Greenpeace Research Laboratories Analytical Results 2022-01

Hazardous chemical contaminants in samples of surface water, soil, ash, sediment and waste plastic from waste dumpsites in Turkey

January 2022

Introduction

Mixed plastic waste can contain numerous hazardous chemicals incorporated in the plastic during manufacture. A previous investigation of sites in Malaysia where mixed plastic waste had been disposed of, and in some cases burned, highlighted a broad range of hazardous chemical contaminants within plastic wastes and in post burning residues, as well as in the local environment (GRL 2019).

A recent investigation by Greenpeace highlighted the large-scale disposal of waste plastic from a number of European countries to locations in Adana Province in Turkey, with plastic waste being burned at some sites (Greenpeace 2021). A total of 31 samples (10 of ash, 12 of soil, 2 sediments, 3 surface waters and 4 of shredded plastic waste) were received from Greenpeace Turkey for analysis at the Greenpeace Research Laboratories (GRL) on 30th April 2021. According to documentation supplied, all samples were collected during April 2021 from several sites at which plastic waste had been disposed of, and in some instances burned.

The descriptions of the samples, including the locations from where they were collected, are given in Table 1a, together with GPS coordinates for the sample collection locations in Table 1b.

Sample details

Samples were collected from five separate dumpsites where the disposal and burning of wastes were ongoing, located in four areas in the vicinity of the city of Adana, Turkey. All samples of soil were collected from the top 5cm layer. Where ash and soil were collected from the same location, following collection of the ash sample, all material covering the underlying soil was removed and then a sample of soil was collected from the top 5cm layer.

One of the dumpsites sampled was located at Incirlik, an area in the town of Yüregir, located on land that appears to have previously been used for agricultural purposes, and surrounded by agricultural land (crops & fruit orchard). It is located approximately 1 km to the northwest from a large cement manufacturing facility which, according to information received, uses plastic as part of its fuel mix. The cement facility has a large dedicated waste disposal site and there are no indications that wastes from the cement facilities are disposed of at the plastic waste dumpsite from where samples were

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collected. In addition to waste plastic, other types of wastes have also been observed at the dumpsite, including what appeared to be building insulation material.

