also seen washing the rice grains in the water.
28	30.05.2017	WS7 (Water)	Sample of drinking water in Kodkel village. Villagers report getting coal particles in their water and suspect that water from mines is being channelized as drinking water by the mining company.

Results

Air Samples:

	Results in µg/m3												
Sample Location	**Date**	**Pb**	**Ni**	**As**	**Mn**	***Si***	***Fe***	***Al***	***Ca***	**PM2.5**	***Si+Fe+Al+Ca/PM2.5***		***EPA AQI Level***
Kosampali	18.05.2017	0.0374	0.0322	0.0082	0.2236	27.54	8.767	14.78	6.48	Not tested			
Sarasmal	19.05.2017	0.0498	0.0168	0.0105	0.1573	30.89	9.99	18.36	6.1	Not tested			
Donga Mahua	20.05.2017	0.0366	0.014	0.0014	0.1617	31.81	8.42	20.17	4.86	Not tested			
Sakta Sitapur	24.05.2017	0.0245	0.0093	0.0016	0.178	25.14	8.23	13.15	6.65	166.67	31.9%		Very Unhealthy
Health-based standards													
Califirnia OEHHA, annual standard		none	0.014	0.015	0.09	3*							
Califirnia OEHHA, 24-hour standard		none	0.2	0.2	none								
EPA 3-month standard		0.15	none	none	none								
India annual standard		0.5	0.02	0.006	none								
India 24-Hour standard		1	none	none	none								
WHO annual standard										10			
WHO 24-hour standard										25			
U.S. EPA annual standard										12			
U.S. EPA 24-hour standard										35			
India annual standard										40			
India 24-Hour standard										60			
*Crytaline Silicon Dioxide (Silica)													
US EPA AQI Level													
35.5 - 55.4	**Unhealthy for sensitive groups**												
55.5 - 150.4	**Unhealthy**												
150.5 - 250.4	**Very unhealthy**												
> 250.5	**Hazardous**												

PM2.5: The levels of very fine particulate matter in the filtered air sample ($PM_{2.5}$) from Sakta Sitapur greatly exceed the 24-hour WHO standard of 25 $\mu g/m^3$; the 24-hour USEPA standard of 35 $\mu g/m^3$; and the Indian MoEF standard of 60 $\mu g/m^3$. This level exceeded the Indian standards by 2.8 times. Levels of $PM_{2.5}$ in the sample is so high that the US EPA would issue an advisory for very unhealthy air quality. In addition, aggregate levels of PM2.5 as Na. Mg, Al, Si, S K, Ca, Fe in the air samples from Kosampali, Sarasmal Dongamahua, were all above 70 $\mu g/m^3$ - in excess of the Indian MoEF standard of 60 $\mu g/m^3$. It is virtually certain that levels of PM2.5 in air from Kosampali, Sarasmal Dongamahua would also be considered very unhealthy.

Manganese results: Levels of manganese (which cause adverse neurodevelopmental and neurobehavioral health effects) exceed health-based guidelines for long-term exposure in all four samples [see yellow shaded cells] by 1.75 to 2.48 times.

Arsenic results: The levels of arsenic in two samples at Kosampali and Sarasmal exceed the Indian MoEF annual standard of 0.006 $\mu g/m^3$ [see red shaded cells] by 1.36 to 1.75 times respectively.

Nickel results: The levels of nickel (which causes adverse immune system and respiratory system impacts) in two samples (Kosampali and Sarasmal) exceed health-based guidelines for long-term exposure [see yellow shaded cells] by 1.2 to 2.3 times.

Silicon/Silica: The California standard for exposure to crystalline silicon dioxide (silica) is 3 $\mu g/m^3$ for the prevention of respiratory effects[7]. Coal/coal dust is known for having relatively high quantities of crystalline silica.

The method used for analysis of air samples from current batch quantifies **silicon** levels, not silica levels. However, considering that silicon levels averaged 30 $\mu g/m^3$, and that silica is the predominant form of silicon in the environment, it is safe to assume that ambient air in the area has unsafe crystalline silica levels above 3 $\mu g/m^3$.

Source of Dust and Contaminants in the dust:

According to the Dr. Mark Chernaik, Staff Scientist, ELAW US, "the four elements that occur in the highest levels in coal ash are aluminum, calcium, iron, and silicon, with somewhat varying compositions. These four elements comprise a strikingly high fraction of total PM2.5 in the filtered air sample from Sakta Sitapur at about 31.9%. By contrast, these same four elements comprised only 1.3% of total $PM_{2.5}$ levels of a typical urban area in the U.S. (Wilmington, DE)[8]. **One can therefore conclude that overall $PM_{2.5}$ in this sample is likely impacted by sources of coal ash emissions and not significantly impacted by sources of liquid fuel combustion (e.g. vehicle emissions and diesel generators) alone."**

[7] California Office of Environmental Health Hazard Assessment "All OEHHA Acute, 8-hour and Chronic Reference Exposure Levels (chRELs) as of June 2014" Chronic REL for silica. http://oehha.ca.gov/air/hot_spots/2008/AppendixD3_final.pdf#page=486 (Accessed on 7 October 2014).

