Annexure 1:

Summary of Scientific Studies Conducted on Contamination of Union Carbide Site and Surrounding Areas in Bhopal

S. No	Year	Agency	Study Title	Samples examined	Conclusions
1.	1989	Union Carbide Corporation	Site Rehabilitation Project –Bhopal Plant	Ground water inside factory premises	All samples cause 100% mortality to fish in toxicity assessment studies.
2.	1990	Bhopal Group for Information and Action	Union Carbide in Bhopal, India-The lingering legacy	Soil sediments and waste stored inside the factory. Water in the adjacent communities	High levels of toxic materials were found in the samples from the waste storage area. One of the most toxic, dichlorobenzene, were also found in the community's drinking water. Dichlorobenzenes damage the liver, kidneys and respiratory system. Polynuclear aromatic hydrocarbons (PAHs), a group of known cancer causing agents were also discovered in the waste impoundment area. Phthalates were discovered in the surface soils in the waste pond. Phthalates are toxic to the liver. Additional toxins were also discovered in soil samples from the area
3	1991	State Research Laboratory, Public Health Engineering Deaprtment, Government of Madhya Pradesh	Report of Chemicals found in Water for Communities around UCIL premises,	Ground water samples from 13 spots in the vicinity of the factory	The samples tested had Chemical Oxygen Demand (C.O.D.) values between 45 mg/l and 98 mg/l whereas the World Health Organization (W.H.O.) has fixed the standard value of C.O.D. for natural water at 6mg/l. The ground water is contaminated with bacteria and heavy chemicals
4.	1992	National Environmental Engineering Research Institute (N.E.E.R.I.)	Process Package for disposal of SEP contents at UCIL, Bhopal	Soil and ground water samples from in and around UC factory	Water quality within an area of radius 1 km met the quality standards. Presence of **Volatiles** and **Semi-volatiles** in tested soil samples. Recommended the need to undertake a detailed investigation.
5.	1996	State Research Laboratory, Public Health	Report of Chemicals found in Water for	Ground water samples from 13 spots in the vicinity of	The samples tested had Chemical Oxygen Demand (C.O.D.) values between 45 mg/l and 98 mg/l

		Engineering Deaprtment, Government of Madhya Pradesh	Communities around UCIL premises,	the factory	whereas the World Health Organization (W.H.O.) has fixed the standard value of C.O.D. for natural water at 6mg/l. The ground water is contaminated with bacteria and heavy chemicals
6.	1997	NEERI	Assessment of contaminated areas due to past waste disposal practices by EIIL, Bhopal	Samples collected from waste disposal areas, spilled areas and open area. Samples of soil, ground water and dump material from within the factory	The study found high levels of toxins and identified hot spots. Presence of Carbaryl, Temik, Manganes, Lindane, Alpha-napthol etc was reported in the soil samples. 17 samples of ground water and none showed contamination and study noted that soil in & around the plant premises was mainly clayey with permeability rate of 1x10 -8 which would have taken 23 years for contaminants to reach groundwater level.
7.	1999	Greenpeace International	The Bhopal Legacy: Toxic contaminants at the former Union Carbide factory site, Bhopal, India: 15 years after the Bhopal accident.	Samples from Sludge and soil were collected at locations both within the plant and in an area to the north of the plant at which solar evaporation ponds (SEPs) Groundwater samples from drinking water wells to the north and south of the former UCIL site	The results of the survey indicate that the former UCIL site and immediate surrounding environment at Bhopal is contaminated with heavy metals and toxic organochlorine chemicals, including Persistent Organic Pollutants. Groundwater samples from around the site, showed high levels of chemical contamination, indicative of long-term contamination. Overall contamination of the site and immediate surroundings with chemicals have resulted either from routine processes during the operation of the plant, spillages and accidents, or continued release of chemicals from materials which remain dumped or stored on site. Some of the chemicals founds in the water are mercury, lead, nickel, copper, chromium, cholorobenzens, Trichlorobenzenes, Carbon tetrachloride and Hexachlorocyclohexane.
8.	2001	Peoples Science Institute, Dehradun	A Report on Mercury Contamination of the Ground water Near UC Factory at Bhopal	Groundwater samples from communities surrounding the UCIL factory and Solar Evaporation Ponds	The sampling sites located nearer to the Carbide factory show elevated levels of the contaminant (Mercury) in the groundwater. Highest concentrations of Mercury occur in the groundwater samples taken from sites located towards the northern direction of the factory.