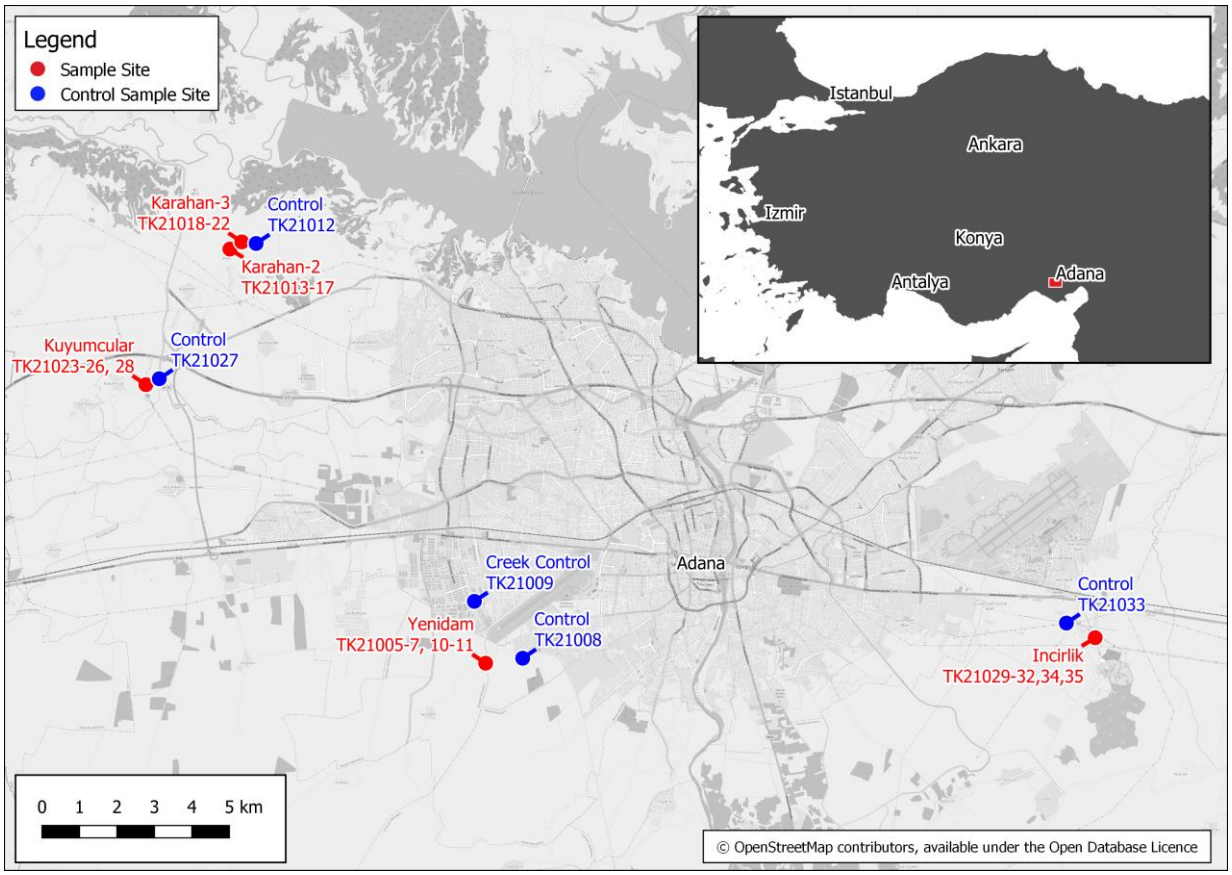

Figure 1. Map of the plastic waste dumpsites in the vicinity of the city of Adana, Turkey

Two samples of ash (TK21031-32) and associated soil (TK21029-30) were collected from this site, together with a sample of partially shredded plastic waste (TK21035). In addition, a sample of water (TK21034) was collected from a pond situated within the site. It was not possible to collect a sample of sediment from this pond. For comparison to samples collected within the dumpsite, a sample of soil (TK21033) was collected from agricultural land located 0.8 km north west of the dumpsite (approximately 2 km to the north west of the cement facility).

Another of the dumpsites sampled in this investigation is located on the banks of a creek in the Yenidam area in the town of Seyhan. Local people reported that the site had been operating for over a year, and that the site had been regularly cleaned up by the municipality. Two samples of ash (TK21006-07) were collected from within the dumpsite, together with water from the creek within the dumpsite area (TK21005) and also from a location upstream of the dumpsite, within an industrial area (TK21009). Two samples of sediment (TK21010-11) were also collected from the creek, at the same location as the creek water sampled was collected within the dumpsite (TK21005). Due to the nature of the site, it was not possible to collect a sample of soil from this location, and no shredded plastic was available at this site for collection. Similarly, no sample of sediment from the creek at the upstream location could be collected due to the nature of the creek bottom at this location. To gain insight into chemical contamination of land in the vicinity of the dumpsite but not directly impacted by it, a sample of soil was collected from agricultural land located 1 Km east of the site.

Code	Type	Date	Sample location
Incirlik, Yüregir			
TK21029	soil	15/04/2021	within site
TK21030	soil	15/04/2021	within site (different location to TK21029)
TK21031	ash	15/04/2021	within site (as TK21029)
TK21032	ash	15/04/2021	within site (as TK21030)
TK21033	soil-control	15/04/2021	agricultural crop growing land, 0.8 km north west of the site
TK21034	water	15/04/2021	pond within the dumpsite
TK21035	SP	15/04/2021	from material dumped within site
Yenidam, Seyhan			
TK21005	water	16/04/2021	creek within dumpsite
TK21009	water	16/04/2021	creek (control sample), upstream of site, within industrial area
TK21006	ash	16/04/2021	burning area within site
TK21007	ash	16/04/2021	burning area within site (different to TK21006)
TK21008	soil-control	16/04/2021	agricultural field 1 Km east of the site
TK21010	sediment	16/04/2021	creek within dumpsite, as TK21005
TK21011	sediment	16/04/2021	creek within dumpsite, as TK21005
Karahan, Cukurova			
TK21012	soil-control	15/04/2021	agricultural field 0.7 Km east of Karahan-2, 0.4 Km east of Karahan-3
TK21013	SP	15/04/2021	Karahan-2: From material dumped within site
TK21014	soil	15/04/2021	Karahan-2: within site
TK21015	soil	15/04/2021	Karahan-2: within site (different location to TK21014)
TK21016	ash	15/04/2021	Karahan-2: within site (as TK21014)
TK21017	ash	15/04/2021	Karahan-2: within site (TK21015)
TK21018	SP	15/04/2021	Karahan-3: From material dumped within site
TK21019	ash	15/04/2021	Karahan-3: within site
TK21020	ash	15/04/2021	Karahan-3: within site (different location to TK21019)
TK21021	soil	15/04/2021	Karahan-3: within site (as TK21019)
TK21022	soil	15/04/2021	Karahan-3: within site (as TK21020)
Kuyumcular, Seyhan			
TK21023	soil	15/04/2021	within site
TK21024	soil	15/04/2021	within site (different location to TK21023)
TK21025	ash	15/04/2021	within site (as TK21023)
TK21026	ash	15/04/2021	within site (as TK21024)
TK21027	soil-control	15/04/2021	agricultural orchard land 0.4 km north east of the site
TK21028	SP	15/04/2021	from material dumped within site

