BEFORE THE NATIONAL GREEN TRIBUNAL, SOUTHERN ZONE, CHENNAI
APPLICATION No.8 OF 2016 etc

ENVIRONMENTAL IMPACTS OF COAL ASH POLLUTION ON ENNORE CREEK AND SURROUNDING AREAS OF NORTH CHENNAI THERMAL POWER STATION (NCTPS) ENNORE, CHENNAI

EXPERT COMMITTEE REPORT OF
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September - December
2017

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THE HON'BLE NATIONAL GREEN TRIBUNAL,
SOUTHERN BENCH

Application Nos. 8, 152 & 198 of 2016

R. Ravimaran, Ennore, Chennai	....	Applicant
	Vs	
Union of India, MoEF& CC, Rep. by its Secretary New Delhi and 7others	....	Respondents

INTERIM REPORT OF EXPERT COMMITTEE

1. **Background**:

   a. The Hon'ble National Green Tribunal by order dated 4.08.17 constituted an Expert Committee and tasked with several Terms of Reference to assess the extent of coal flyash pollution in Kosasthalaiyar, Ennore Creek and associated regions, and to gauge its impacts. The scope of this report is restricted to the flyash contamination caused by TANGEDCO's North Chennai Thermal Power Station.

   b. However, it is noteworthy that coal flyash ponds of three power plants – TANGEDCO's North Chennai Thermal Power Station and the now closed Ennore Thermal Power Station, and NTPC's Vallur power plant -- are located in and near the Creek.

   c. On 13.8.2017, the Committee visited Ennore Creek following which the three subject experts – Dr. Balaji Narasimhan (Water Resources and Hydrology), Dr. Sultan Ismail (Soil Biology) and Dr. D. Narasimhan (Botany) drew up independent programs of study on their respective topics.

d. A consolidated response to the Terms of Reference and additional issues arising from the study is below. The individual reports of the three experts is in Annexures.

e. It is to be noted that the duration and nature of the study limits it to being a preliminary scoping study, and cannot be the basis for full and final remediation of the region. However, it can be the basis for a pre-remediation assessment and further development of a Detailed Project Report for remediation and restoration of the contaminated site.

2. **General Observations**

- Pursuant to the recommendation of this committee that a health study of workers and exposed people should be conducted, TANGEDCO had on 12.9.2017 written to Dr.Hisamuddin Papa of Human Hospital requesting him to undertake the study. However, Dr. Papa has updated the Committee that he is awaiting certain details and documents from TANGEDCO and can proceed with a study upon receipt of the information.
- The Committee intended to map the affected area using aerial drones to get a more accurate picture of the extent and intensity of the contaminated area . However, a drone survey could not be carried out for want clearance from DGCA. A rough estimate of the fly ash spill extent and the likely volume of fly ash in the ponds have been calculated based on field survey and mapping from highly resolution google earth imagery. A drone survey will be essential for improving the reported estimates as well as for formulating any remediation measures and monitoring of actual follow-up actions.
- The tail-end of the Kosasthalaiyar and the Ennore Creek and backwaters are subject to heavy siltation and pollution from multiple sources, not restricted to coal flyash pollution.
- Industrial activities in general, and coal flyash pollution from ash conveyance and storage/impoundment structures have drastically altered

the hydrology, ecology and topography of the area.

- The estuarine ecosystem consists of several habitats and is a transition zone buffering the inland freshwater areas from the coastal saline areas. Any further degradation to this region will make inland areas vulnerable to extreme weather and marine events and salinity intrusion.
- Water, flora and fauna are severely contaminated with toxic chemicals, some of which can with reasonable certainty be linked to coal flyash.
- Fish diversity, availability and quality has declined leading to a significant economic loss to fisherfolk.
- Dumping of earth for reclamation of low-lying areas and flyash pollution has reduced the area under mangroves and harmed the biological productivity of the Creek.

3. Terms of Reference:

TOR1: Location of ash ponds, their storage capacity, present storage levels, their present condition and steps taken to avoid leakage and consequent pollution from the ash ponds.

a) Location: *TANGEDCO operates two sets of Ash Ponds that fall partly or wholly within the Ennore Creek. The NCTPS' ash pond, which is subject of this enquiry, is located in the vicinity of Athipattu, Seppakkam and Puzhuthivakkam villages.. The Northern portion of the pond is the largest, and is filled with old flyash. This is the site of a new power plant being constructed by TANGEDCO.*

b) Storage capacity, present storage levels

Original Constructed Volume	**Based on the original design drawings, field measurements and satellite imagery**
Fly ash Dyke 1 (Million m^3) Old Pond	12.03
Fly ash Dyke 2 (Million m^3)	6.82
Total Installed Capacity (Million m^3)	**18.85**

Current levels of Storage	Based on an intensive field survey campaign undertaken
Fly ash Dyke 1 (Million m^3) Old Pond	11.33
Fly ash Dyke 2 (Million m^3)	6.79
Current Storage (Million m^3)	**18.12**

c) ***Their present condition and steps taken to avoid leakage and consequent pollution from the ash ponds:***

The Environmental Clearance for NCTPS II specifies as part of Condition XI that the ash pond for Phase 1 should be used only after properly lining the pond base. ***The existing ash pond is in violation of the Environmental Clearance as it is completely unlined***. The structural integrity of the impoundment structures is also not sound.

TANGEDCO's NCTPS does not have a response protocol for flyash spills caused by leaking pipelines or failure of impoundment structures. The latter can release very large quantities of coal ash into the environment with grave immediate and long-term consequences.

NCTPS' ash pond causes flyash and supernatant water pollution through several routes.

- *Through a natural drainage channel that now carries flyash-contaminated supernatant from the last stage of the pond.*
- *Supernatant water from the last stage of the flyash pond can be seen spilling out of a pipe near the TNEB pumping station at the end of the Pipeline Road. This water flows into the creek.*
- *Through spills from leaky pipelines along the Pipeline road leading from power plant to Ash Pond.*
- *Through spills as a result of flyash dyke breaches.*
- *Tidal action carries the discharged flyash up and down the creek.*
- *Intentional dumping of flyash for reclaiming low-lying areas of the Creek by*

industries. Intentional dumping of fly ash for reclaiming in the Creek region would amount to dumping of fly ash and not productive utilization of fly ash.

TOR 2: Quantity of fly ash generated by the units from the beginning of the production of the units, quantity stored in the ash ponds and quantity utilized verifying the records.

Fly Ash Generation from Stage 1 (Million Tons)		
2002 to 2017 September	Reported by NCTPS	17.31
1994 to 2001	Estimated @ 43.69% ash content of coal consumed	7.80
Fly Ash Generation from Stage 2 (Million Tons)		
2013 to 2017 September	Reported by NCTPS	5.16
	Total Fly ash Generated	**30.27**
Fly Ash Utilization from Stage 1 (Million Tons)		
2002 to 2017 September	Reported by NCTPS	15.95
1994 to 2001	Estimated annual utilization @ 20% of the total available	3.78
Fly Ash NOT SENT TO DYKE from Stage 2 (Million Tons)		
2013 to 2017 September	Inferred from the NCTPS record	2.35
(It is not clear if this fly ash not sent is utilized or stored at the NCTPS site itself)		
	Total Fly ash utilization	**22.08**
Fly Ash in Dyke after utilization (Million Tons)		
Stage 1 (2002 to 2017 September)	Reported by NCTPS	1.36
Stage 1 (1994 to 2001)	Estimated annual utilization @ 20% of the total available	4.02
Stage 2 (2013 to 2017 September)	Reported by NCTPS	2.81
	Total Fly Ash in remaining in Dyke after Utilization	**8.19**

TOR 3: Unaccounted quantity of fly ash as per the records maintained by the units

Likely Volume of Fly ash in Dyke as per the reported mass of fly ash sent to Dyke	Mass is converted to volume using a Bulk Density of 1.01 T/m^3 and 1.341 T/m^3 based	6.11 Mm^3 to 8.11 Mm^3

	on the observed density from the field extracted soil core samples	
Actual volume of fly ash present in the dykes	Based on the field survey	18.12 Mm^3 (Installed capacity is only 18.85 Mm^3)
Discrepancy in the fly ash volume	Difference between the reported fly ash sent to Dyke and the fly ash actually present in the dyke	10.01 Mm^3 to 12.01 Mm^3 more (in excess) fly ash is present in the Dykes than what is reported by NCTPS. **This means either no spill has happened or utilization as reported by NCTPS has not actually taken place or more fly ash than reported by NCTPS has take place**

TOR 4: Quantity of fly ash that leaked/ discharged/ dumped into the water bodies andpresent approx. quantity lying the water bodies.

As per note dated 31.7.2017 submitted by TANGEDCO to the Hon'ble Tribunal, the totalestimated quantum of settled flyash is 218257 m^3. However, this appears to be an underestimate. **This appears to be only less than 2% of total fly ash volume that is in discrepancy. Still more than 98% of fly ash has to be accounted for and recovered from the site.**

Visible extent of fly ash spill noticeable	From the google earth imagery and field survey	344.39 ha
Likely extent of fly ash in rivers, canals and water bodies	Best guess assessment (At least 50% of the extent of rivers, canals, waterbodies and salt pans)	309.00 ha
Estimated Volume of fly ash in the field (Mm^3)	Assuming an average fly ash deposit of 1.5m based on the field observation from the auger holes	> 9.8 Mm^3

(Note: This is only an approximate estimate. A thorough survey using Drone is needed and aided with more intense field campaign to accurately map the extent of fly ash spill in water bodies, sensitive marshland area and other areas outside the designated zone)

TOR 5: Environmental impacts resulting from the leakage/ discharge/ dumping of flyash on the following categories:

- Effect on biota health
- Effect on flora and fauna and local biodiversity including mangroves
- Reduction in species diversity, habitat loss
- Transformation of natural landscape
- Effect on human health
- Effect on use of land and resources for traditional purposes by local community, if any
- Water pollution in the water bodies. i.e. streams/canals
- Effect on ground water
- Effect on hydrology in the area and its surroundings
- Percolation of hazardous material from flyash and consequent damage to the soil and land degradation.

a. Description of Original Habitats

The tail-end of Kosasthalai River is home to several kinds of habitat – tidal mud flats, mangroves, salt marshes, deep and perennial tidal water bodies typical of coastal wetlands. The Coastal Zone Management Plan for the region, prepared and approved in 1996, (Sheet No. 2, Thiruvallur District) describes the area between Sattankuppam and the MMA (Madras Metropolitan Area) boundary as ecologically sensitive due to the presence of salt marshes and mudflats. A 2012 report of the Space Applications Centre of the Indian Space Research Organisation titled "Coastal Zones of India" describes the river in this region as intertidal mudflats, salt marsh and mud with vegetation. http://moef.nic.in/sites/default/files/Coastal_Zones_of_India.pdf

Plants are the best indicators of the habitat. The habitat is a typical saline marsh or mangrove vegetation as evidenced by the presence of sedges, mangrove and its associated species. This habitat is an interphase between coastal saline regions and inland freshwater regions and should be treated as a critical ecosystem.

b. Effect of Flyash Pollution

Flyash is transported as a slurry using seawater and dumped into the flyash pond. Leaky pipelines, leaks from the flyash pond, and accidental breaches seem to have caused the spread of flyash over large areas of the Kosasthalai river and Ennore backwaters. Flyash pollution has physically and chemically altered the ecosystem. This has had an impact on biodiversity, water and soil quality, fisheries and the livelihoods dependent on the system.

c. **Physical Effects:** The spread of flyash has altered the topography and hydrology of the area by silting up low-lying areas and water courses. The flyash ponds too have blocked eastward drainage of rain water leading to changes in land-cover and habitat types in the local region.

d. **Chemical Effects:** Flyash contains traces of several toxic heavy metals, which tend to leach out into the surrounding environment. Further, the transportation and storage of large volumes of seawater-based flyash slurry can aggravate salinisation of groundwater in an area that is already facing salinity intrusion.

e. **Water Pollution in the Water Bodies**

A total of 20 water samples were taken – 5 from the Kosasthalai River; 5 from Backwater; 3 from the river near the village; 2 samples of water from the Daikin area; 2 borewell samples; 2 Metrowater samples; 1 sample from secondary pond.

Table 3: Kosasthalaiyar River Water Sample Test Result Analysis:

PARA-METERS	KOSASTHALAYAR SAMPLES (mg/L)				
	1	2	3	4	5
B	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	0.35	BQL (LOQ :0.1
NH_3	0.63	0.72	0.62	0.65	0.62
Ba	0.52	0.49	BQL (LOQ :0.1	0.85	0.23
H2S	0.12	0.13	0.23	0.23	0.1
Cu	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	0.56	2.65
Mn	**2.36**	0.23	0.25	0.23	0.23
Hg	**23.18**	**29.1**	**18.19**	**22.11**	**18.81**
Cd	0.1049	0.1031	0.099	0.1049	0.1092
Se	**1.62**	**2.32**	**2.46**	**1.66**	**2.06**
As	**7.66**	**4.346**	**2.175**	**1.067**	**2.522**
Pb	**0.111**	**0.2379**	**0.3723**	**0.3338**	**0.277**
Zn	2.36	**6.25**	2.36	**6.23**	2.37
Al	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1
Cr	0.098	0.08	0.066	0.019	0.044
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1
Mo	BQL (LOQ :0.1	0.26	0.21	0.23	BQL (LOQ :0.1
Ni	0.56	0.51	0.78	0.65	1.57

Table 4: Backwater Sample Test Result Analysis:

PARAMETERS	BACKWATER SAMPLES(mg/L)				
	1	2	3	4	5
B	0.1	0.35	0.65	0.65	0.12
NH_3	0.67	0.75	1.25	0.23	0.56
Ba	0.23	0.45	0.56	0.85	0.74
H2S	0.14	0.35	0.23	0.04	0.15
Cu	**3.65**	**15.23**	**13.24**	**13.65**	2.36
Mn	**4.52**	**2.36**	**5.67**	0.78	0.56
Hg	**30.28**	**16.55**	**24.66**	**24.99**	**22.18**
Cd	0.09473	0.10053	0.09617	0.7729	0.07569
Se	**0.207**	**2.99**	0.01	BQL (LOQ :0.1	BQL (LOQ :0.1
As	**3.267**	**2.0895**	0.01	BQL (LOQ :0.1	BQL (LOQ :0.1
Pb	**0.3215**	**2.168**	0.01	**0.143**	**0.156**
Zn	1.26	2.78	5	BQL (LOQ :0.1	BQL (LOQ :0.1
Al	BQL (LOQ :0.1	BQL (LOQ :0.1	0.03	BQL (LOQ :0.1	BQL (LOQ :0.1
Cr	0.081	0.051	0.05	0.053	BQL (LOQ :0.1
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1	0.1	BQL (LOQ :0.1	BQL (LOQ :0.1
Mo	BQL (LOQ :0.1	BQL (LOQ :0.1	0.07	BQL (LOQ :0.1	BQL (LOQ :0.1
Ni	**3.56**	2.36	0.02	2.78	2.78

Table 5: River water Sample Test Result Analysis:

PARAMETERS	RIVER WATER SAMPLES (mg/L)				
	1	2	3		
B	0.56	0.23	0.42		
NH_3	0.23	0.36	0.56		
Ba	0.14	0.45	0.85		
H2S	0.14	1.12	1.12		
Cu	1.25	1.56	**12.56**		
Mn	0.35	0.35	0.35		
Hg	**16.95**	BQL (LOQ :0.1	**18.11**		
Cd	0.03363	0.0099	0.0227		
Se	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
As	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Pb	**0.1618**	0.088	BQL (LOQ :0.1		
Zn	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Al	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Cr	0.022	0.0024	0.044		
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Mo	0:36	0.23	0.23		
Ni	1.14	0.56	1.56		

Table 6: Daikin Vicinity water Sample Test Result Analysis:

PARAMETERS	NEAR DAIKINSAMPLES(mg/L)				
	1	2	3	4	5
B	BQL (LOQ :0.1	BQL (LOQ :0.1			
NH_3	0.79	0.75			
Ba	0.87	0.35			
H2S	0.56	0.12			
Cu	2.35	2.56			
Mn	0.18	0.23			
Hg	**10.74**	**19.35**			
Cd	0.06378	0.09544			
Se	BQL (LOQ :0.1	BQL (LOQ :0.1			
As	BQL (LOQ :0.1	BQL (LOQ :0.1			
Pb	**0.1265**	**0.1988**			
Zn	2.56	BQL (LOQ :0.1			
Al	BQL (LOQ :0.1	BQL (LOQ :0.1			
Cr	0.043	0.054			
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1			
Mo	0.56	0.52			
Ni	1.11	1.65			

- All samples from Kosasthalai River, the Backwater and secondary pond contained elevated levels of several toxic metals.
- The sample from secondary flyash pond contained elevated levels of

Barium, Sulphide (as Hydrogen Sulphide), Copper, Manganese, Mercury, Cadmium, Lead, Zinc, Molybdenum and Nickel.