[8] "Analysis of Speciation Trends Network Data Measured at the State of Delaware" http://regulations.delaware.gov/register/november2008/general/Appendix9-11.pdf

Water Samples:

		Pollutant level, µg/L									
Sample	**Comments**	**Al**	**As**	**B**	**Cd**	**Cr***	**Pb**	**Mn**	**Se**	**TDS**	**Additional Comments**
WS1	Water leaking out of ash pond rom JPL in Regaon village (joins river Kelo)	126	17.4	554	0.4	BDL	0.2	326	34.3	443000	this water is used for bathing, cleaning, drinking and irrigation purposes
WS2	Pond about 400 meters north of Regaon JPL fly ash dump	BDL	4.8	158	BDL	BDL	BDL	1000	BDL	375000	this water is used for bathing, cleaning and household needs
WS3	Pond next to JPL coal mine in Kosampali	BDL	0.1	48	BDL	BDL	BDL	0.7	BDL	701000	this water is used for bathing, cleaning
WS4	Confluence of two streams from mine and power plant and joining Bendra Nala (joins river Kelo further)	BDL	0.5	22.8	BDL	0.2	BDL	0.7	BDL	360000	Oily film on the water and sharp oil-like odor
WS5	Abandoned mine turned pond	25.3	3.2	19.5	BDL	0.2	0.2	782	BDL	654000	Red in color, used for bathing and washing utensils
WS6	Bendra Nala, carrying water from Hindalco mines in Kodkel (joins river Kelo further down)	34.6	0.3	96	BDL	BDL	BDL	BDL	BDL	157000	Black in color, used for agricultural purposes and household cleaning
WS7	Drinking water in Kodkel supplied by HINDALCO	169	0.2	91.3	BDL	BDL	BDL	BDL	BDL	161000	
	WHO drinking water guideline value, health-based values	900	10	2400	3	50	10	400	40	none	
	WHO drinking water guideline value, acceptability-based values	100-200	NA	NA	NA	NA	NA	100	NA	1000000	
	Indian drinking water standard (IS 10500 : 2012) Toxic Substances	NA	10	NA	3	50	10	NA	NA	NA	
	Indian drinking water standard (IS 10500 : 2012) Substances Undesirable in Excessive Amounts	30	NA	500	NA	NA	NA	100	10	500000	
	USEPA water quality criteria, freshwater chronic	87	150	NA	0.72	74	2.5	NA	3.1	NA	
	Canadian Council of Ministers of the environment										
	Water quality Guidelines for protection of Aquatic Life (long term)	100	5	1500	0.09	NA	NA	NA	1	NA	
	*California's Public Health Goal for Hexvalent Chromium in drinking water					0.02					
	http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Chromium6.shtml										

Aluminum results: The levels of Aluminum found in water samples from Regaon village (WS1), Bendra nala (WS4) and Kodkel village (WS7) exceed the Indian drinking water standard (IS 10500:2012) (substances undesirable in excessive amounts) by 1.15 to 5.6 times. Levels found in Regaon (WS1) and Kodkel (WS7) samples also exceed the CCME guidelines for protection of aquatic life in the long term by 1.2 to 1.6 times.

Arsenic results: The levels of Arsenic found in water samples from Regaon village (WS1) exceed the health based values of WHO's drinking water guidelines by 1.7 times. These levels also exceed the CCME guidelines for protection of aquatic life in the long term by 3.4 times.

Boron results: The levels of Boron found in water samples from Regaon village (WS1), exceed the Indian drinking water standard (IS 10500:2012) (substances undesirable in excessive amounts) by 1.1 times.

Cadmium results: The levels of Cadmium found in water samples from Regaon village (WS1), exceed the CCME guidelines for protection of aquatic life in the long term by 4.4 times.

Manganese results: The levels of Manganese found in water samples from Regaon village (WS1), Nishad pond in Regaon village (WS2) and abandoned mine turned pond in Daurabhata (WS5) exceed the Indian drinking water standard (IS 10500:2012) (substances undesirable in excessive amounts) by 3.2 to 10 times.

Selenium results: The levels of Selenium found in water samples from Regaon village (WS1), exceed the Indian drinking water standard (IS 10500:2012) (substances undesirable in excessive amounts) by 3.4 times. These levels also exceed the CCME guidelines for protection of aquatic life in the long term by 34.3 times. Selenium is one element that is consistently found elevated in coal ash. Presence of Selenium in the water hence indicates coal ash contamination in the waterbodies.

Total Dissolved Solids (TDS) results: The levels of Total Dissolved Solids (TDS) found in water samples from the pond in Kosampali village (WS3),and abandoned mine turned pond in Daurabhata (WS5) exceed the Indian drinking water standard (IS 10500:2012) (substances undesirable in excessive amounts) by 1.1 to 1.4 times.

Chromium results: The California Public Health Goal for Hexavalent Chromium in drinking water is 0.02 ug/L. The method used to test water samples in this study is for Total Chromium, but according to a US EPA study in December 2009, the chromium that leaches from coal ash is "nearly 100 percent [hexavalent] Cr(VI)."[9]
The levels of Total Chromium found in water samples from the confluence of streams at Bendra nala (WS4) and an abandoned mine turned pond (WS5) clearly indicates that they are at least 10 times above the health based standards of hexavalent chromium in drinking water.