9.	2002	Greenpeace International	Chemical Stockpiles at Union Carbide India Limited n Bhopal: An Investigation	Stockpile sample from inside the plant and soil samples from Solar Evaporation Ponds	Eleven of the twelve stockpile samples were found to contain Carbaryl at concentrations in the parts per billion range. Ten contained hexachlorocyclohexanes, with total concentration varying between tens of parts per billion.
10.	2002	Fact Finding Mission on Bhopal, New Delhi	Surviving Bhopal: Toxic Present, Toxic Future	10 samples of soil with 6 samples from outside the factory. 3 samples of vegetables grown in area & 8 samples of breast milk	Study showed contaminants in soil and ground water but also the presence of chromium, lead nickel and mercury in vegetables grown in the area and in breast milk of mothers in the community adjacent to the Union Carbide factory
11.	2003	Madhya Pradesh Pollution Control Board	Summary of ground water samples collected around UCIL premises (April 03 - Jan 04)	Ground water for 13 locations and soil samples from Solar Evaporation Ponds	The analysis of these samples reveals that the parameters viz. Colour, turbidity & chlorides of some samples exceeds the desirable limits of bis-10500 whereas parameters viz. Total hardness, total alkalinity, ds & fluorides exceeds the said limits in most of the samples. Pesticides like - lindane, endosulfan - i, ii, aldrin and b-bhc were detected in some of the samples.
12.	2009	Central Pollution Control Board	CPCB Study	8 Soil samples & 14 ground water samples in UC factory in communities	Detected arsenic, mercury and chromium & isomers of HCH in all samples. Detected Carbaryl in 75% of the samples tested for soil HCH isomers, Cholorinated Benzens, zinc and copper found in water samples
13.	2009	Centre for Science & Environment, New Delhi	Contamination of soil and water inside and outside the Union Carbide India Limited, Bhopal	Ground water and soil samples from inside the factory. Ground water from communities adjacent to the factory and soil from Solar Evaporation Ponds	The waste stored within the UCIL premises had all chlorinated benzene compounds and all organochlorine compounds. The soil samples contained all chlorinated benzene compounds and organochlorine pesticides The surface water sample collected from within the factory had the hightlest level of contamination The concentration of pesticides found in all water samples were 1.1 to 59.3 times the only mandatory 1water standard in India fixed by the Bureau of Indian Standard. The average concentration in all groundwater samples was .006 ppm which is 12 times the standard.

					Carbamate pesticides as a general group are considered to be moderately persistent in the environment. But finding carbamates in groundwater, 25 years since the plant shut down, clearly means that the UCIL plant is acting as a continuous source of groundwater contamination.
14.	2010	National Environmental Engineering Research Institute (NEERI) and National Geophysical Research Institute (NGRI)	Assessment & Remediation of Hazardous Waste contaminated areas in and around M/s Union Carbide India Ltd, Bhopal	Bore wells dug inside UCIL plant to test soil 30 Ground water samples collected from inside the factory	Three isomers of HCH (Lindane) detected in many soil samples. Carbaryl, Napthol, Dicholorobenzene and Mercury detected. Carbaryl, A-Napthol and B-HCH and Mercury were detected near SEP area. None of the samples collected from within UCIL were found to be contaminated. Only few had dicholorobenze and Aldicarb
15-16	2012-2013	Indian Institute of Toxicology Research	Analysis of Soil and groundwater Samples in Bhopal	These were two separate studies over a duration of 2 years. 10 samples of soil and 30 samples of ground water from around the UC plant. 24 samples of Surface and subsurface soil from inside and UC factory	Organic Contaminants such as Carbaryl, Aldicarb, HCH isomers and cholorinated benzenes & Heavy Metals such as Mercury, Lead and Chromium found in soil inside the factory A-BHC, Dichlorobenzene and TCB, Aldrin, HCH, Carbaryl found in ground water of communities around UC factory. Study reported contamination of ground water in 22 communities situated around UC factory premises
17	2018	Indian Institute of Toxicology Research	Analysis of ground water in Bhopal	20 samples of ground water of 20 communities situated around Union Carbide Factory	A-BHC, Dichlorobenzene and TCB, Aldrin, HCH, Carbaryl found in ground water of communities around UC factory. Study reported contamination of ground water in additional 20 communities situated around UC factory premises. A total of 42 communities affected by ground water contamination