- Both borewell samples taken from Seppakkam, the village west of the Ash Pond, were severely contaminated with the following heavy metals – Copper, Manganese, Cadmium, Mercury, Selenium, Lead, Chromium and Nickel. One of the samples was additionally contaminated with Molybdenum. These metals were found at levels in excess of Indian drinking water standards.
- Kosasthalai River samples were more contaminated than even legally permitted treated effluent quality. All 5 samples taken from Kosasthalai River had Lead, Mercury, Selenium and Arsenic in excess of standards for discharge of environmental pollutants into inland water bodies. 2 out of 5 samples had above standard levels of Zinc and 1 out of 5 had Manganese in excess of standard for discharge into water bodies.
- Backwater samples too were more contaminated that even legally permitted treated effluent quality. All 5 samples had mercury levels in excess of standards for discharge of environmental pollutants into inland water bodies. 4 out of 5 had Lead and Copper levels in excess of prescribed standards. 3 out of 5 had above standard levels of Manganese. 2 out of 5 had above standard levels of Arsenic and Selenium. 1 out of 5 had above standard levels of Nickel and Zinc.
- River water samples taken far from the flyash spread area too were contaminated but to a lesser extent and with fewer metals. 2 out of 3 samples had mercury in excess of standards for discharge of environmental pollutants into inland water bodies. 1 out of 3 samples had Copper and Lead in excess of standards.

***f.* Effect on ground water; Percolation of hazardous material from flyash and consequent damage to the soil and land degradation**

- Both borewell samples taken from Seppakkam, the village west of the

Ash Pond, were severely contaminated with the following heavy metals – Copper, Manganese, Cadmium, Mercury, Selenium, Lead, Chromium and Nickel. One of the samples was additionally contaminated with Molybdenum. These metals were found at levels in excess of Indian drinking water standards.

- The presence of these metals indicates that toxic contamination has already resulted due to seepage from the flyash pond. The land to the east, northeast and southeast of Seppakkam village is visibly contaminated with flyash and seawater. To the south, the area is permanently water-logged as the rainwaters are blocked by the bunds of the flyash pond.

g. Effect on biota health; Effect on flora and fauna and local biodiversity including mangroves

A total of 20 samples of fish, including 5 each of fin fish, crab, prawn and oyster/mussels were taken in addition to 5 samples of locally home-grown vegetables such as drumstick, drumstick leaves, brinjal and ladies finger.

European Union Regulation 1881/2006/EU has established the following maximum concentration limits of cadmium (Cd) and lead (Pb) in fish tissues – **Cd (0.05 mg/kg); Pb (0.30 mg/kg)**

http://eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:32006R1881&from=EN

The levels found in various fish taken from Ennore Creek have levels of Cadmium and Lead in excess of maximum concentration limits prescribed by European Union Regulation.

All 20 samples of fish contained detectable levels of Copper with a maximum recorded concentration of 68.42 mg/kg in Oyster, 66.18 mg/kg in fish, 48.36 mg/kg in crab and 0.59 mg/kg in prawn. Copper accumulates in fish gills and can cause deformity of gills, and harm their ability to navigate and hunt for food by compromising their olfactory facilities.

RoA of Oyster

- 5 out of 5 samples contained lead with range of 1.32 to 15.01 mg/kg. Lead consumption can harm bones and the mental development of young children.
- 4 out of 5 samples contained Selenium with maximum recorded concentration of 27.92 mg/kg. Selenium harms the ability of fish to reproduce.
- 1 out of 5 samples contained Cadmium with maximum recorded concentration of 0.106 mg/kg.

RoA of Prawn

- 2 out of 5 samples contained Selenium with a maximum recorded concentration of 6.37 mg/kg.
- 3 out of 5 samples contained Cadmium with a maximum recorded concentration of 1.245 mg/kg.
- 5 out of 5 samples contained lead with a maximum recorded concentration of 13.2 mg/kg.

RoA of Crab

- 2 out of 5 samples contained lead with maximum recorded concentration of 4.85 mg/kg.
- 4 out of 5 samples contained Cadmium with maximum recorded concentration of 1.37 mg/kg.

RoA of Fish

- 2 out of 5 samples contained lead with maximum concentration of 6.85 mg/kg.
- 1 out of 5 samples contained Cadmium with maximum concentration of 0.94 mg/kg.

RoA of Vegetables

- All 5 samples of home-grown vegetables returned with detectable and significant levels of Chromium and Lead. Chromium levels ranged from 1.12 to 5.56 mg/kg.

  The presence of these heavy metals cannot be linked solely to flyash given that the entire Ennore region is critically polluted due to the presence of air pollution intensive industries, and high movement of heavy vehicles, container trucks and flyash lorries.

h. Reduction in species diversity, habitat loss

i. Habitat Loss

- Intertidal, aquatic and terrestrial habitats have been altered, lost and degraded.
- To the southwest of the ash pond, dense scrub has been turned into a marshy swamp because the bund of the flyash pond blocks the eastward flow of water.

- Tidal mudflats, salt marshes and mangroves have degraded due to flyash pollution and reclamation by dumping of earth and soil from other habitats. This is leading to desertification of this critical ecosystem.
- Degradation of mangroves that form the coastal shield makes the landscape vulnerable to coastal calamities.
- These habitats are an interphase between coastal saline regions and the inland non-saline regions, and should be treated as a critical ecosystem.

ii. Reduction in Species Diversity

- Vegetation along the river bank near NCTPS is under heavy stress. Many dead stumps of the dominant mangrove species – *Avicennia marina* – can be seen, and what remains is stunted and deteriorating possibly due to the flyash deposits.
- Core mangrove species and their associates are sparsely distributed.
- *Aeluropuslagopoides*, a saline marsh grass recorded in abundance in this

area, is reduced to a few individuals.

- Mangrove and saline marsh species have significantly reduced in population. Flyash pollution and dumping of soil from outside the mangrove habitats for port-related infrastructure, roads, bridges and other industrial installations and power plants has not only shrunk the mangrove populations but also has introduced several non-habitat and alien species some of which are invasive.
- Mangrove and salt marsh habitats have undergone severe degradation and continuation of causal factors may lead to extinction of this critical coastal ecosystem.
- There are no endemic and endangered plant species recorded from this area. However, a few species recorded from Ennore are very rare in Tamil Nadu. These include *Ammaniaoctandra, Indigoferaoblogigolia,* and two sea grasses namely *Halophila ovata and Halophilaovalios.* These are locally extinct.

- *Suaedamonoica*, a saline habitat shrub that was recorded as a mono-dominant species from Kattupalli for the Northern east coast of Tamil Nadu is nearly extinct locally except for a few scattered bushes.
- Analysis based on baseline studies conducted from as early on as 1929 clearly indicates the loss of several species such as Allotropiscimicina, Atriplexrepens, Commelinasubulata, Fimbristylistriflora, Halophiaovalis, H. ovata, Indigoferaoblongifolia, Salicornia brachiata and Schoenoplectussupinus from the habitats of Ennore and Kattupalli.
- Local fisherfolk confirm that the following species of fish have either disappeared oR declined to insignificance – white prawns (*vellaiiral*), black prawns (*karuppuiral*), sand prawns (*manniral*), tiger prawn, green crab, *Plotosuscanius*(grey eel catfish or *Irun Keluthi*), *Mugilcephalus* (mullet or *madavai*), Silver biddy (*oodan*), *Sillagosihama* (*kezhangan*), *Teraponjarbua* (Perch or *keesan*), Sea bass (*koduvai*), and other fish

locally called *kalvaan*, *uppathi*, *panna* and *oodan.*

iii. Effects on Human Health

- A separate health study was commissioned by the Hon'ble Tribunal, and the results of that study will shed more light on this aspect.
- The chemicals found in the water and fish are known to exert a variety of health effects on virtually every system of the human body, including reproductive system, central and peripheral nervous systems, cardiovascular system, gastrointestinal systems etc. Some of the metals are carcinogens, and some affect the brain, kidneys and can even harm the developing foetus.
- Fisherfolk are exposed to the toxins because fishing involves prolonged contact with contaminated waters, and also accidental ingestion of contaminated water and sediment.
- Fish consumers too are at risk due to the high levels of toxic contaminants found in fish, crab, prawn and mussels.

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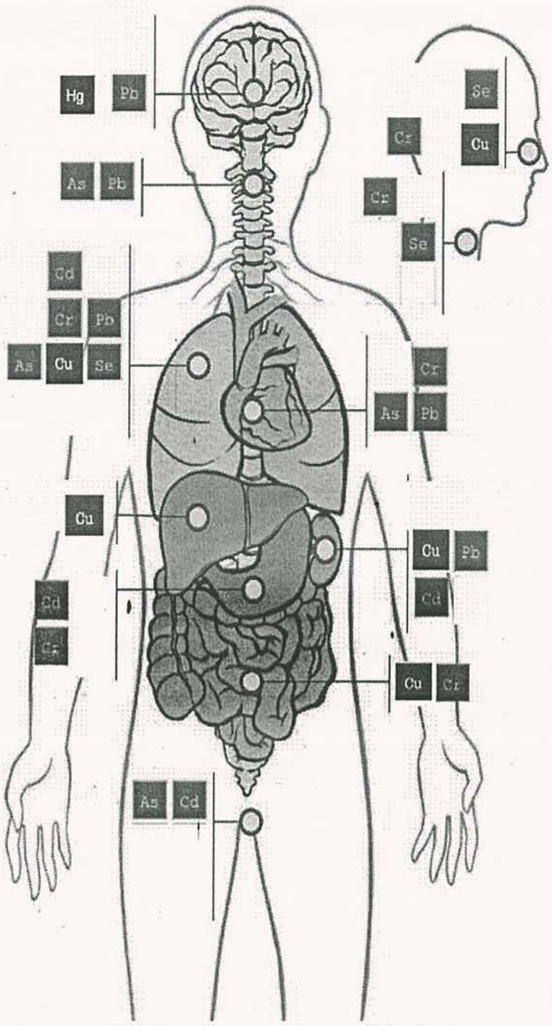
HEALTH IMPACTS OF COAL TOXICANTS



Hg MERCURY

Affects different areas of the brain and their associated functions, resulting in a variety of symptoms. These include personality changes (irritability, shyness, nervousness), tremors, changes in vision (constriction (or narrowing) of the visual field), deafness, muscle incoordination, loss of sensation, and difficulties with memory.

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.

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.

Cu COPPER

Long-term exposure to copper dust can irritate your nose, mouth, and eyes, and cause headaches, dizziness, nausea, and diarrhea.High intakes of copper can cause liver and kidney damage

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.

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

- Airborne flyash poses a serious health risk to people in the region especially since the region is already subject to severe air pollution from other sources, including other power plants, movement of diesel vehicles and container trucks to and from the port. A study titled Global Burden of Disease by US-based Health Effects Institute estimates that outdoor air pollution is the fifth major cause of premature deaths accounting for up to 6.2 lakh premature deaths in India annually.

- Residents of Seppakkam village are particularly at risk due to high levels of airborne dust, and contact with contaminated water and groundwater.

- Residents from as far away as Vallur, Minjur, Nandiambakkam and Athipattu report increased dust pollution in their residential areas. Besides toxic heavy metals, flyash is also rich in silica which can cause a lethal disease called Silicosis – often misdiagnosed as Tuberculosis.

- Workers engaged in removal of flyash – pursuant to this Court's order – continue to work without adequate respiratory or dermal protection. Considering that most of these workers are young men with a life ahead, exposure could seriously harm their economic prospects and lifespan.

- Exposed populations are also likely to bear the brunt of increased health care costs for treating recurring pollution-induced ailments.

iv. Effect on use of land and resources for traditional purposes by local community;

- The area was once a productive fishing grounds and salt pans. Salt production has virtually disappeared as a result of pollution and takeover of the salt pan wetlands for industrial sites.

- Fisherfolk continue to use the area for fishing, but the fisheries have suffered severely. Fish catch has fallen and fish quality has declined resulting in lower incomes for fishermen.

- Women from the fishing community who were engaged in cleaning and selling fish have also seen their livelihoods decline, and their livelihood efforts intensify as many of them now have to go to the fishing harbour to purchase fish for vending.
- The disappearance of oysters and mussels has also killed the livelihoods of fisherfolk who collected oyster shells for lime (Sunnambu) production.

v. Effect on hydrology in the area and its surroundings

- The fly ash dyke with western bunds that rise 6 metres above prevailing contours block the eastward flow of rainwaters from the hinterland into the Creek, resulting in flooding of settlements in Seppakam, Mouthambedu. Given that the Northern tip of the NCTPS fly ash dyke to the southern tip of the NTECL and ETPS ash pond is an unbroken dam obstructing the water flows, the impact on surface water hydrology has to be seen in a cumulative context. This hinterland has now perpetually become waterlogged.