Harm to Aquatic Life

Elevated levels of Aluminum, Arsenic, Cadmium and Selenium in the water bodies and streams that eventually meet one of the biggest river in the region, river Kelo, indicates that this is significant risk to the aquatic life. According to US EPA "Selenium bioaccumulates in the aquatic food chain and chronic exposure in fish and aquatic invertebrates can cause reproductive impairments (e.g., larval deformity or mortality). Selenium can also adversely affect juvenile growth and mortality. Selenium is also toxic to water fowl and other birds that consume aquatic organisms containing excessive levels of selenium."[10]

[9] Characterization of Coal Combustion Residues from Electric Utilities – Leaching and Characterization Data; December 2009; page 91, https://grist.files.wordpress.com/2011/02/600r09151.pdf

[10] https://www.epa.gov/wqc/aquatic-life-criterion-selenium

Soil Sample:

Client ID	Site	Sample Date	Units	V	Cr	Ni	Zn	As	Se	Cd	Sb	Pb
				Vandanium	Chromium	Nickel	Zinc	Arsenic	Selenium	Cadmium	Antimony	Lead
BSS1	Regaon Village	29-05-17	ug/g	173.5	**202.8**	**100.3**	263.6	21.41	30.42	**236.6**	**349.3**	74.36
BSS2	Kunjemura Village	29-05-17	ug/g	194.3	**258.4**	**109.4**	77.97	9.31	BDL	BDL	BDL	53.53
BSS3	Kosampli and Sarasmal Village	29-05-17	ug/g	186.7	**124.9**	45.31	92.68	10.98	BDL	3.433	BDL	32.27
BSS4	Dongamahua Village	29-05-17	ug/g	198.4	**126.6**	39.56	85.71	13.84	BDL	**13.84**	**37.58**	46.15
BSS5	Kodkel Village	29-05-17	ug/g	153	**142**	52.81	218.5	BDL	BDL	**45.53**	**145.7**	52.81
BSS6	Kodkel Village	29-05-17	ug/g	160.1	**110.8**	53.04	124.1	44.52	BDL	BDL	**56.83**	67.25
BSS7	Beljor Village	30-05-17	ug/g	217.5	**146.1**	60.27	99.57	7.861	BDL	BDL	BDL	39.3
BSS8	Dhaurabhata Village	30-05-17	ug/g	89.61	**97.2**	30.38	77.46	3.038	BDL	BDL	BDL	BDL
BSS9	Banjikod Mod. Village	30-05-17	ug/g	111.1	**178.2**	49.51	94.63	5.501	BDL	**47.31**	**110**	82.52
FAS1	Regaon Village	29-05-17	ug/g	193.2	**172**	57.08	98.92	20.56	2.837	BDL	**25.53**	54.6
FAS2	Kosampli Village	29-05-17	ug/g	236.1	**186.9**	78.69	144.1	BDL	BDL	BDL	6.943	90.84
Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health				130	64	45	230	12	1	1.4	20	70
Dutch Intervention Levels					78	100	720	76		13	22	530
Ref: http://envfor.nic.in/sites/default/files/Task.pdf												
Volume II-2.1-b Screening and Response Levels												

Vanadium results: The levels of Vanadium found in 9 out of 11 soil samples exceed the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* by 1.1 to 1.8 times.

Chromium results: The levels of Chromium found in all 11 soil samples exceed the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health by 1.5 to 4 times.

Nickel results: The levels of Nickel found in 9 out of 11 soil samples exceed the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health by 1 to 2.4 times.

Zinc results: The levels of Zinc found in one soil sample from Regaon village exceed the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health by 1.14 times.

Arsenic results: The levels of Arsenic found in 4 out of 11 soil samples exceed the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health by 1.15 to 3.71 times.

Selenium results: The levels of Selenium found in two soil samples, both from Regaon village exceed the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health by 2.8 to 30.4 times.

Cadmium results: The levels of Cadmium found in 5 out of 11 soil samples exceed the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health by 2.4 to 169 times.

Antimony results: The levels of Antimony found in 6 out of 11 soil samples exceed the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health by 1.3 to 17.4 times.

Lead results: The levels of Lead found in 3 out of 11 soil samples exceed the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health by 1.06 to 1.29 times.

HAZARDOUS WASTE SITE ALERT!

Ministry of Enviornment and Forests (Government of India), under the National Program for Rehabilitation of Polluted Sites in India, has commissioned a report on Guidance document for assessment and remediation of contaminated sites in India. This document lists the Dutch Intervention Levels for Soil. Intervention levels are levels above which if chemicals are found, then remedial action would be required.

Levels of CHROMIUM, NICKEL, CADMIUM and ANTIMONY found in soil above would trigger remedial action as per the Intervention levels stated in the Ministry documents.

*__Note:__ There are no standards for chemicals in soil and sediment in India. A 2015, Ministry of Environment and Forest (Government of India) commissioned report on Guidance document for assessment and remediation of contaminated sites in India refers to the Canadian Council of Ministers of the Environment as guideline values. Hence these values for soil and sediment has been referred to wherever applicable.