- The design drawing seems to indicate that there are future plans to raise the bund height in three additional stages of 5m each to an ultimate height of 21m from the present height of 6m. This would mean that NCTPS is preparing themselves for more fly ash generation and less fly ash utilization which is an unsustainable model.

- The flood plains, bed of' Kosathaliyarriver and Buckingham canal have considerably aggraded due to fly ash deposits by as much as 1.0 or higher. This has considerable influence on the ecological function of the sensitive marshland ecosystem. Further, the flood carrying capacity of the river and canal also would have considerably reduced resulting in poor disposal rate of flood waters and eventually resulting in increased inundation in the upstream areas.

TOR 6: Social and economic impact if any, on the local fishermen community

- The region's fisherfolk have suffered economically and socially. Those from

SivanpadaiKuppam, Kattukuppam and Mugatwarakuppam are wholly dependent on the river and creek, and do not fish in the sea. Irulars – a scheduled tribe that lives in small hamlets in Sadayankuppam, Kattupally and in a few clusters in AthipattuPudunagar – are also traditionally dependent on creek fishing. The villages of EnnoreKuppam, Thazhankuppam and Nettukuppam fish in the creek when the sea is rough.

- A separate survey would be required to quantify the historical and ongoing losses suffered by fishers.

TOR 7: Method of Restitution/Remediation, technology to be adopted and time period and amount of funds required to restore the environment.

- Flyash is not listed as a Hazardous Waste under the Hazardous Wastes Rules, 2008. However, one report of the Central Pollution Control Board is relevant to guide the process of pre-remediation assessment, preparation of Detailed Project Report and execution of remediation and restoration plan. The document is titled "Guidelines on Implementing Liabilities for Environmental Damages due to Handling & Disposal of Hazardous Waste and Penalty."

  http://www.cpcb.nic.in/Guidelines_Environmenal_Damages_Costs_200116.pdf

- Restitution/Remediation is a specialised effort requiring coordinated execution involving experts from various disciplines. The exercise should be framed within the three principles of sound science, polluter pays and public participation.

- An independent Project Management Consultant with experience in restoring flyash contaminated sites should be engaged to prepare the pre-remediation assessment and Detailed Project Report and EIA for remediation. The DPR and EIA should be subject to public scrutiny.

- People already affected by pollution, and likely to be affected during the course of the remediation should be identified and compensated.

- The ongoing removal of flyash is incomplete and crude, as the method and depth of removal is left to the discretion of the JCB operator. Further, the equipment being used is not appropriate and not up to the task particularly of removing the flyash from the main channel and Buckingham Canal. Certain areas that are slushy with deep deposits of flyash require specialised equipment that can be identified only by remediation experts.
- Remediation should include: removal of flyash and flyash contaminated soils; treatment of formerly flyash contaminated sites to restore soil and water quality; removal and treatment of return water (supernatant); environmental assessment to verify removal of residual contamination.
- Restitution should include: putting in place mechanisms for revival of various habitats, using identifiers such as return of indicator species of flora and fauna typical of their respective habitats.

TOR 8: Any afforestation is required to be undertaken in the affected areas, if so, methodology and technique

It is premature to talk about afforestation before restoration and remediation is well underway.

TOR 9: Present position of transportation of fly ash slurry and condition of pipelines transporting flyash and action taken by the units in preventing leakage and modernisation of pipelines

- Based on our field visits, we can confirm that there have not been any leaks from the pipeline running East-West along the Ash Pipeline Road in recent months, and work has been ongoing to replace pipes here. However, minor leaks continue to be seen in the pipelines near Seppakkam. Further, the ruptured pipe carrying supernatant water from the last stage of the pond to the Pumphouse has not been plugged. Supernatant water continues to spill into the Creek. We recommend establishing and strictly adhering to a maintenance

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schedule and replacement schedule of pipes and this schedule be published to the court.

- We noticed that in addition to pipelines, a lot of fly ash (Dry) is transported in dump trucks with inadequate covering. The process of loading, vehicle transport and unloading generate fly ash dust which remains suspended for long periods and gets transported over long distances. Drivers and helpers engaged are not wearing any nose masks. We also observed that the fly ash in the dykes themselves are very dry and do not have a thin sheet of supernatant water thus resulting in dry fly ash being carried away in the wind. If it is not possible to maintain a thin sheet of water, it would be better to install a sprinkler system in place that would recycle the supernatant water to maintain a moist layer, thus preventing the fly ash from being carried away by wind. This fine dust of fly ash can cause severe respiratory problems for the workers of NCTPS as well as to the local community.

TOR 10: Implementation of MoEF& CC Notification dated 14th September, 1999 amended in 2003, 2009 and 2016 on utilisation of flyash with present position with full statistical data.

Statistics of Stage I plant

Year	Fly ash Utilization (%)
2002	12.29%
2003	23.30%
2004	22.80%
2005	32.18%
2006	57.56%
2007	74.68%
2008	188.13%
2009	148.83%
2010	109.29%
2011	241.87%
2012	159.58%
2013	86.75%
2014	63.99%
2015	138.95%
2016	92.11%
2017	43.95%

Year on year utilization percentage of fly ash is not 100%. Total cumulative utilization of fly ash generated in Stage I plant since 2002 is about 92.14%. However, based on our estimates since inception (1994) the total cumulative utilization of fly ash is about 78.58%.

Utilization of fly ash from NCTPS stage II is not very clear from the numbers provided. But we infer that it could be about 39.39% of the total cumulative ash produced till date.

The MoEF notification mandates 100% of fly ash before 31st December 2017.

The design drawing seems to indicate that there are future plans to raise the bund height in three additional stages of 5m each to an ultimate height of 21m. This would mean that NCTPS is preparing themselves for more fly ash generation and less fly ash utilization which is an unsustainable model.

4. **Additional Observations of the Members of the Committee**

- The wetlands of Kosasthalai's tail-end are subject to pollution and degradation due to reclamation activities in addition to flyash pollution and pollution from other point and non-point sources. Any restoration/remediation effort needs to be looked at from a landscape point of view and not as a piecemeal approach.

- The main river channel, which is heavily silted, would need to be desilted on a priority basis as this will facilitate tidal flow and also ease navigation and access to fisherfolk marginally improving their livelihoods.

- The pollution that is the subject of this Committee's study has been caused by two stages of North Chennai Thermal Power Station (1830 MW). In addition, there is a 1500 MW coal-fired power plant and ash pond of NTECL in Vallur. An 800 MW NCTPS Stage III, 660 MW Ennore Thermal Power Station (Annexe) and 800 MW Ennore SEZ power plants are currently under construction. Additionally, a 660 MW ETPS Replacement, 1200 MW North Chennai Power Company and 1030 MW Chennai Power Generation Ltd in Kattupalli and Kalanji are in the pipeline. Given that all these will generate flyash, a cumulative impact assessment study and carrying capacity study may be conducted before it is too late.

- Fisherfolk have already suffered heavily – both economically and socially. It would be advisable to work out a mechanism for compensating them for past damage and ongoing damage until the remediation is complete and the Creek ecosystem restored.

- Workers, including lorry and JCB drivers, cleaners, loaders and TANGEDCO officials, engaged in handling flyash or supervising such operations are totally unprotected. They must be required to wear adequate respiratory and dermal protective gear.

- Flyash surfaces must be sprinkled regularly to avoid becoming air borne.

Chennai
December 13, 2017

Dr. SULTAN AHMED ISMAIL
EXPERT COMMITTEE COORDINATOR

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ANNEXURE 1

REPORT ON FLY ASH MASS BALANCE AND EFFECT ON HYDROLOGY DUE TO FLY ASH SPILLS AROUND NORTH CHENNAI THERMAL POWER STATION (NCTPS)

ENNORE, CHENNAI

Submitted By

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November 2017

IMPORTANT NOTE: The standard SI symbol of metric ton "t" not "T" or "MT". The records of NCTPS use an informal symbol "MT" to mean "Metric Ton". But this has caused serious confusion in the analysis of the data provided by NCTPS, where the data is reported in "ton" at some places whereas in "Lakh Metric Ton" at other places but abbreviated to symbol "MT", leaving out the "Lakhs" leading to a confusion that it was "Mega ton" or "Million ton" which is 10 times more than "Lakh Metric Ton". The standard SI unit representation for Million metric ton is "Mt" or Mega gram "Mg". It is suggested that the NCTPS uses standard SI units and abbreviation while maintaining and reporting of the data.

Introduction

Visual inspections as well as corroboration with high resolution satellite imagery show that a considerable portion of the Ennore creek has been laden with fly ash deposits leading to serious hydrological and ecological impacts. A mass balance of the fly ash has been carried out to assess the likely quantum of fly ash spill.

For this assessment the following datasets have been used:

1. Fly ash generation and utilization tables provided by the NCTPS for Stage I and Stage II
2. Design drawings of the embankment and original contours of the fly ash pond site
3. Intense ground survey of the site (Note: Still DGCA permission is awaited for carrying out the drone survey as we prepare this interim report; hence, an ground survey campaign was undertaken to collect the necessary data from the accessible places on the ground itself. Such an intense ground survey was not part of the original assessment plan)
4. Mapping of the fly ash extent using high resolution satellite imagery available from google earth
5. Bore auger sampling across the site to assess the depth of fly ash deposits

Mass Balance

Table 1: Original Constructed Volume of the Dykes:

Fly ash Dyke 1 (Million m^3) Old Pond	12.03
Fly ash Dyke 2 (Million m^3)	6.82
Total Installed Capacity (Million m^3)	**18.85**

Source: Estimated based on the original design drawings, field measurements and satellite imagery

Table 2: Current levels of storage in the Dykes:

Fly ash Dyke 1 (Million m^3) Old Pond	11.33
Fly ash Dyke 2 (Million m^3)	6.79
Current Storage (Million m^3)	**18.12**

Source: Estimated as a difference between the original ground levels from the contour data provided by the NCTPS and the current elevation of fly ash fill in the ponds and integrated over the pond area (Figures 1, 2 and 3)

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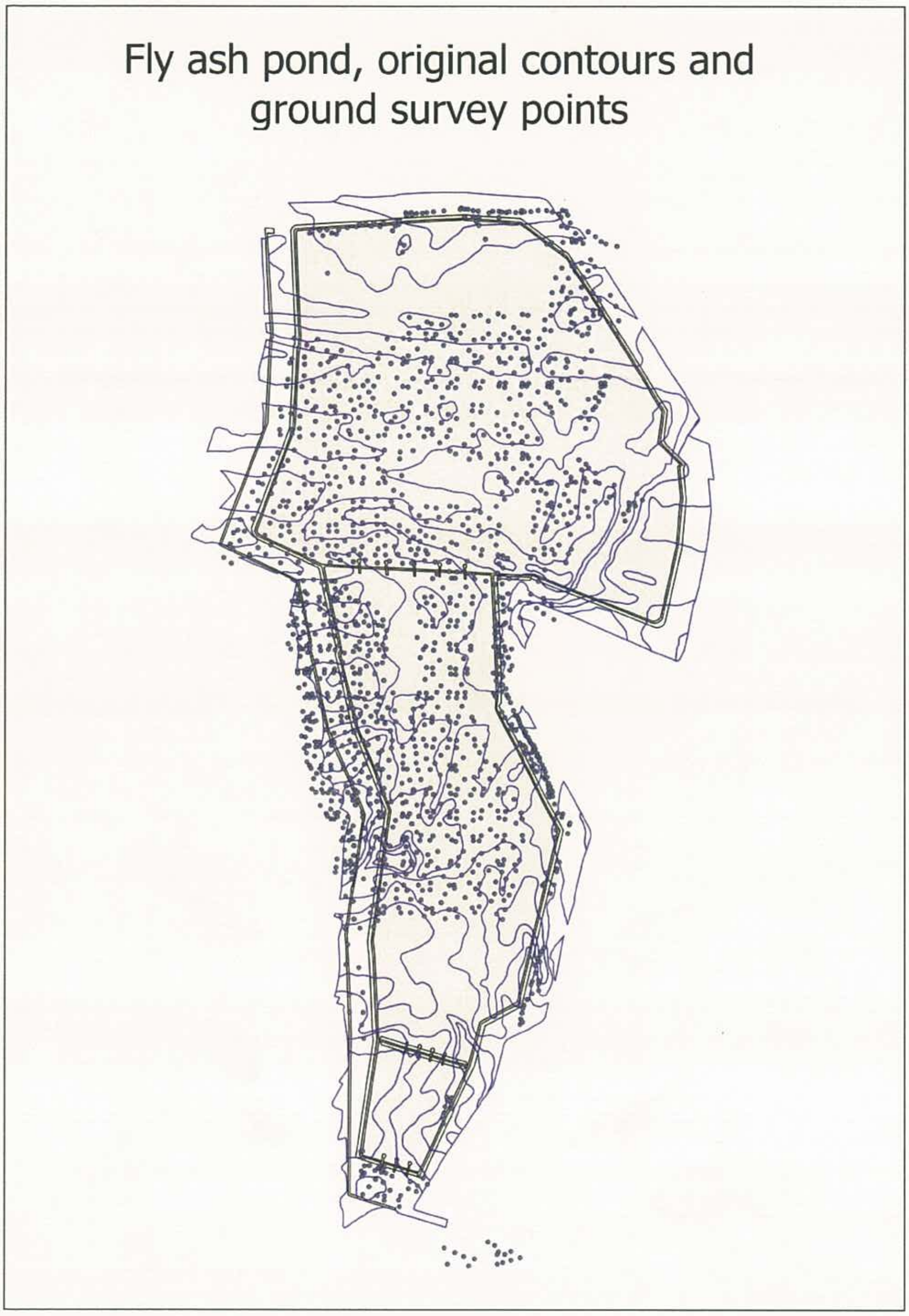

Figure 1

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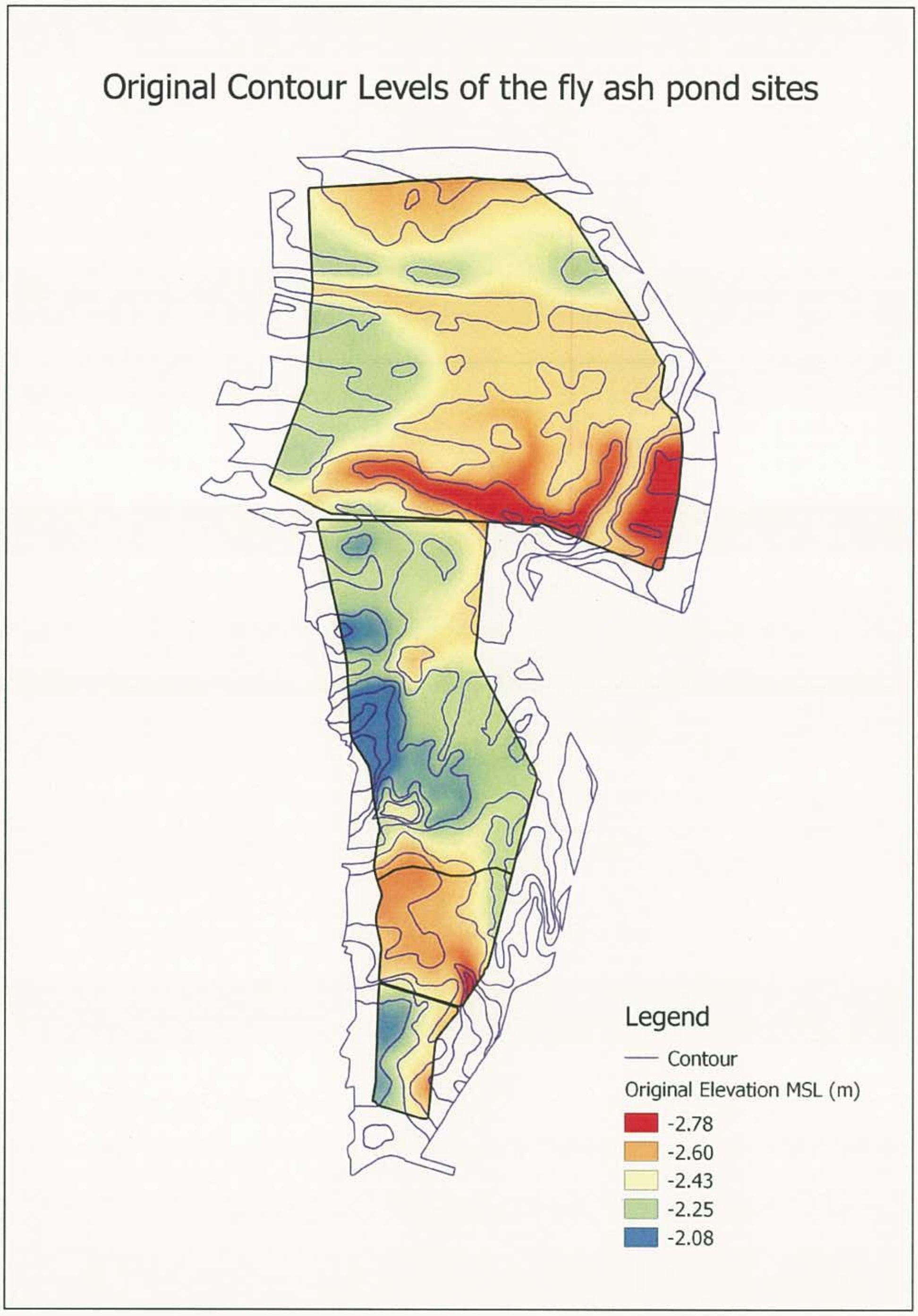
Original Contour Levels of the fly ash pond sites
Legend
Contour
Original Elevation MSL (m)
-2.78
-2.60
-2.43
-2.25
-2.08

Figure 2

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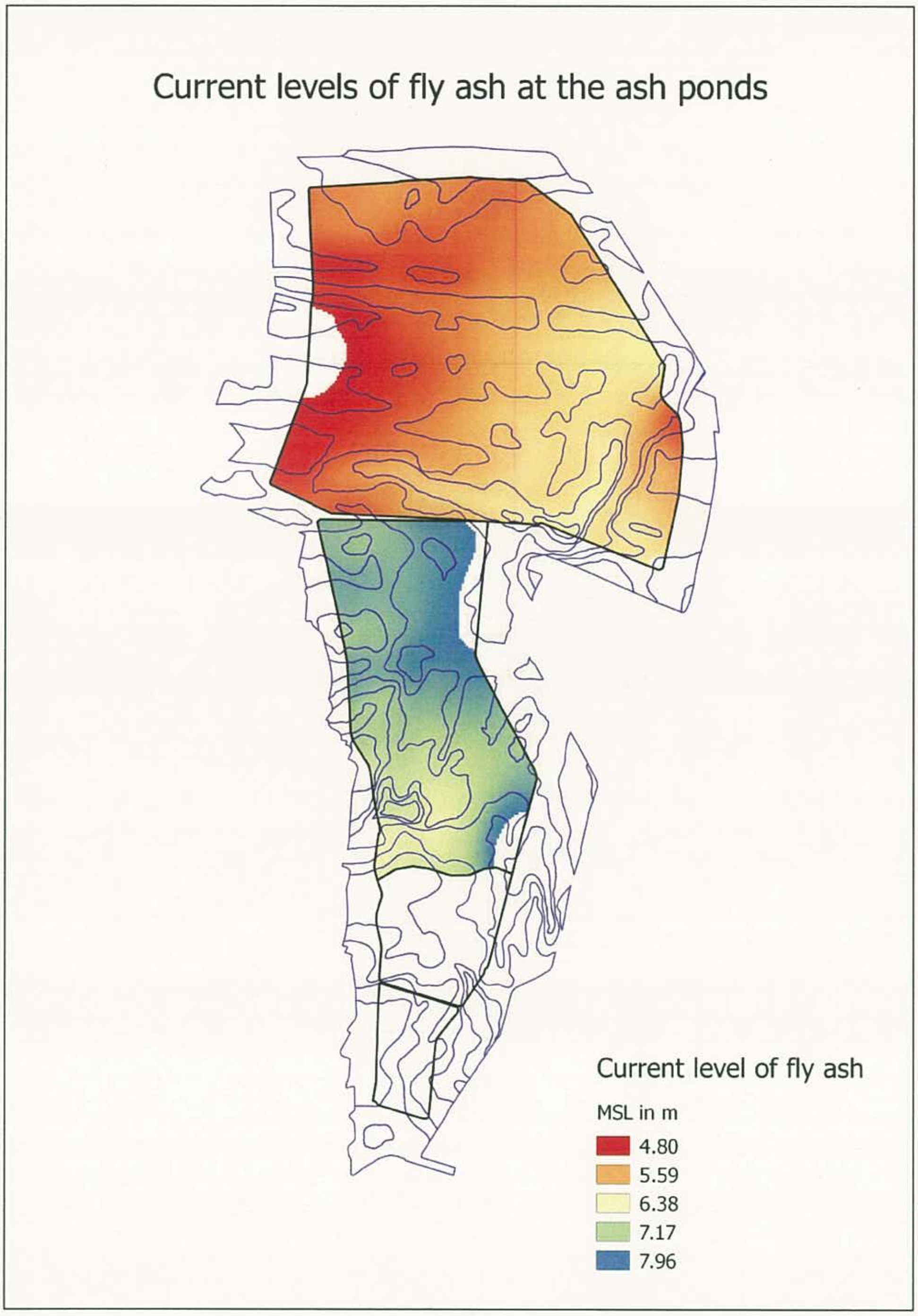

Current levels of fly ash at the ash ponds
Current level of fly ash
MSL in m
4.80
5.59
6.38
7.17
7.96

Figure 3

Table 3: Fly ash generation and utilization

Fly Ash Generation from Stage 1 (Million Tons)		
2002 to 2017 September	Reported by NCTPS	17.31
1994 to 2001	Estimated @ 43.69% ash content of coal consumed based on the ash content reported for 2001	7.80
Fly Ash Generation from Stage 2 (Million Tons)		
2013 to 2017 September	Reported by NCTPS	5.16
	Total Fly ash Generated	**30.27**
Fly Ash Utilization from Stage 1 (Million Tons)		
2002 to 2017 September	Reported by NCTPS	15.95
1994 to 2001	Estimated annual utilization @ 20% of the total available <u>(not total annual production)</u> **(This is a very optimistic estimate given the fly ash utilization reported across the country was at a level less than 5% during 1993-94)**	3.78
Fly Ash NOT SENT TO DYKE from Stage 2 (Million Tons)		
2013 to 2017 September	Inferred from the NCTPS record	2.35
(It is not clear if this fly ash not sent is utilized or stored at the NCTPS site itself)		
	Total Fly ash utilization	**22.08**
Fly Ash in Dyke after utilization (Million Tons)		
Stage 1 (2002 to 2017 September)	Reported by NCTPS	1.36
Stage 1 (1994 to 2001)	Estimated annual utilization @ 20% of the total available	4.02
Stage 2 (2013 to 2017 September)	Reported by NCTPS	2.81
	Total Fly Ash remaining in Dyke after Utilization	**8.19**

Year on year utilization percentage of fly ash is not 100%. Total cumulative utilization of fly ash generated in Stage I plant since 2002 is about 92.14%. Estimates of fly ash generated and utilized during the period 1994 to 2001 was not available. Hence, an estimate of fly ash generation was made assuming a fly ash generation of 43.69%, the same percentage as reported during 2001. Further, a very optimistic utilization rate of 20% of available fly ash, not a percentage of annual generated fly ash was assumed. This is because in any given year utilization can be more than the generated amount due to carry over of fly ash to subsequent years. This is optimistic because, the fly ash utilization reported across the country was at a level less than 5% during 1993-94. Hence, based on our estimates since inception (1994) the total cumulative utilization of fly ash is estimated to be about 78.58% including the 92% utilization rate reported by NCTPS during the 2002 to 2017 time period.

Utilization of fly ash from NCTPS stage II is not very clear from the numbers provided. But we infer that it could be about 39.39% of the total cumulative ash produced till date.

<u>The MoEF notification mandates 100% of fly ash before 31st December 2017.</u>

The design drawing seems to indicate that there are future plans to raise the bund height in three additional stages of 5m each to an ultimate height of 21m. This would mean that NCTPS is preparing themselves for more fly ash generation and less fly ash utilization which is an unsustainable model.

Conversion of mass estimates to volume estimates of fly ash

Conversion of this mass of fly ash into volume would need an estimate of bulk density which would vary considerably based on the level of consolidation of the fly ash over a period of time. Hence, undisturbed bore auger samples were collected for collecting fly ash up to depth of 9ft at the fly ash pond locations using a special equipment called as "Hollow Stem Auger" at 6 locations and at 18 locations using "Slide Hammer" auger.

The in-situ dry bulk density of the core samples at different depths and sites ranged from 0.990 g/cc to 1.801 g/cc thus indicating different levels of compaction of fly ash in the field. The average bulk density of different samples is about 1.341 g/cc. Hence, 8.19 Million ton of fly ash would be in volume terms vary based on the level of looseness or consolidation in the field.

Assuming that the bulk density of the fly ash is between 1.01 g/cc and 1.341 g/cc, the volume of fly ash remaining in the Dyke after utilization should be between only 6.11 Mm^3 to 8.11 Mm^3. However, the fly ash estimated to be in the pond is much higher, 18.12 Mm^3 (Table 2). There is a discrepancy of 10.01 Mm^3 to 12.01 Mm^3 more (in excess) fly ash is present in the Dykes than what is reported by NCTPS. This means either no spill has happened (which is contrary to the observation on the site) or utilization as reported by NCTPS has not actually taken place or more fly ash than reported by NCTPS has taken place during the power generation.

Figure 4. Undisturbed core samples collected using slide hammer auger (18 locations)

Figure 5. Undisturbed core samples collected using Hollow Stem Auger

Figure 6. Undisturbed fly ash core sample collection locations

Extent of Fly ash spill in the study area and impediments to the hydrological flows

The Committee intended to map the affected area using aerial drones to get a more accurate picture of the extent and intensity of the contaminated area . However, a drone survey could not be carried out for want of clearance from DGCA. A rough estimate of the fly ash spill extent and the likely volume of fly ash in the ponds have been calculated based on field survey and mapping from highly resolution google earth imagery. A drone survey will be essential for improving the reported estimates as well as for formulating any remediation measures and monitoring of actual follow-up actions.

The survey data of the region from the recent survey of India open series map clearly shows the fly ash affected region to be predominantly salt pans. (Figure 7). This corroborate well with the 1965 declassified aerial imagery (Figure 8) from NASA which clearly shows the predominant salt pan activity in this region. Further this image also clearly shows the free cross drainage of runoff through the salt pan region into the Kosathaliyar river.

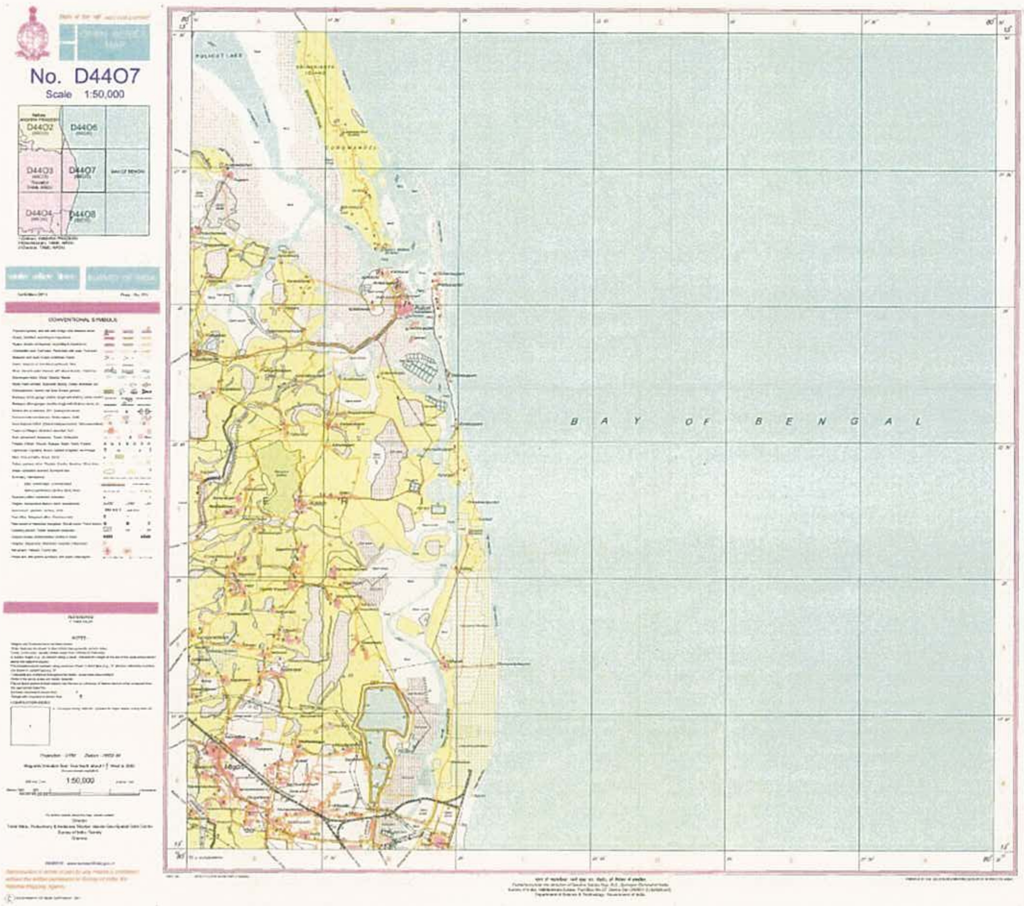

Figure 7. Survey of India toposheet clearly showing the affected area as salt pan region

Figure 8. High resolution aerial imagery of the region acquired from the declassified imagery of NASA acquired during the 1960's (most probably 1965)

Figure 9. High resolution satellite imagery of the region from google earth (between February and March 2017)

The recent google earth imagery as well as the field visits clearly shows the extent of fly ash spill in the region and the devastation it is causing to the sensitive marshland ecosystem.