Sediment Sample:

Client ID	Site	Sample Date	Units	Cr	Zn	As	Cd	Pb
				Chronium	Zinc	Arsenic	Cadmium	Lead
SS1	Regaon Village	29-05-17	ug/g	101.3	144	65.9	BDL	80.54
SS1-Duplicate	Regaon Village	29-05-17	ug/g	126.1	73.79	31.02	11.18	30.74
SS2	Regaon Village	29-05-17	ug/g	169.8	142.6	21.09	99.44	70.31
SS3	Kosampali and Sarasmal Village	29-05-17	ug/g	183.6	157.5	BDL	1.133	36.27
SS4	Dongamahua Village	29-05-17	ug/g	160	101.4	BDL	BDL	76.46
SS5	Kodkel Village	29-05-17	ug/g	127.5	144.5	14.05	46.16	36.13
SS6	Beljor Village	30-05-17	ug/g	107.8	91.48	14.93	9.629	54.41
Canadian Sediment Quality Guidelines for the Protection of Aquatic Life - Freshwater ISQG			ug/g	37.3	123	5.9	0.6	35
http://ceqg-rcqe.ccme.ca/en/index.html#void								

Chromium results: The levels of Chromium found in all 7 sediment samples exceed the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life** (in Freshwater) by 2.7 to 4.9 times.

Zinc results: The levels of Zinc found in 4 out of 7 sediment samples exceed the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (in Freshwater) by 1.15 to 1.28 times.

Arsenic results: The levels of Arsenic found in 5 out of 7 sediment samples exceed the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (in Freshwater) by 2.3 to 11.1 times.

Cadmium results: The levels of Cadmium found in 5 out of 7 sediment samples exceed the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (in Freshwater) by 1.8 to 165.7 times.

Lead results: The levels of Lead found 6 out of 7 sediment samples exceed the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (in Freshwater) by 1.03 to 2.3 times.

FLY ASH and COAL DUST EVERYWHERE!

According to Dr. Mark Chernaik, Staff Scientist at Environmental Law Alliance Worldwide (ELAW) US:

"9 of the 17 samples (SS1, SS2, FAS1, BSS1, BSS2, FAS2, SS4, BSS4, and BSS7) are suspected to be heavily contaminated by escaped fly ash. Three of the seventeen samples (BSS3, BSS8 and BSS9) are suspected to be heavily contaminated by escaped coal dust. The remaining 5 samples (SS3, SS5, BSS5 and BSS6) are suspected to be impacted by releases from either coal washeries or coal mines.

Compared to soil, fly ash is substantially enriched in *aluminum, iron, titanium and zinc;* somewhat enriched in *calcium and magnesium* (two elements found in highly variable levels in soil); and slightly less enriched in *silicon* (especially compared to sandy soils).

All 9 of the samples suspected to be heavily contaminated by escaped fly ash are heavily enriched in *aluminum, iron, titanium and zinc,* either above at the very high end of the range these elements are found in soil. These 9 samples differ significantly from samples suspected to be only contaminated by coal dust (BSS8 and BSS9), which have only modest levels of aluminum, titanium and zinc."

Note: There are no standards for chemicals in soil and sediment in India. A 2015, Ministry of Environment and Forest (Government of India) commissioned report on Guidance document for assessment and remediation of contaminated sites in India refers to the Canadian Council of Ministers of the Environment as guideline values. Hence these values for soil and sediment has been referred to wherever applicable

Health Effects of the Chemicals found

There are three main routes by which the chemicals found in the soil, sediment, water and air can get into the bodies of the humans and animals in the area and harm them.

a) Ingestion – Ingestion or Swallowing is the route where the chemicals enters the body through the food and drinks that one takes and is then absorbed by the digestive tract.

b) Inhalation – This is a route where the chemicals enters the body via the air that we breathe into our respiratory tract and later absorbed into our blood streams from there.

c) Contact – In this route the chemicals get absorbed by the skin after it comes in contact with it thus contaminating our blood systems and causing damages.

Different chemicals behave differently in the body. Some chemicals target specific organs or systems while others affect the body overall. Here is a list of health effects of the chemicals found in the sampling exercise in the air, water, soil and sediment.

Snapshot of Chemicals found:

1. A total of 12 toxic metals including Aluminum, Arsenic, Antimony, Boron, Cadmium, Chromium, Lead, Manganese, Nickel, Selenium, Zinc and Vanadium were found in the water, soil and sediment samples taken around the region.

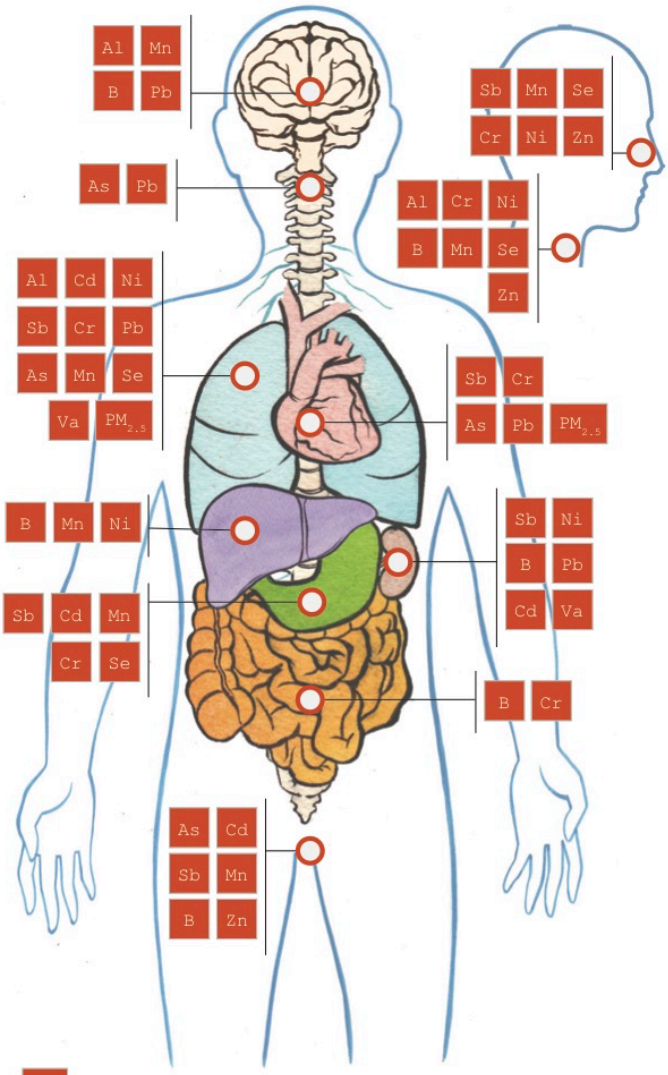
2. Out of the 12 toxic metals found, 2 are carcinogens and 2 are probable carcinogens. Arsenic and Cadmium are known carcinogens and Lead and Nickel are probable carcinogens.

3. Many of the metals cause respiratory disorders, shortness of breath, lung damage, reproductive damage, liver and kidney damage, skin rashes, hair loss, brittle bones, nausea, vomiting, diarrhea, stomach pains, muscle and joint pain and weakness etc.

4. Humans and animals in the area are at risk of amplified harm because of the exposure to multiple toxicants and carcinogens all at once. Many of these toxic chemicals adversely affect the same organ (e.g. lungs, kidneys) or have similar impacts (cancer, skin damage, damage to reproductive system). It is clear that there is an increased cumulative threat when the exposure is to many toxic chemicals at the same time.

5. Many chemicals found are known to bio accumulate and move up the food chain.

HEALTH IMPACTS OF COAL TOXICANTS



Al ALUMINUM
Long-term exposure to dust can cause scarring of lungs (pulmonary fibrosis) with symptoms of cough and shortness of breath. May be linked to dementia.

Sb ANTIMONY
Long-term inhalation can cause a hole in the septum dividing the inner nose and lead to permanent lung damage. May harm female fertility and damage liver, kidneys and heart.

As ARSENIC
Ingestion of arsenic can lead to nervous system damage, cardiovascular issues, and urinary tract cancers. Inhalation and absorption through the skin can result in lung cancer and skin cancer, respectively.

B BORON
Inhalation of boron can lead over the short term to eye, nose, and throat irritation. Ingestion of large amounts can result in damage to the testes, intestines, liver, kidneys, and brain, and eventually lead to death.

Cd CADMIUM
May cause lung and prostate cancer and damage the reproductive system. Inhalation can irritate lungs. Ingestion can cause nausea, vomiting, diarrhea and abdominal pain.

Cr CHROMIUM
Ingestion of chromium can cause stomach and intestinal ulcers, anemia, and stomach cancer. Frequent inhalation can cause asthma, wheezing, and lung cancer. Inhalation can also irritate the nose and throat, resulting in asthma-like symptoms. Long-term exposure can damage the nose's septum.

Pb LEAD
Exposure to lead can result in brain swelling, kidney disease, cardiovascular problems, nervous system damage, and death. It is accepted that there is no safe level of lead exposure, particularly for children.

Mn MANGANESE
Long-term exposure can cause permanent brain damage. Inhalation irritates nose, throat and lungs, causing coughing, wheezing and shortness of breath. May cause harm to the liver and testes and decrease fertility in males.

Ni NICKEL
Inhalation can irritate and damage the nose, throat and lungs. Acute exposure can cause headache, dizziness, nausea and vomiting. Nickel is a probable carcinogen for lung cancer. It can cause chronic bronchitis and scarring of the lungs. Long-term exposure may harm liver and kidneys.

$PM_{2.5}$ PM2.5
Particles less than 2.5mm can lodge deep in the lungs and cause premature death, as well as lung and heart disease, decreased lung function, asthma attacks, heart attacks and cardiac arrhythmia.

Se SELENIUM
Breathing selenium can irritate the nose, throat, and lungs, causing coughing, wheezing, and shortness of breath. Selenium can also cause nausea, diarrhea, abdominal pain, and headache. Repeated exposure can cause irritability, fatigue, dental cavities, loss of nails and hair, and depression.

Va VANADIUM
Lung irritant. Long-term exposure can cause asthma attacks with shortness of breath, wheezing, cough, and chest tightness. May damage the kidneys. Repeated high exposure may cause anemia.

Zn ZINC
Inhaling zinc can irritate the nose and throat and cause wheezing and coughing. Zinc appears to affect the male reproductive system, including sperm count.

ILLUSTRATION: JOSHUA HERBOLSHEIMER. HEAD PROFILE: SERGEY NIVENS / SHUTTERSTOCK.

Discussion

The air, water, soil and sediment sampling results show a very concerning level of harmful substances that adversely effect health. Their presence at such high levels shows that there is a significant possibility of chronic health effects. Heavy metals found in the samples are well known toxins and their effects on human health have been well documented. The measurement of such toxic substances from the areas of human settlements is indeed a cause for concern. It is also a clear indication that the coal mines and the power plants have not followed the environmental clearance conditions and have mis-managed the operations at their units thus putting the communities at risk. The results also indicate the failure of the State and Central regulatory agencies in discharging their duties, enforcing the conditions on the plants and mines and protecting the environment and public health.