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Figure 10

Table 4: Extent of fly ash spill

Visible extent of fly ash spill noticeable	From the google earth imagery and field survey	344.39 ha
Likely extent of fly ash in rivers, canals and water bodies	Best guess assessment (At least 50% of the extent of rivers, canals, waterbodies and salt pans)	309.00 ha
Estimated Volume of fly ash in the field (Mm^3)	Assuming an average fly ash deposit of 1.5m based on the field observation from the auger holes	> 9.8 Mm^3

From the high resolution google earth imagery the mapped extent of visible fly ash spill is about 344.39 ha outside the pond area. Further, we infer that about 309 ha salt pans, canals, rivers and water bodies are also likely impacted with fly ash. However, detailed mapping using drone and aided with much more intensive field survey is needed to map the actual extent of fly ash spill due to the difficult terrain conditions and loose sand like conditions at several places.

As per note dated 31.7.2017 submitted by TANGEDCO to the Hon'ble Tribunal, the total estimated quantum of settled flyash is 2,18,257 m^3. However, this appears to be a gross underestimate. This appears to be only less than 2% of total fly ash volume that is in discrepancy. Still more than 98% of fly ash has to be accounted for and recovered from the site.

Effect on hydrology in the area and its surroundings

The fly ash dyke with western bunds that rise 6 metres above prevailing contours block the eastward flow of rainwaters from the hinterland into the Creek, resulting in flooding of settlements in Seppakam, Mouthambedu. Given that the Northern tip of the NCTPS fly ash dyke to the southern tip of the NTECL and ETPS ash pond is an unbroken dam obstructing the water flows, the impact on surface water hydrology has to be seen in a cumulative context. This hinterland has now perpetually become waterlogged.

The design drawing seems to indicate that there are future plans to raise the bund height in three additional stages of 5m each to an ultimate height of 21m from the present height of 6m. This would mean that NCTPS is preparing themselves for more fly ash generation and less fly ash utilization which is an unsustainable model.

The flood plains, bed of Kosathaliyar river and Buckingham canal have considerably aggraded due to fly ash deposits by as much as 1.0 or higher. This has considerable influence on the ecological function of the sensitive marshland ecosystem. Further, the flood carrying capacity of the river and canal also would have considerably reduced resulting in poor disposal rate of flood waters and eventually resulting in increased inundation in the upstream areas.

The design drawing seems to indicate that there are future plans to raise the bund height in three additional stages of 5m each to an ultimate height of 21m. This would mean that NCTPS is preparing themselves for more fly ash generation and less fly ash utilization which is an unsustainable model.

Based on our field visits, we can confirm that there have not been any leaks from the pipeline running East-West along the Ash Pipeline Road in recent months, and work has been ongoing to replace pipes here. However, minor leaks continue to be seen in the pipelines near Seppakkam. Further, the ruptured pipe carrying supernatant water from the last stage of the pond to the Pumphouse has not been plugged. Supernatant water continues to spill into the Creek. We recommend establishing and strictly adhering to a maintenance schedule and replacement schedule of pipes and this schedule be published to the court.

Closing Remarks:

There is a discrepancy of 10.01 Mm^3 to 12.01 Mm^3 more (in excess) fly ash is present in the Dykes than what is reported by NCTPS. This means either no spill has happened (which is contrary to the observation on the site) or utilization as reported by NCTPS has not actually taken place or more fly ash than reported by NCTPS has taken place during the power generation. Hence a thorough audit of all records regarding fly ash generation and fly ash utilization is needed to check for errors in reporting.

A detailed mapping using drone and aided with much more intensive field survey is needed to map the actual extent of fly ash spill due to the difficult terrain conditions and loose sand like conditions at several places. Further, drone survey will be essential for improving the reported estimates as well as for formulating any remediation measures and monitoring of actual follow-up actions by the NCTPS. It is requested that the honourable court issue a directive for a speedy clearing of the request to the DGCA for undertaking the drone survey. However, I wish to submit that water logging due to the recent monsoon may impede the timing to undertake the drone survey immediately. The drone survey aided with intensive field campaign can take place after the ground has sufficiently dried out leaving only the influence due to the tides.

Chennai
December 13, 2017

Dr. Balaji Narasimhan

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ANNEXURE - 11

REPORT ON ENVIRONMENTAL INVESTIGATION OF IMPACTS OF COAL ASH POLLUTION ON ENNORE CREEK AND SURROUNDING AREAS AROUND NORTH CHENNAI THERMAL POWER STATION (NCTPS)

ENNORE, CHENNAI

Submitted By

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Professor & HOD (Retd), Department of Biotechnology,
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November 2017

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INTRODUCTION

Ennore Creek is a site of gross flyash pollution. However, because of high combustion temperatures for coal, the resultant flyash is also known to contain nano particles of compounds such as Titanium dioxide that may be biologically active under certain conditions.

Fly ash can easily be carried for long distances by air as well as by water. Their easy incorporation into soil pores as the estuary is predominantly sand based system can also affect the rhizospheres of the halophytes present over there. The tendency of these particles to clog the lamellae of crustacean and molluscan forms can also have a significant effect on the biodiversity of the region.

The whole region is the interface between saline marsh areas and the freshwater and terrestrial habitats further inland. For a tidal wetland of this size, we saw a remarkable lack of floral and faunal diversity. Birds, which are an indicator of healthy biomass, were conspicuously absent. Predominant halophytes have been marginalized and the density of crab pores and shells of clams and oysters on the shores is sparse.

Coal typically contains large quantities of silica, iron oxides, and calcium oxides, and trace quantities of other minerals containing mercury, arsenic, cadmium, chromium, lead, antimony, strontium, uranium and thorium. The latter two also decay into other radioactive products like radium and radon. All these metals are toxic. Some, such as mercury, can change into more lethal forms and build up in the environment to dangerous levels. (See Table 1)

Coal ash or fly ash contains high levels of iron, silica, and traces of heavy metals like arsenic, chromium, zinc, copper, cadmium, lead and selenium. One of the most significant contaminant in coal ash is silica. Silica-laden dust is particularly dangerous as it is known to cause "silicosis" -- a fatal lung disease caused by inhaling silica.

According to the US Geological Survey's factsheet titled "Trace Elements in Coal Ash," "Coal fly ash consists of fine particles, which contain a mixture of minerals such as clays, quartz, iron oxides, aluminosilicate glass formed by melting of mineral matter at the high temperatures of combustion, and unburned carbon remaining after the combustion process. Major chemical constituents of coal fly ash typically include silicon (Si), aluminum (Al), and iron (Fe), listed in order of decreasing abundance when expressed as oxides (elements in combination with oxygen), with lesser amounts of oxides of calcium (Ca), magnesium (Mg), potassium (K), sulfur (S), titanium (Ti), and phosphorus (P) whose proportions tend to be more variable. Coal ash also contains minor amounts of trace elements, including chromium (Cr), nickel (Ni), zinc (Zn), arsenic (As), selenium

(Se), cadmium (Cd), antimony (Sb), mercury (Hg), and lead (Pb). In addition, uranium (U) is commonly present at concentrations ranging from 10 to 30 ppm, which is near the upper limit of concentrations found in naturally formed rocks such as granite and black shale."

Source: https://pubs.usgs.gov/fs/2015/3037/pdf/fs2015-3037.pdf

Table 1: Toxic Heavy Metals in North American Coal in milligram per kg of coal

Metal	Content in Coal (mg/kg)	Health and ecological effects
Arsenic	7.6	Carcinogen. Affects heart, skin, peripheral nervous system. Accumultates in freshwater plants and bivalves and enters food supply
Cadmium	0.058	Causes lung and prostate cancer, bone diseaser, anemia and learning disabilities
Chromium	22	Nasal ulcers, respiratory disorders, lung cancer, stomach tumours. Sperm damage reported in lab animals.
Lead	48	No safe level for children. Neurological damage. Learning disabilities, attention disorders and behavioural problems
Antimony	0.7	Respiratory, cardiovascular and gastroenteric disorders.
Strontium	340	Naturally occuring strontium not harmful. But radioactive isotopes can cause bone cancer.
Uranium	1	Reproductive toxin. Can also affect kidney, brain, liver and heart. Uranium decays into radon which is associated with lung cancer.
Mercury	0.22	Potent neurotoxin. Affects central nervous system. Dental problems. Memory loss. Methyl mercury can affect pregnancy outcomes. Cause serious birth defects.

**** Note: Levels of metals in coal varies widely from one mine to another.***

Storage and Risks Associated with Fly Ash Impoundment Structures

In the United States, coal ash is required to be stored in ash ponds or engineered impoundment structures. However, storage and disposal of large volumes of coal ash is expensive and is associated with high risk of groundwater contamination and potential spillage into surrounding environment due to failure of impoundment structures. The US Geological Survey notes that "Long-term storage of coal ash can be problematic because water infiltration (from rain or snow) combined with leaky storage sites may result in the transport of coal ash and its constituent elements into the local environment. If ash impoundments fail, there is potential for widespread and prolonged impacts such as impairment of ecosystem functions and the loss of plant and animal life and habitat"

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The Study

20 samples each of flyash, water and fish (5 samples each of fin fish, crab, oyster/mussel and prawn), and 5 samples of vegetables grown in the neighbouring area were collected. Fish, vegetables and water samples were taken by a technician from Tamil Nadu Test House on 28.9.2017. Flyash samples were taken on 7.10.2017 by Stratus Inc.

Flyash, fish and vegetables were analysed for 8 metals – Lead (Pb), Mercury (Hg), Cadmium (Cd), Selenium (Se), Arsenic (As), Chromium (Cr), Tin (Sn) and Copper (Cu). The fish and vegetables were additionally analysed for the presence of aflatoxins and pathogenic indicators.

The water samples were tested for the following parameters, in addition to aflatoxins and pathogenic indicators – Barium (Ba), Boron (B), Ammonia (NH3), Hydrogen Sulphide (H2S), Manganese (Mn), Zinc (Zn), Aluminum (Al), Silver (Ag), Molybdenum (Mo), Nickel, Lead (Pb), Mercury (Hg), Cadmium (Cd), Selenium (Se), Arsenic (As), Chromium (Cr) and Copper (Cu).

The samples were additionally tested for the presence of pathogenic microorganisms and Aflatoxins.

Findings

The Results of Analyses are presented below and compared against the standards in Table 2.

RoA Water

A total of 20 water samples were taken – 5 from the Kosasthalai River; 5 from Backwater; 3 from the river near the village; 2 samples of water from the Daikin area; 2 borewell samples; 2 Metrowater samples; 1 sample from secondary pond.

- All samples from Kosasthalai River, the Backwater and secondary pond contained elevated levels of several toxic metals.
- The sample from secondary flyash pond contained elevated levels of Barium, Sulphide (as Hydrogen Sulphide), Copper, Manganese, Mercury, Cadmium, Lead, Zinc, Molybdenum and Nickel.
- Both borewell samples taken from Seppakkam, the village west of the Ash Pond, were severely contaminated with the following heavy metals – Copper, Manganese, Cadmium, Mercury, Selenium, Lead, Chromium and Nickel. One of the samples was additionally contaminated with Molybdenum. These metals were found at levels in excess of Indian drinking water standards.
- Kosasthalai River samples were more contaminated than even legally permitted treated effluent quality. All 5 samples taken from Kosasthalai River had Lead, Mercury, Selenium and Arsenic in excess of standards for discharge of environmental pollutants into inland water bodies. 2 out of 5

samples had above standard levels of Zinc and 1 out of 5 had Manganese in excess of standard for discharge into water bodies.

- Backwater samples too were more contaminated that even legally permitted treated effluent quality. All 5 samples had mercury levels in excess of standards for discharge of environmental pollutants into inland water bodies. 4 out of 5 had Lead and Copper levels in excess of prescribed standards. 3 out of 5 had above standard levels of Manganese. 2 out of 5 had above standard levels of Arsenic and Selenium. 1 out of 5 had above standard levels of Nickel and Zinc.

- River water samples taken far from the flyash spread area too were contaminated but to a lesser extent and with fewer metals. 2 out of 3 samples had mercury in excess of standards for discharge of environmental pollutants into inland water bodies. 1 out of 3 samples had Copper and Lead in excess of standards.

- Most samples had above permissible levels of B1 aflatoxin and other pathogenic microorganism including E. Coli. However, the source of this dangerous contamination is likely to be from sewage and fecal contamination not flyash. This indicates that the ecosystem is suffering from insults from various sources.

Effect on ground water; Percolation of hazardous material from flyash and consequent damage to the soil and land degradation

- Both borewell samples taken from Seppakkam, the village west of the Ash Pond, were severely contaminated with the following heavy metals – Copper, Manganese, Cadmium, Mercury, Selenium, Lead, Chromium and Nickel. One of the samples was additionally contaminated with Molybdenum. These metals were found at levels in excess of Indian drinking water standards.

- The presence of these metals indicates that toxic contamination has already resulted due to seepage from the flyash pond. The land to the east, northeast and southeast of Seppakkam village is visibly contaminated with flyash and seawater. To the south, the area is permanently water-logged as the rainwaters are blocked by the bunds of the flyash pond.

Table 2: Standard for Discharge of Pollutants to Inland Water Body

Metal/Parameter	Surface Water (mg/L) The Environment (Protection) Rules, 1986 Schedule VI General standards for discharge of environmental pollutants into Inland Water Body
Cu (Copper)	**3 mg/l**
Mn (Manganese)	**2 mg/l**
Hg (Mercury)	**0.01 mg/l**
Cd (Cadmium)	**2 mg/l**
Se (Selenium)	**0.05 mg/l**
As (Arsenic)	**0.2 mg/l**
Pb(Lead)	**0.1 mg/l**
Zn(Zinc)	**5 mg/l**
Cr (Chromium)	**2 mg/l**
Ni (Nickel)	**3 mg/l**

http://cpcb.nic.in/GeneralStandards.pdf

Table 3: Kosasthalaiyar River Water Sample Test Result Analysis:

PARAMETERS	KOSASTHALAYAR SAMPLES (mg/L)				
	1	2	3	4	5
B	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	0.35	BQL (LOQ :0.1
NH_3	0.63	0.72	0.62	0.65	0.62
Ba	0.52	0.49	BQL (LOQ :0.1	0.85	0.23
H2S	0.12	0.13	0.23	0.23	0.1
Cu	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	0.56	2.65
Mn	**2.36**	0.23	0.25	0.23	0.23
Hg	**23.18**	**29.1**	**18.19**	**22.11**	**18.81**
Cd	0.1049	0.1031	0.099	0.1049	0.1092
Se	**1.62**	**2.32**	**2.46**	**1.66**	**2.06**
As	**7.66**	**4.346**	**2.175**	**1.067**	**2.522**
Pb	**0.111**	**0.2379**	**0.3723**	**0.3338**	**0.277**
Zn	2.36	**6.25**	2.36	**6.23**	2.37
Al	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1
Cr	0.098	0.08	0.066	0.019	0.044
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1
Mo	BQL (LOQ :0.1	0.26	0.21	0.23	BQL (LOQ :0.1
Ni	0.56	0.51	0.78	0.65	1.57

Table 4: Backwater Sample Test Result Analysis:

PARAMETERS	BACKWATER SAMPLES (mg/L)				
	1	2	3	4	5
B	0.1	0.35	0.65	0.65	0.12
NH_3	0.67	0.75	1.25	0.23	0.56
Ba	0.23	0.45	0.56	0.85	0.74
H2S	0.14	0.35	0.23	0.04	0.15
Cu	**3.65**	**15.23**	**13.24**	**13.65**	2.36
Mn	**4.52**	**2.36**	**5.67**	0.78	0.56
Hg	**30.28**	**16.55**	**24.66**	**24.99**	**22.18**
Cd	0.09473	0.10053	0.09617	0.7729	0.07569
Se	**0.207**	**2.99**	0.01	BQL (LOQ :0.1	BQL (LOQ :0.1
As	**3.267**	**2.0895**	0.01	BQL (LOQ :0.1	BQL (LOQ :0.1
Pb	**0.3215**	**2.168**	0.01	**0.143**	**0.156**
Zn	1.26	2.78	5	BQL (LOQ :0.1	BQL (LOQ :0.1
Al	BQL (LOQ :0.1	BQL (LOQ :0.1	0.03	BQL (LOQ :0.1	BQL (LOQ :0.1
Cr	0.081	0.051	0.05	0.053	BQL (LOQ :0.1
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1	0.1	BQL (LOQ :0.1	BQL (LOQ :0.1
Mo	BQL (LOQ :0.1	BQL (LOQ :0.1	0.07	BQL (LOQ :0.1	BQL (LOQ :0.1
Ni	**3.56**	2.36	0.02	2.78	2.78

Table 5: River water Sample Test Result Analysis:

PARAMETERS	RIVER WATER SAMPLES (mg/L)				
	1	2	3		
B	0.56	0.23	0.42		
NH_3	0.23	0.36	0.56		
Ba	0.14	0.45	0.85		
H2S	0.14	1.12	1.12		
Cu	1.25	1.56	**12.56**		
Mn	0.35	0.35	0.35		
Hg	**16.95**	BQL (LOQ :0.1	**18.11**		
Cd	0.03363	0.0099	0.0227		
Se	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
As	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Pb	**0.1618**	0.088	BQL (LOQ :0.1		
Zn	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Al	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Cr	0.022	0.0024	0.044		
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Mo	0.36	0.23	0.23		
Ni	1.14	0.56	1.56		

Table 6: Daikin Vicinity water Sample Test Result Analysis:

PARAMETERS	NEAR DAIKIN SAMPLES (mg/L)				
	1	2	3	4	5
B	BQL (LOQ :0.1	BQL (LOQ :0.1			
NH_3	0.79	0.75			
Ba	0.87	0.35			
H2S	0.56	0.12			
Cu	2.35	2.56			
Mn	0.18	0.23			
Hg	**10.74**	**19.35**			
Cd	0.06378	0.09544			
Se	BQL (LOQ :0.1	BQL (LOQ :0.1			
As	BQL (LOQ :0.1	BQL (LOQ :0.1			
Pb	**0.1265**	**0.1988**			
Zn	2.56	BQL (LOQ :0.1			
Al	BQL (LOQ :0.1	BQL (LOQ :0.1			
Cr	0.043	0.054			
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1			
Mo	0.56	0.52			
Ni	1.11	1.65			

Effect on biota health; Effect on flora and fauna and local biodiversity including mangroves

Flyash

Flyash was pervasively found in and around the wetlands associated with the Kosasthalaiyar and Ennore backwaters. 20 samples of flyash were collected from various locations and analysed for heavy metals.

RoA Flyash samples

- 3 out of 20 samples contained Selenium. Maximum concentration 16.49 mg/kg. Selenium is a signature chemical that marks contamination by products of fossil fuel combustion. As such it is a good indicator of coal ash contamination. Selenium is a reproductive toxin for fish, and is harmful to fish diversity and quantity.
- All samples contained Copper, with maximum recorded concentration of 40.18.
- 13 out of 20 flyash samples contained Chromium (Total Cr) with a maximum recorded concentration of 13.71 mg/kg. Hexavalent chromium is a toxic chemical.
- 6 out of 20 samples contained lead (Pb) with maximum recorded concentration of 6.61 mg/kg.
- 6 out of 20 samples contained Cadmium with a maximum recorded concentration of 0.54 mg/kg.

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Fish

A total of 20 samples of fish, including 5 each of fin fish, crab, prawn and oyster/mussels were taken in addition to 5 samples of locally home-grown vegetables such as drumstick, drumstick leaves, brinjal and ladies finger.

European Union Regulation 1881/2006/EU has established the following maximum concentration limits of cadmium (Cd) and lead (Pb) in fish tissues – Cd (0.05 mg/kg); Pb (0.30 mg/kg)
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006R1881&from=EN

The levels found in various fish taken from Ennore Creek have levels of Cadmium and Lead in excess of maximum concentration limits prescribed by European Union Regulation.

- All 20 samples of fish contained detectable levels of Copper with a maximum recorded concentration of 68.42 mg/kg in Oyster, 66.18 mg/kg in fish, 48.36 mg/kg in crab and 0.59 mg/kg in prawn. Copper accumulates in fish gills and can cause deformity of gills, and harm their ability to navigate and hunt for food by compromising their olfactory facilities.

  - ***RoA of Oyster***

    - 5 out of 5 samples contained lead with range of 1.32 to 15.01 mg/kg. Lead consumption can harm bones and the mental development of young children.
    - 4 out of 5 samples contained Selenium with maximum recorded concentration of 27.92 mg/kg. Selenium harms the ability of fish to reproduce.
    - 1 out of 5 samples contained Cadmium with maximum recorded concentration of 0.106 mg/kg.

  - ***RoA of Prawn***

    - 2 out of 5 samples contained Selenium with a maximum recorded concentration of 6.37 mg/kg.
    - 3 out of 5 samples contained Cadmium with a maximum recorded concentration of 1.245 mg/kg.
    - 5 out of 5 samples contained lead with a maximum recorded concentration of 13.2 mg/kg.

- ***RoA of Crab***
  - 2 out of 5 samples contained lead with maximum recorded concentration of 4.85 mg/kg.
  - 4 out of 5 samples contained Cadmium with maximum recorded concentration of 1.37 mg/kg.

- ***RoA of Fish***
  - 2 out of 5 samples contained lead with maximum concentration of 6.85 mg/kg.
  - 1 out of 5 samples contained Cadmium with maximum concentration of 0.94 mg/kg.

- ***RoA of Vegetables***
  - All 5 samples of home-grown vegetables returned with detectable and significant levels of Chromium and Lead. Chromium levels ranged from 1.12 to 5.56 mg/kg.
  - The presence of these heavy metals cannot be linked solely to flyash given that the entire Ennore region is critically polluted due to the presence of air pollution intensive industries, and high movement of heavy vehicles, container trucks and flyash lorries.

Reduction in species diversity, habitat loss

Habitat Loss

- Intertidal, aquatic and terrestrial habitats have been altered, lost and degraded.
- To the southwest of the ash pond, dense scrub has been turned into a marshy swamp because the bund of the flyash pond blocks the eastward flow of water.

Reduction in species diversity

- Local fisherfolk confirm that the following species of fish have either disappeared to declined to insignificance – white prawns (*vellai iral*), black prawns (*karuppu iral*), sand prawns (*mann iral*), tiger prawn, green crab, *Plotosus canius* (grey eel catfish or *Irun Keluthi*), *Mugil cephalus* (mullet or *madavai*), Silver biddy (*oodan*), *Sillago sihama* (*kezhangan*), *Terapon jarbua* (Perch or *keesan*), Sea bass (*koduvai*), and other fish locally called *kalvaan*, *uppathi*, *panna* and *oodan.*

- Selenium can harm the ability of fish species to reproduce and harm entire populations over the long run. Copper can interfere with oxygen exchange in fish gills.

Effect s on Human Health

- A separate health study was commissioned by the Hon'ble Tribunal, and the results of that study will shed more light on this aspect.
- The chemicals found in the water and fish are known to exert a variety of health effects on virtually every system of the human body, including reproductive system, central and peripheral nervous systems, cardiovascular system, gastrointestinal systems etc. Some of the metals are carcinogens, and some affect the brain, kidneys and can even harm the developing foetus.
- Fisherfolk are exposed to the toxins because fishing involves prolonged contact with contaminated waters, and also accidental ingestion of contaminated water and sediment.
- Fish consumers too are at risk due to the high levels of toxic contaminants found in fish, crab, prawn and mussels.
- Airborne flyash poses a serious health risk to people in the region especially since the region is already subject to severe air pollution from other sources, including other power plants, movement of diesel vehicles and container trucks to and from the port. A study titled Global Burden of Disease by US-based Health Effects Institute estimates that outdoor air pollution is the fifth major cause of premature deaths accounting for up to 6.2 lakh premature deaths in India annually.
- Residents of Seppakkam village are particularly at risk due to high levels of airborne dust, and contact with contaminated water and groundwater.
- Residents from as far away as Vallur, Minjur, Nandiambakkam and Athipattu report increased dust pollution in their residential areas. Besides toxic heavy metals, flyash is also rich in silica which can cause a lethal disease called Silicosis – often misdiagnosed as Tuberculosis.
- Workers engaged in removal of flyash – pursuant to this Court's order – continue to work without adequate respiratory or dermal protection. Considering that most of these workers are young men with a life ahead, exposure could seriously harm their economic prospects and lifespan.
- Exposed populations are also likely to bear the brunt of increased health care costs for treating recurring pollution-induced ailments.

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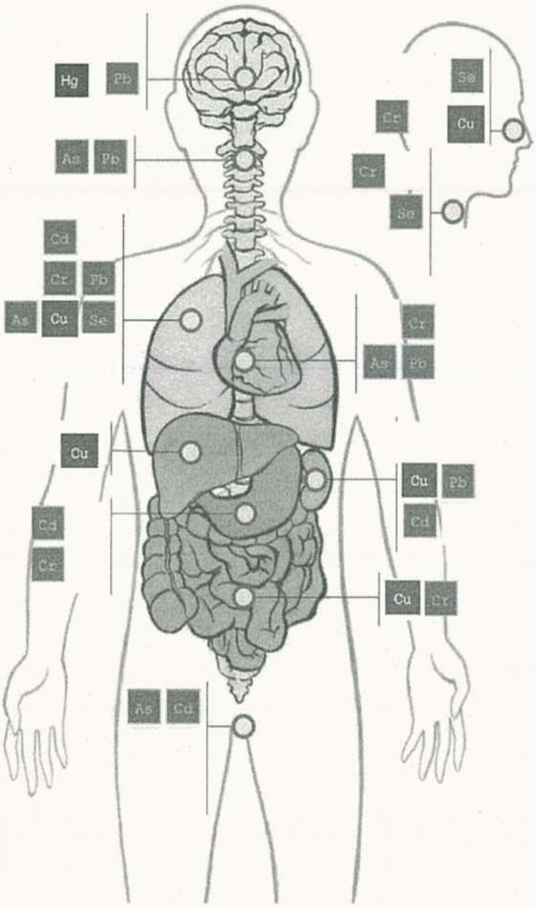
HEALTH IMPACTS OF COAL TOXICANTS



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.

Cu **COPPER**
Long-term exposure to copper dust can irritate your nose, mouth, and eyes, and cause headaches, dizziness, nausea, and diarrhea.High intakes of copper can cause liver and kidney damage

Hg **MERCURY**
Affects different areas of the brain and their associated functions, resulting in a variety of symptoms. These include personality changes (irritability, shyness, nervousness), tremors, changes in vision (constriction (or narrowing) of the visual field), deafness, muscle incoordination, loss of sensation, and difficulties with memory.

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.

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.

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Effect on use of land and resources for traditional purposes by local community;

- The area was once a productive fishing grounds and salt pans. Salt production has virtually disappeared as a result of pollution and takeover of the salt pan wetlands for industrial sites.
- Fisherfolk continue to use the area for fishing, but the fisheries have suffered severely. Fish catch has fallen and fish quality has declined resulting in lower incomes for fishermen.
- Women from the fishing community who were engaged in cleaning and selling fish have also seen their livelihoods decline, and their livelihood efforts intensify as many of them now have to go to the fishing harbour to purchase fish for vending.
- The disappearance of oysters and mussels has also killed the livelihoods of fisherfolk who collected oyster shells for lime (Sunnambu) production.

Social and economic impact if any, on the local fishermen community

- The region's fisherfolk have suffered economically and socially. Those from Sivanpadai Kuppam, Kattukuppam and Mugatwarakuppam are wholly dependent on the river and creek, and do not fish in the sea. Irulars – a scheduled tribe that lives in small hamlets in Sadayankuppam, Kattupally and in a few clusters in Athipattu Pudunagar – are also traditionally dependent on creek fishing. The villages of Ennore Kuppam, Thazhankuppam and Nettukuppam fish in the creek when the sea is rough.
- A separate survey would be required to quantify the historical and ongoing losses suffered by fishers.

Inferences and Suggestions

- The wetlands of Kosasthalai's tail-end are subject to pollution and degradation due to reclamation activities in addition to flyash pollution and pollution from other point and non-point sources. Any restoration/remediation effort needs to be looked at from a landscape point of view and not as a piecemeal approach.
- The main river channel, which is heavily silted, would need to be desilted on a priority basis as this will facilitate tidal flow and also ease navigation and access to fisherfolk marginally improving their livelihoods.

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- The pollution that is the subject of this Committee's study has been caused by two stages of North Chennai Thermal Power Station (1830 MW). In addition, there is a 1500 MW coal-fired power plant and ash pond of NTECL in Vallur. An 800 MW NCTPS Stage III, 660 MW Ennore Thermal Power Station (Annexe) and 800 MW Ennore SEZ power plants are currently under construction. Additionally, a 660 MW ETPS Replacement, 1200 MW North Chennai Power Company and 1030 MW Chennai Power Generation Ltd in Kattupalli and Kalanji are in the pipeline. Given that all these will generate flyash, a cumulative impact assessment study and carrying capacity study may be conducted before it is too late.

- Fisherfolk have already suffered heavily – both economically and socially. It would be advisable to work out a mechanism for compensating them for past damage and ongoing damage until the remediation is complete and the Creek ecosystem restored.

- Workers, including lorry and JCB drivers, cleaners, loaders and TANGEDCO officials, engaged in handling flyash or supervising such operations are totally unprotected. They must be required to wear adequate respiratory and dermal protective gear.