There is an urgent need not only to take immediate steps to remediate the site to reduce the presence of such toxins in the air, water, soil and sediment but also to institute a comprehensive health survey to assess what damage has already been done. It is also important to institute follow up of the population for detecting long term harm from the exposure till now. Further the health system needs to take these chemicals into account and develop a plan on how to provide relevant and adequate care to those who have been so exposed.

Based on these findings and observations, local communities demand that the Chhattisgarh Environment Conservation Board and the Chhattisgarh Government should immediately:

1. Initiate continuous and long-term monitoring of emissions in the region and publish the results periodically and issue advisories. This should include the comprehensive monitoring of air, soil waterbodies, drinking water and fish in the region.

2. Use the pollution data to apprehend polluters and take corrective remediation action to bring the levels of dust and heavy metals in in residential areas to below detection limits.

3. Commission a Cumulative Environmental and Health Impact Assessment study of the densely industrialized areas of Tamnar block.

4. Commission a study to assess the carrying capacity of the densely industrialized areas of Tamnar block for any further industrialization.

5. Enforce a moratorium on any expansion of coal mines and coal-fired thermal power plants and any other polluting industries in the region pending the findings of the study.

6. Provide for long-term health monitoring by initiating health studies among the residents of villages and workers in and around Tamnar, Chhattisgarh.

7. Set up specialized health care infrastructure operated by the Government health department at polluters' cost to cater to pollution-impacted Tamnar residents and factory workers.

8. Set up an oversight committee comprising of government officials from various departments (including the pollution control board, health and local administration) and local residents from various villages to oversee the time-bound execution and implementation of the above-mentioned recommendations.

Table 2: Factsheet on health impacts of the chemicals found

Aluminum	
Acute Health Effects	Contact can irritate skin and eyes Exposure to **Aluminum** can cause *"metal fume fever."* This is a flu-like illness with symptoms of metallic taste in the mouth, headache, fever and chills, aches, chest tightness and cough. The symptoms may be delayed for several hours after exposure and usually last for a day or two.
Chronic Health Effects	
Cancer Hazard	Not a carcinogen
Reproductive Hazard	No adverse effect
Other Long-Term Effects	Exposure to find dust can cause scarring of lungs (pulmonary fibrosis) with symptoms of cough and shortness of breath. While there is no evidence to suggest that ingestion of foods or beverages that naturally contain traces of aluminum is harmful, several investigators have recently reported cases in which short-term exposures to high aluminum levels in drinking water or dialysis fluid resulted in clinical diagnoses of dementia. In addition to these reports, researchers in France and Canada have reported slightly higher rates of Alzheimer's Disease among residents of communities that had elevated aluminum levels in their water supplies. Because Alzheimer's Disease has a strong genetic component, the effect of aluminum on its development is controversial and needs further study. Infants and older people who suffer from diseases that affect kidney or liver function may be especially sensitive to the effects of ingested aluminum.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/0054.pdf https://www.dhs.wisconsin.gov/publications/p0/p00261.pdf
Arsenic	
Acute Health Effects	Eye contact can cause irritation, burns and red, watery eyes. Inhaling **Arsenic** can irritate the nose and throat causing coughing and wheezing. Exposure to **Arsenic** can cause weakness, poor appetite, nausea, vomiting, headache, muscle cramps and even death.
Chronic Health Effects	
Cancer Hazard	**Arsenic** is a **CARCINOGEN** in humans. It has been shown to cause skin and lung cancer. Many scientists believe there is no safe level of exposure to a carcinogen

Arsenic	
Reproductive Hazard	Chronic **Arsenic** exposure has been associated with spontaneous abortions and still births. There is limited evidence that **Arsenic** is a teratogen in animals. Until further testing has been done, it should be treated as a possible teratogen in humans.
Other Long-Term Effects	Repeated skin contact can cause thickened skin and/or patchy areas of darkening and loss of pigment. Some persons may develop white lines on the nails. Long-term exposure can cause an ulcer or hole in the "bone" (septum) dividing the inner nose, hoarseness and sore eyes. **Arsenic** may damage the nervous system causing numbness, "pins and needles," and/or weakness in the hands and feet. **Arsenic** may damage the liver.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/0152.pdf
Antimony	
Acute Health Effects	Contact can irritate the skin and eyes. Prolonged or repeated contact may cause redness and itchy skin rash (dermatitis). Inhaling **Antimony** can irritate the nose, throat and lungs causing coughing, wheezing and/or shortness of breath. Exposure to **Antimony** can cause headache, dizziness, nausea and vomiting, abdominal pain, and loss of sleep.
Chronic Health Effects	
Cancer Hazard	Not a carcinogen
Reproductive Hazard	There is limited evidence that **Antimony** may affect female fertility
Other Long-Term Effects	Inhaling **Antimony** can cause an ulcer or a hole in the "bone" (septum) dividing the inner nose, sometimes with bleeding, discharge, and/or formation of a crust. Repeated exposure can affect the lungs, cause an abnormal chest x-ray to develop, and lead to permanent lung damage. **Antimony** may damage the liver and kidneys and may affect the heart.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/0141.pdf

Boron	
Acute Health Effects	People working in dusty workplaces where borates are mined and processed have reported irritation of the nose, throat, and eyes. The irritation does not persist for long periods after leaving the dusty area. Exposure to large amounts of boron (about 30 g of boric acid) over short periods of time can affect the stomach, intestines, liver, kidney, and brain and can eventually lead to death.
Chronic Health Effects	
Cancer Hazard	Not a carcinogen
Reproductive Hazard	Studies of dogs, rats, and mice indicate that the male reproductive organs, especially the testes, are damaged if large amounts of boron are ingested for short or long periods of time.
Other Long-Term Effects	NA
	More details at: https://www.atsdr.cdc.gov/toxprofiles/tp26-c1-b.pdf
Cadmium	
Acute Health Effects	Contact can irritate the skin and eyes. Exposure to **Cadmium** may cause *"metal fume fever."* This is a flu-like illness with symptoms of metallic taste in the mouth, headache, fever and chills, aches, chest tightness and cough. The symptoms may be delayed for several hours after exposure and usually last for a day or two. **Cadmium** can cause nausea, vomiting, diarrhea and abdominal pain. Inhaling **Cadmium** can irritate the lungs causing coughing and/or shortness of breath. Higher exposures may cause a build-up of fluid in the lungs (pulmonary edema), a medical emergency, with severe shortness of breath.
Chronic Health Effects	
Cancer Hazard	**Cadmium** is a **CARCINOGEN** in humans. It has been shown to cause lung and prostate cancer. Many scientists believe there is no safe level of exposure to a carcinogen.
Reproductive Hazard	**Cadmium** is a PROBABLE TERATOGEN in humans. **Cadmium** may damage the male reproductive system (testes) and affect the female reproductive cycle.

Cadmium	
Other Long-Term Effects	**Cadmium** can irritate the lungs. Repeated exposure may cause bronchitis to develop with coughing, phlegm, and/or shortness of breath. Repeated low exposures can cause liver and kidney damage. **Cadmium** can cause anemia, loss of sense of smell (anosmia) and/or discoloration of teeth.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/0305.pdf
Chromuim	
Acute Health Effects	Contact can irritate and burn the skin and eyes with possible eye damage. Inhaling **Chromium** can irritate the nose and throat causing coughing and wheezing. Exposure to **Chromium** *fumes* can cause *"metal fume fever."* This is a flu-like illness with symptoms of metallic taste in the mouth, headache, fever and chills, aches, chest tightness and cough. The symptoms may be delayed for several hours after exposure and usually last for a day or two.
Chronic Health Effects	
Cancer Hazard	Not a carcinogen
Reproductive Hazard	No adverse effect
Other Long-Term Effects	Inhaling **Chromium** can cause a sore and/or a hole in the "bone" (septum) dividing the inner nose, sometimes with bleeding, discharge, and/or formation of a crust. **Chromium** may cause a skin allergy. If allergy develops, very low future exposure can cause itching and a skin rash. **Chromium** may cause an asthma-like allergy. Future exposure can cause asthma attacks with shortness of breath, wheezing, coughing, and/or chest tightness. Prolonged skin contact can cause burns, blisters and deep ulcers. **Chromium** may affect the liver and kidneys.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/0432.pdf

Lead	
Acute Health Effects	Contact can irritate the eyes. **Lead** can cause headache, irritability, reduced memory, disturbed sleep, and mood and personality changes. Exposure can cause upset stomach, poor appetite, weakness and fatigue.
Chronic Health Effects	
Cancer Hazard	**Lead** is a **PROBABLE CARCINOGEN** in humans. There is some evidence that **Lead** and *Lead compounds* cause lung, stomach, brain and kidney cancers in humans and they have been shown to cause kidney cancer in animals. Many scientists believe there is no safe level of exposure to a carcinogen.
Reproductive Hazard	**Lead** may be a TERATOGEN in humans since it is a teratogen in animals. It may decrease fertility in males and females, and damage the developing fetus and the testes (male reproductive glands).
Other Long-Term Effects	Repeated exposure to **Lead** can cause *Lead poisoning*. Symptoms include metallic taste, poor appetite, weight loss, colic, nausea, vomiting, and muscle cramps. **Lead** is a neurotoxin and is known to cause low IQ among children. Higher levels can cause muscle and joint pain, and weakness. High or repeated exposure may damage the nerves causing weakness, "pins and needles," and poor coordination in the arms and legs. **Lead** exposure increases the risk of high blood pressure. **Lead** may cause kidney and brain damage, and damage to the blood cells causing anemia. Repeated exposure causes **Lead** to accumulate in the body. It can take years for the body to get rid of excess **Lead**.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/1096.pdf

Manganese	
Acute Health Effects	Contact can irritate the skin and eyes. Inhaling **Manganese** can irritate the nose, throat and lungs causing coughing, wheezing and/or shortness of breath. Exposure to **Manganese** can cause *"metal fume fever."* This is a flu-like illness with symptoms of metallic taste in the mouth, headache, fever and chills, aches, chest tightness and cough. The symptoms may be delayed for several hours after exposure and usually last for a day or two.
Chronic Health Effects	
Cancer Hazard	Not a carcinogen
Reproductive Hazard	**Manganese** may damage the testes (male reproductive glands) and may decrease fertility in males.
Other Long-Term Effects	Manganese is a neurotoxin and repeated exposure can cause permanent brain damage. Early symptoms include poor appetite, weakness and sleepiness. Later effects include changes in speech, balance, mood and personality, loss of facial expressions, poor muscle coordination, muscle cramps, twitching and tremors. The later symptoms are identical to Parkinson's disease. Prolonged or repeated exposure can lead to permanent lung damage. **Manganese** may affect the liver and may cause anemia.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/1155.pdf
Nickel	
Acute Health Effects	Contact can irritate and may burn the skin and eyes. Inhaling **Nickel** can irritate the nose, throat and lungs. Exposure to **Nickel** may cause *"metal fume fever."* This is a flu-like illness with symptoms of metallic taste in the mouth, headache, fever and chills, aches, chest tightness and cough. The symptoms may be delayed for several hours after exposure and usually last for a day or two. **Nickel** can cause headache, dizziness, nausea and vomiting
Chronic Health Effects	