- Flyash surfaces must be sprinkled regularly to avoid becoming air borne.

Chennai
December 13, 2017

13.12.2017

Dr. Sultan Ahmed Ismail

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ANNEXURE B III

REPORT ON THE STATUS OF PLANT DIVERSITY AROUND NORTH CHENNAI THERMAL POWER STATION (NCTPS) ENNORE, CHENNAI

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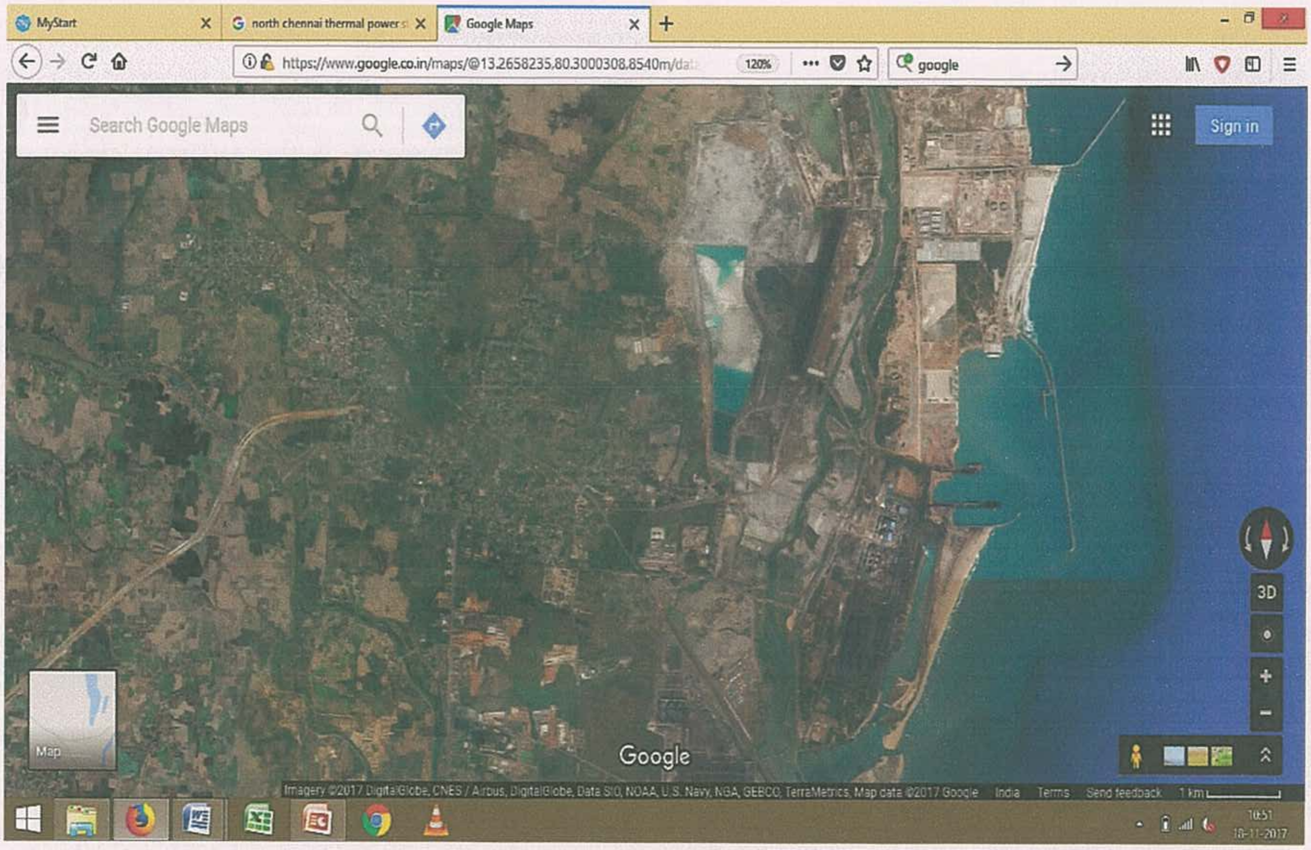
November 2017

ANNEXURE B

INTRODUCTION

A rapid plant survey was conducted around the North Chennai Thermal Power Station (NCTPS), Ennore, Chennai on 30.09.2017, 08.10.2017, 13.10.2017 and 22.10.2017. The surveyed areas include Ash pond (Dyke Area), site reclaimed with Sand, sites where Ash Removal is currently underway, Kosasthalaiyar riverbank, Buckingham Canal near NCTPS and the outer periphery of Kamarajar Port Ltd. (Figure 1). Three different habitats such as inter tidal, salt marsh and coastal wetland were observed. All the plant species were recorded from the study area and the population size were calculated by visual estimate. This survey has recorded a total of 63 plant species from all the three habitats.

Figure: 1 Map showing survey sites



Vegetation in and around areas where Ash Removal is in progress

A total of 28 species recorded from this area (Appendix 1). The sites are devoid of the typical plant representatives of this region (Photos 1, 2 & 4). The areas around these sites however, show some of the halophytes such as *Cyperus arenarius, Cyperus procerus, Fimbristylis cymosa* var. *spathacea, Fimbristylis ferruginea, Fimbristylis polytrichoides, Sesuvium portulacastrum, Suaeda maritima* and *Suaeda monoica. Avicinia marina* which was once dominant mangrove species of this area have recorded in scattered patches around ash cleared sites. Species such as *Halosarcia indica, Suaeda vermiculata* and *Trianthema triquetra* populations are found to be very low density. Some non habitat species such as *Achyranthes aspera,*

Alysicarpus vaginalis, Corchorus trilocularis, Trianthema portulacastrum and *Pavonia zeylanica* are recorded from this area and these species possibly could have gained entry due to transport of soil and sand from outside. Remnants of saline marsh species such as *Cyperus cuspidates, Fimbristylis ferruginea, Sesuvium portulacastrum, Suaeda vermiculata* and *Trianthema triquetra* are recorded from the ash cleared sites (Photos 3, 8, 9 & 10).

Vegetation in and around Sites Reclaimed using Sand

A total of 50 species recorded in and around sand dumped site (Appendix 2), most of the species are non habitat. Species such as *Abutilon indicum, Achyranthes aspera, Alternanthera ficoidea, Alysicarpus vaginalis, Calotropis gigantean, Chloris barbata, Citrullus colocynthis, Cleome viscose, Corchorus trilocularis, Cucumis melo, Cyperus rotundus, Dactyloctenium aegyptium, Datura metel, Eclipta prostrate, Glinus oppositifolius, Indigofera tinctoria, Ipomoea pes-caprae, Physalis minima, Prosopis juliflora, Saccharum spontaneum, Scoparia dulcis, Sesamum alatum, Sesbania bispinosa, Solanum americanum, Tephrosia purpurea* and *Trianthema portulacastrum* are not typical of actual habitat of the locality (Photo 5). These species were probably introduced in this area by the soil brought from outside.

Around the sand dumped site, remnant populations of *Cyperus cuspidatus, Fimbristylis cymosa* var. *spathacea, Fimbristylis ferruginea, Fimbristylis ferruginea, Sesuvium portulacastrum, Suaeda maritime, Suaeda vermiculata* and *Avicennia* *marina* are still found to thrive. Species such as *Halosarcia indica, Pentatropis capensis* and *Trianthema triquetra* are found to be very sparsely distributed.

Vegetation in Kosasthalaiyar riverbank near NCTPS

A total of 27 species recorded from this area (Appendix 3). We observed that many dead stumps of *Avicennia marina* and rest of the population is also deteriorating (Photo 7) probably due to the deposition of the slurry ash. Further addition of slurry ash may completely obliterate the existing population.

Core mangrove species and its associates such as *Cressa cretica, Cyperus arenarius, Cyperus cuspidatus, Cyperus proceru,s Fimbristylis cymosa* var. *spathacea, Fimbristylis ferruginea, Halosarcia indica, Heliotropium curassavicum, Sesuvium portulacastrum, Suaeda maritima, Suaeda vermiculata* and *Trianthema triquetra* are found to be sparse. Only two individuals of *Suaeda monoica* and few individuals of *Aeluropus lagopoides* a saline marsh grass recorded in this area though earlier reports recorded them in abundance.

Buckingham Canal near NCTPS

A total of 47 species documented in Buckingham canal near NCTPS (Appendix 4). Canal is dominated by both saline marsh and fresh water marsh species. Apart from these species some non habitat species such as *Alternanthera ficoidea, Calotropis gigantean, Canthium coromandelicum, Cucumis melo, Datura metel, Flueggea leucopyrus, Saccharum spontaneum, Sesamum alatum, Sesbania bispinosa* and *Ziziphus oenopolia* are also recorded from this area probably introduced due to transport of soil from outside.

Vegetation near Ash Pond (Dyke Area)

A total of 44 species recorded on the Ash pond bund and outside of the bund (Appendix 5). Ash pond bund is totally covered by *Prosopis juliflora* along with few individuals of *Salvadora persica* a saline species (photo 6). Saline marsh species *Suaeda maritima* and *Suaeda vermiculata* are recorded from outside of the ash pond in sparse populations. Apart from these some of the non habitat species are also recorded from this area.

Analysis of the locally grown vegetables

The analysis of the locally grown vegetables collected from Atthipattu village and tested by Tamil Nadu Testing House show significantly high amounts of Chromium, a heavy metal. Accumulation Chromium in the human systems produces lethal effects. Chromium was detected in vegetables such as Cluster beans, Moringa leaves and fruits, Brinjal and Ochra (Bhendi) that are commonly eaten by the public. The Chromium levels ranges from 1.12 mg/Kg to 5.56 mg/Kg (The report from TTNH is already submitted to the NGT).

Inference

Plants are the best indicators of the habitat. The habitat is a typical saline marsh or mangrove vegetation as evidenced by the presence of sedges, mangrove and its associated species. This habitat an interphase between coastal saline regions and inland no-saline regions and should be treated as a critical ecosystem.

- Present survey shows that there is a significant reduction of the mangrove and saline marsh species populations. Dumping of soil from outside in the mangrove habitats not only shrunk the mangrove populations but also has introduced several non-habitat and alien species some of which are invasive. The mangrove and salt marsh habitats have undergone severe degradation and continuation of causal factors may lead to the extinction of the critical costal ecosystem.

- There are no endemic and endangered species recorded from this area. However, a few species recorded from Ennore are very rare in Tamil Nadu and these include *Ammania octandra, Indigofera oblongigolia,* and two sea grasses namely *Halophila ovata, Hlaophila ovalios* have completely disappeared form the habitat. *Suaeda monoica* a saline habitat shrub that was recorded as a mono-dominant species form Kattupalli for the Northern east coast of Tamil Nadu is nearly eliminated except for a few scattered bushes.

- Earlier taxonomists such as Mayuranathan (1929), Barnes (1938), Livingstone (1987), Livingstone & Henry (1994) and Narasimhan (1991) have well explored this area. Analysis based on these studies clearly indicates the loss of several species such as *Allotropis cimicina, Atriplex repens, Commelina subulata, Fimbristylis triflora, Halophia ovalis, H. ovata, Indigofera oblongifolia, Salicornia brachiata and Schoenoplectus supinus* from the habitats of Ennore and Kattupalli. The only mangrove species that is recorded form Ennore always seen in a stunted form owing to the increased salinity.

- This critical habitat has drastically changed from being a salt marsh and mangrove to a degraded region that leads to desertification. Degradation of mangroves that form the coastal shield makes the land scape very vulnerable to coastal calamities.

- Heavy metals such as Mercury and Chromium are significantly high in the soil and water that has turned this critical habitat in to toxic and is hazardous for human life, agriculture and for other animal life including fish, prawn and molluscs.

- There is no direct dependent on plant resources from this region. However, interaction with local populations has revealed that some species such as *Sueada nudiflora* and *Sesuvium portulacastrum* have been used as food occasionally by the local population especially as a famine food.

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Appendices

Appendix: 1 List of species recorded in and around ash cleared site

S.No	Binomial	Family	Habit
1	*Achyranthes aspera* L.	Amaranthaceae	Hr
2	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	Hr
3	*Avicennia marina* (Forssk.) Vierh.	Acanthaceae	Tr
4	*Azima tetracantha* Lam.	Salvadoraceae	Sh
5	*Blepharis integrifolia* (L.f.) E.Mey. & Drège ex Schinz	Acanthaceae	Hr
6	*Chloris barbata* Sw.	Poaceae	Hr
7	*Corchorus trilocularis* L.	Malvaceae	Hr
8	*Cynodon dactylon* (L.) Pers.	Poaceae	Hr
9	*Cyperus arenarius* Retz.	Cyperaceae	Hr
10	*Cyperus cuspidatus* Kunth	Cyperaceae	Hr
11	*Cyperus procerus* Rottb.	Cyperaceae	Hr
12	*Cyperus rotundus* L.	Cyperaceae	Hr
13	*Fimbristylis cymosa* var. *spathacea* (Roth) T.Koyama	Cyperaceae	Hr
14	*Fimbristylis ferruginea* (L.) Vahl	Cyperaceae	Hr
15	*Fimbristylis polytrichoides* (Retz.) Vahl	Cyperaceae	Hr
16	*Halosarcia indica* (Willd.) Paul G.Wilson	Amaranthaceae	Hr
17	*Paspalidium geminatum* (Forssk.) Stapf	Poaceae	Hr
18	*Pavonia zeylanica* (L.) Cav.	Malvaceae	Hr
19	*Pentatropis capensis* (L. f.) Bullock	Apocynaceae	Cl
20	*Pycreus polystachyos* (Rottb.) P.Beauv.	Cyperaceae	Hr
21	*Ruellia patula* Jacq.	Acanthaceae	Hr
22	*Sauropus bacciformis* (L.) Airy Shaw	Phyllanthaceae	Hr
23	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	Hr
24	*Suaeda maritima* (L.) Dumort.	Chenopodiaceae	Sh
25	*Suaeda monoica* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
26	*Suaeda vermiculata* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
27	*Trianthema portulacastrum* L.	Aizoaceae	Hr
28	*Trianthema triquetra* Rottler & Willd.	Aizoaceae	Hr