Nickel	
Cancer Hazard	**Nickel** is a **PROBABLE CARCINOGEN** in humans. There is evidence that it causes lung cancer in humans and it has been shown to cause lung cancer in animals. Many scientists believe there is no safe level of exposure to a carcinogen. Such substances may also have the potential for causing reproductive damage in humans.
Reproductive Hazard	While **Nickel** has not been identified as a teratogen or a reproductive hazard, *Nickel salts* and certain *Nickel compounds* are teratogens and may also cause reproductive damage. **Nickel** should be handled WITH EXTREME CAUTION.
Other Long-Term Effects	Exposure to Nickel may cause a skin allergy. If allergy develops, very low future exposure can cause itching and a skin rash. Nickel may cause an asthma-like allergy. Future exposure can cause asthma attacks with shortness of breath, wheezing, coughing, and/or chest tightness. Inhaling Nickel can cause a sore and/or a hole in the "bone" (septum) dividing the inner nose, sometimes with bleeding, discharge and loss of smell (anosmia). Nickel can cause chronic bronchitis and may cause scarring of the lungs. Nickel may affect the liver and kidneys.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/1341.pdf
Selenium	
Acute Health Effects	Contact can irritate and burn the skin and eyes. Breathing **Selenium** can irritate the nose, throat and lungs causing coughing, wheezing and/or shortness of breath. **Selenium** can cause nausea, vomiting, diarrhea, abdominal pain, and headache.
Chronic Health Effects	
Cancer Hazard	Not a carcinogen.
Reproductive Hazard	There is limited evidence that **Selenium** may decrease fertility in females.

Selenium	
Other Long-Term Effects	High or repeated exposure can cause a skin rash (dermatitis). Repeated exposure can cause a garlic odor on the breath, metallic taste, irritability, fatigue, increased dental cavities, loss of nails and hair, and mood change (depression).
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/1648.pdf
Zinc	
Acute Health Effects	Contact can irritate the skin and eyes. Inhaling **Zinc** can irritate the nose and throat causing coughing and wheezing. Exposure to **Zinc** can cause *"metal fume fever."* This is a flu-like illness with symptoms of metallic taste in the mouth, headache, fever and chills, aches, chest tightness and cough. The symptoms may be delayed for several hours after exposure and usually last for a day or two.
Chronic Health Effects	
Cancer Hazard	Not a carcinogen
Reproductive Hazard	**Zinc** appears to affect the male reproductive system (including sperm count). Further testing is required to assess its potential to cause reproductive harm.
Other Long-Term Effects	Prolonged or repeated contact can cause dermatitis with drying and cracking of the skin and redness.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/2021.pdf
Vanadium	
Acute Health Effects	Contact can irritate the skin and eyes. Breathing **Vanadium** can irritate the nose, throat and lungs causing coughing, wheezing and/or shortness of breath. High exposure to **Vanadium** can cause nausea, vomiting, abdominal pain and greenish discoloration of the tongue. Exposure to **Vanadium** can cause headache, tremors and dizziness.
Chronic Health Effects	
Cancer Hazard	Not a carcinogen

Vanadium	
Reproductive Hazard	There is limited evidence that **Vanadium** *compounds* may damage the male reproductive system in animals.
Other Long-Term Effects	**Vanadium** can irritate the lungs. Repeated exposure may cause bronchitis to develop with cough, phlegm, and/or shortness of breath. **Vanadium** may cause an asthma-like allergy. Future exposure can cause asthma attacks with shortness of breath, wheezing, cough, and/or chest tightness. **Vanadium** may damage the kidneys. Repeated high exposure may cause anemia.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/3762.pdf
PM 2.5	
Health Effects	Particles less than 2.5 micrometers in diameter (PM2.5) are referred to as "fine" particles and are believed to pose the largest health risks. Because of their small size (less than one-seventh the average width of a human hair), fine particles can lodge deep into the lungs. "Health studies have shown a significant association between exposure to fine particles and premature mortality. Other important effects include aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions, emergency room visits, absences from school or work, and restricted activity days), lung disease, decreased lung function, asthma attacks, and certain cardiovascular problems such as heart attacks and cardiac arrhythmia. Individuals particularly sensitive to fine particle exposure include older adults, people with heart and lung disease, and children." (Ref US EPA)
	More details at: http://www.epa.gov/ttn/naaqs/pm/pm25_index.html
Total Dissolved Solids (TDS)	
Effects	Total Dissolved Solids (TDS) are solids in water that can pass through a filter. TDS is a measure of amount of materials dissolved in water. The extreme levels of TDS in water adversely affect the aquatic life. High TDS concentration may also reduce the water clarity, contribute to a decrease in photosynthesis, combine with toxic compounds and heavy metals, and lead to an increase in water temperature.