Appendix: 2 List of species observed in and around sand cleared site

S.No	Binomial	Family	Habit
1	*Abutilon indicum* (L.) Sweet	Malvaceae	Sh
2	*Achyranthes aspera* L.	Amaranthaceae	Hr
3	*Alternanthera ficoidea* (L.) Sm.	Amaranthaceae	Hr
4	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	Hr
5	*Avicennia marina* (Forssk.) Vierh.	Acanthaceae	Tr
6	*Azima tetracantha* Lam.	Salvadoraceae	Sh
7	*Blepharis integrifolia* (L.f.) E.Mey. & Drège ex Schinz	Acanthaceae	Hr
8	*Calotropis gigantea* (L.) Dryand.	Apocynaceae	Sh
9	*Chloris barbata* Sw.	Poaceae	Hr
10	*Citrullus colocynthis* (L.) Schrad.	Cucurbitaceae	Cl
11	*Cleome viscosa* L.	Capparaceae	Hr
12	*Corchorus trilocularis* L.	Malvaceae	Hr
13	*Cucumis melo* L.	Cucurbitaceae	Cl
14	*Cynodon dactylon* (L.) Pers.	Poaceae	Hr
15	*Cyperus arenarius* Retz.	Cyperaceae	Hr
16	*Cyperus cuspidatus* Kunth	Cyperaceae	Hr
17	*Cyperus procerus* Rottb.	Cyperaceae	Hr
18	*Cyperus rotundus* L.	Cyperaceae	Hr
19	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	Hr
20	*Datura metel* L.	Solanaceae	SSh
21	*Digitaria ciliaris* (Retz.) Koeler	Poaceae	Hr
22	*Eclipta prostrata* (L.) L.	Asteraceae	Hr
23	*Fimbristylis cymosa* var. *spathacea* (Roth) T.Koyama	Cyperaceae	Hr
24	*Fimbristylis ferruginea* (L.) Vahl	Cyperaceae	Hr
25	*Fimbristylis polytrichoides* (Retz.) Vahl	Cyperaceae	Hr
26	*Glinus oppositifolius* (L.) Aug.DC.	Molluginaceae	Hr
27	*Halosarcia indica* (Willd.) Paul G.Wilson	Amaranthaceae	Hr
28	*Indigofera tinctoria* L.	Fabaceae	SSh
29	*Ipomoea pes-caprae* (L.) R. Br.	Convolvulaceae	Cl
30	*Panicum repens* L.	Poaceae	Hr
31	*Paspalidium geminatum* (Forssk.) Stapf	Poaceae	Hr
32	*Pentatropis capensis* (L. f.) Bullock	Apocynaceae	Cl
33	*Phyla nodiflora* (L.) Greene	Verbenaceae	Hr
34	*Physalis minima* L.	Solanaceae	Hr
35	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Tr

36	*Pycreus polystachyos* (Rottb.) P.Beauv.	Cyperaceae	Hr
37	*Ruellia patula* Jacq.	Acanthaceae	Hr
38	*Saccharum spontaneum* L.	Poaceae	Hr
39	*Salvadora persica* L.	Salvadoraceae	Tr
40	*Sauropus bacciformis* (L.) Airy Shaw	Phyllanthaceae	Hr
41	*Scoparia dulcis* L.	Scrophulariaceae	Hr
42	*Sesamum alatum* Thonn.	Pedaliaceae	Hr
43	*Sesbania bispinosa* (Jacq.) W.Wight	Fabaceae	Hr
44	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	Hr
45	*Solanum americanum* Mill.	Solanaceae	Hr
46	*Suaeda maritima* (L.) Dumort.	Chenopodiaceae	Sh
47	*Suaeda vermiculata* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
48	*Tephrosia purpurea* (L.) Pers.	Fabaceae	Hr
49	*Trianthema portulacastrum* L.	Aizoaceae	Hr
50	*Trianthema triquetra* Rottler & Willd.	Aizoaceae	Hr

Appendix: 3 List of species recorded from Kosasthalaiyar riverbank near NCTPS

S.No	Binomial	Family	Habit
1	*Aeluropus lagopoides* (L.) Thwaites	Poaceae	Hr
2	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	Hr
3	*Avicennia marina* (Forssk.) Vierh.	Acanthaceae	Tr
4	*Blepharis integrifolia* (L.f.) E.Mey. & Drège ex Schinz	Acanthaceae	Hr
5	*Chloris barbata* Sw.	Poaceae	Hr
6	*Cressa cretica* L.	Convolvulaceae	Hr
7	*Cynodon dactylon* (L.) Pers.	Poaceae	Hr
8	*Cyperus arenarius* Retz.	Cyperaceae	Hr
9	*Cyperus cuspidatus* Kunth	Cyperaceae	Hr
10	*Cyperus procerus* Rottb.	Cyperaceae	Hr
11	*Fimbristylis cymosa* var. *spathacea* (Roth) T.Koyama	Cyperaceae	Hr
12	*Fimbristylis ferruginea* (L.) Vahl	Cyperaceae	Hr
13	*Fimbristylis polytrichoides* (Retz.) Vahl	Cyperaceae	Hr
14	*Halosarcia indica* (Willd.) Paul G.Wilson	Amaranthaceae	Hr
15	*Heliotropium curassavicum* L.	Boraginaceae	Hr
16	*Ipomoea pes-caprae* (L.) R. Br.	Convolvulaceae	Cl
17	*Panicum repens* L.	Poaceae	Hr
18	*Pavonia zeylanica* (L.) Cav.	Malvaceae	Hr

19	*Phyla nodiflora* (L.) Greene	Verbenaceae	Hr
20	*Pycreus polystachyos* (Rottb.) P.Beauv.	Cyperaceae	Hr
21	*Ruellia patula* Jacq.	Acanthaceae	Hr
22	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	Hr
23	*Suaeda maritima* (L.) Dumort.	Chenopodiaceae	Sh
24	*Suaeda monoica* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
25	*Suaeda vermiculata* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
26	*Trianthema portulacastrum* L.	Aizoaceae	Hr
27	*Trianthema triquetra* Rottler & Willd.	Aizoaceae	Hr

Appendix: 4 List of species documented from Buckingham canal near NCTPS

S.No	Binomial	Family	Habit
1	*Abutilon indicum* (L.) Sweet	Malvaceae	Sh
2	*Achyranthes aspera* L.	Amaranthaceae	Hr
3	*Alternanthera ficoidea* (L.) Sm.	Amaranthaceae	Hr
4	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	Hr
5	*Azima tetracantha* Lam.	Salvadoraceae	Sh
6	*Blepharis integrifolia* (L.f.) E.Mey. & Drège ex Schinz	Acanthaceae	Hr
7	*Calotropis gigantea* (L.) Dryand.	Apocynaceae	Sh
8	*Canthium coromandelicum* (Burm. F.) Alston	Rubiaceae	Sh
9	*Chloris barbata* Sw.	Poaceae	Hr
10	*Cleome viscosa* L.	Capparaceae	Hr
11	*Coccinia grandis* (L.) Voigt	Cucurbitaceae	Cl
12	*Corchorus trilocularis* L.	Malvaceae	Hr
13	*Cucumis melo* L.	Cucurbitaceae	Cl
14	*Cynodon dactylon* (L.) Pers.	Poaceae	Hr
15	*Cyperus procerus* Rottb.	Cyperaceae	Hr
16	*Cyperus rotundus* L.	Cyperaceae	Hr
17	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	Hr
18	*Datura metel* L.	Solanaceae	SSh
19	*Digitaria ciliaris* (Retz.) Koeler	Poaceae	Hr
20	*Fimbristylis cymosa* var. *spathacea* (Roth) T.Koyama	Cyperaceae	Hr
21	*Fimbristylis polytrichoides* (Retz.) Vahl	Cyperaceae	Hr

22	*Flueggea leucopyrus* Willd.	Euphorbiaceae	Sh
23	*Glinus oppositifolius* (L.) Aug.DC.	Molluginaceae	Hr
24	*Indigofera tinctoria* L.	Fabaceae	SSh
25	*Ipomoea pes-caprae* (L.) R. Br.	Convolvulaceae	Cl
26	*Ipomoea sepiaria* Koen.	Convolvulaceae	Cl
27	*Mukia maderaspatana* (L.) M. Roem.	Cucurbitaceae	Cl
28	*Panicum repens* L.	Poaceae	Hr
29	*Paspalidium geminatum* (Forssk.) Stapf	Poaceae	Hr
30	*Pavonia zeylanica* (L.) Cav.	Malvaceae	Hr
31	*Pentatropis capensis* (L. f.) Bullock	Apocynaceae	Cl
32	*Phyla nodiflora* (L.) Greene	Verbenaceae	Hr
33	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Tr
34	*Ruellia patula* Jacq.	Acanthaceae	Hr
35	*Saccharum spontaneum* L.	Poaceae	Hr
36	*Salvadora persica* L.	Salvadoraceae	Tr
37	*Sauropus bacciformis* (L.) Airy Shaw	Phyllanthaceae	Hr
38	*Scoparia dulcis* L.	Scrophulariaceae	Hr
39	*Sesamum alatum* Thonn.	Pedaliaceae	Hr
40	*Sesbania bispinosa* (Jacq.) W.Wight	Fabaceae	Hr
41	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	Hr
42	*Suaeda maritima* (L.) Dumort.	Chenopodiaceae	Sh
43	*Suaeda vermiculata* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
44	*Tephrosia purpurea* (L.) Pers.	Fabaceae	Hr
45	*Trianthema portulacastrum* L.	Aizoaceae	Hr
46	*Tribulus lanuginosus* L.	Zygophyllaceae	Hr
47	*Ziziphus oenopolia* (L.) Mill.	Rhamnaceae	Sh

Appendix: 5 List species recorded from Ash pond area

S.No	Binomial	Family	Habit
1	*Abutilon indicum* (L.) Sweet	Malvaceae	Sh
2	*Alternanthera ficoidea* (L.) Sm.	Amaranthaceae	Hr
3	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	Hr
4	*Calotropis gigantea* (L.) Dryand.	Apocynaceae	Sh
5	*Chloris barbata* Sw.	Poaceae	Hr
6	*Citrullus colocynthis* (L.) Schrad.	Cucurbitaceae	Cl
7	*Cleome viscosa* L.	Capparaceae	Hr
8	*Corchorus trilocularis* L.	Malvaceae	Hr
9	*Cressa cretica* L.	Convolvulaceae	Hr

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10	*Cucumis melo* L.	Cucurbitaceae	Cl
11	*Cynodon dactylon* (L.) Pers.	Poaceae	Hr
12	*Cyperus arenarius* Retz.	Cyperaceae	Hr
13	*Cyperus cuspidatus* Kunth	Cyperaceae	Hr
14	*Cyperus procerus* Rottb.	Cyperaceae	Hr
15	*Cyperus rotundus* L.	Cyperaceae	Hr
16	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	Hr
17	*Datura metel* L.	Solanaceae	SSh
18	*Eclipta prostrata* (L.) L.	Asteraceae	Hr
19	*Fimbristylis cymosa* var. *spathacea* (Roth) T.Koyama	Cyperaceae	Hr
20	*Fimbristylis ferruginea* (L.) Vahl	Cyperaceae	Hr
21	*Fimbristylis polytrichoides* (Retz.) Vahl	Cyperaceae	Hr
22	*Glinus oppositifolius* (L.) Aug.DC.	Molluginaceae	Hr
23	*Heliotropium curassavicum* L.	Boraginaceae	Hr
24	*Indigofera tinctoria* L.	Fabaceae	SSh
25	*Ipomoea pes-caprae* (L.) R. Br.	Convolvulaceae	Cl
26	*Pentatropis capensis* (L. f.) Bullock	Apocynaceae	Cl
27	*Phyla nodiflora* (L.) Greene	Verbenaceae	Hr
28	*Physalis minima* L.	Solanaceae	Hr
29	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Tr
30	*Pycreus polystachyos* (Rottb.) P.Beauv.	Cyperaceae	Hr
31	*Saccharum spontaneum* L.	Poaceae	Hr
32	*Salvadora persica* L.	Salvadoraceae	Tr
33	*Scoparia dulcis* L.	Scrophulariaceae	Hr
34	*Sesamum alatum* Thonn.	Pedaliaceae	Hr
35	*Sesbania bispinosa* (Jacq.) W.Wight	Fabaceae	Hr
36	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	Hr
37	*Solanum americanum* Mill.	Solanaceae	Hr
38	*Suaeda maritima* (L.) Dumort.	Chenopodiaceae	Sh
39	*Suaeda vermiculata* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
40	*Tephrosia purpurea* (L.) Pers.	Fabaceae	Hr
41	*Trianthema portulacastrum* L.	Aizoaceae	Hr
42	*Trianthema triquetra* Rottler & Willd.	Aizoaceae	Hr
43	*Tribulus lanuginosus* L.	Zygophyllaceae	Hr
44	*Typha domingensis* Pers.	Typhaceae	Hr

Chennai
December 13, 2017

Dr D. NARASIMHAN

Received on 15/9/2017 @ 5.40pm

:: TANGEDCO Ltd::

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APPENDIX 1

From semdnctps@tnebnet.org To

Er.M.THATCHINAMOORTHY, B.E.,B.L.,
Superintending Engineer,
Mechanical -I
North Chennai Thermal Power Station-I,
Chennai 600 120

Dr. Hisamuddin Papa
Huma Hospital,
Nandanam,
Chennai 600035

Lr.No:SE/MI/NCTPS/EE/AHP/F.40/D. 2152 /17. Dt 12 .09.2017.

Sir,

Sub: NCTPS-SE/Mech.I Cirlce - AHP Dn- Letting out of Ash slurry into Buckingham Canal- App.no:08/2016- Received from National Green Tribunal – Preliminary report submitted by the committee – Consultation fees for Health check up – Details requested – Regarding.

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The application No.08 of 2016 has been filled by Mr. R. Ravimaran, S/o Ramachandran, Chennai – 600057, before the NGT(SZ) through his counsel Mr. A. Yogeshwaran, Chennai – 104, mentioning the 2nd respondent as TANGEDCO represented by CMD/TANGEDCO and 3rd respondent as NCTPS represented by CE/NCTPS, in the National Green Tribunal (SZ) regarding letting out of Ash Slurry into Buckingham canal.

The Hon'ble National Green Tribunal, by order dated 04/08/2017 had appointed an expert committee comprising of Dr. Sultan Ahamed Ismail, Director, Ecoscience Research Foundation, Chennai, Dr. Narasimhan, Retired Professor of Madras Christian College, Tambaram and Expert in bio diversity, Dr. Balaji Narasimhan, Professor, IIT Madras, Department of Hydrology and Mr. K.Elangovan, Executive Engineer, PWD(WRD), Chennai to inspect the entire area to find out the actual extent of ash in the form of sediments settled, damage caused to the ecology of the area and the method of remediation.

Accordingly the committee had inspected the site on 13.08.2017 and submitted a preliminary report to National Green Tribunal bench on 06/09/2017. The committee member Dr. Sultan Ahamed Ismail, Director, Ecoscience Research Foundation, Chennai, has recommended your name to conduct the health checkup of staff, workers of TANGEDCO and truck drivers and excavator operators being engaged in fly ash removal works.

Hence it is requested that the details of Health checkup in this regard for respiratory ailments with consultation fees may be furnished for further processing please.

13/09/17

SUPERINTENDING ENGINEER,
MECHANICAL-I / N.C.T.P.S. 2/4

Copy submitted to the Chief Engineer/NCTPS-I.
Copy to the Executive Engineer/Mech/AHP

21/9/2017 hearing.
Approx (100)

MR J P. Madhavan
9445856675 (AEE)
9445856648 Ex → MR R. Raichandran EE
9445856688 Sup Engr.

No. working Tiruvallur