Table 1A: Details of surface water, soil, ash, sediment, ash and shredded plastic (SP) samples from waste plastic dumpsites in Turkey received and analysed at the Greenpeace Research Laboratories

Site	location	Sample code	N degree (º)	E degree (º)
Incirlik	Dumpsite	TK21029-32,34,35	36.972347	35.446314
	Control soil	TK21033	36.975852	35.437704
Yenidam	Dumpsite	TK21005-7, 10-11	36.966248	35.263696
	Control soil	TK21008	36.967441	35.274791
	Creek, Control	TK21009	36.981044	35.260326
Karahan	Control soil	TK21012	37.066612	35.194922
	Karahan-2 dumpsite	TK21013-17	37.065278	35.187054
	Karahan-3 dumpsite	TK21018-22	37.066984	35.190625
Kuyumcular	Dumpsite	TK21023-26, 28	37.032868	35.161887
	Control soil	TK21027	37.034283	35.165912

Table 1b: GPS coordinates of sample collection locations.

A number of smaller waste sites were located in the Karahan area in the town of Cukurova. It was only possible to collect samples from two of these sites; Karahan–2 and Karahan-3, located approximately 0.4 Km northeast of Karahan-2. The Karahan-2 site is an older site at which wastes have been disposed for a number of years, whereas the Karahan-3 site is a more recent site. Samples collected from the Karahan–2 site included two samples of ash (TK21016-17) and associated soil from the same locations (TK21014-15), together with a sample of partially shredded plastic (TK21013).

Similarly, samples from the Karahan–3 site also included two samples of ash (TK21019-20) and associated soil (TK21021-22), and a sample of partially shredded plastic (TK21018). A control soil sample was collected from agricultural land located 0.7 Km and 0.4 Km east of the Karahan-2 and Karahan-3 sites, respectively.

Lastly, at a site in the Kuyumcular area in the town of Seyhan, two samples of ash (TK21025-26) and associated soil (TK21023-24), together with a sample of partially shredded plastic waste (TK21028) were collected from within the site, as well as a control soil sample from an orchard located 0.4 km northeast of the site.

Following collection of the samples, local people have reported that a partial clean-up of all the sites samples in this investigation has been undertaken, removing wastes and ashes, but not the underlying soil, and with the material removed being taken to the nearby ITC municipal waste landfill.

Analytical methods

Concentrations of metals and metalloids were determined for the samples by ICP mass spectrometry (MS) following acid digestion, using appropriate certified reference samples. For water samples, a portion of unfiltered sample, and separately a portion of the sample filtered through a 0.45 micron filter, were analysed in each case.

The four samples of plastic were each composed of a heterogeneous mix of different plastic fragments. For each sample, the concentrations of metals and metalloids were analysed in three separate, non-identical, subsamples to determine the variation in concentrations within the heterogeneous samples.

Three different techniques were used in the preparation for the analysis for organic compound contaminants: Solid (soil and ash) samples were prepared using an Accelerated Solvent Extraction (ASE) system, with a mixture of pentane and acetone (ratio 3:1) as extraction solvents. A solid phase extraction (SPE) technique was used for the preparation of the water samples, using a Dionex Autotrace unit. Finally, the shredded plastic samples were blended, homogenized, sieved and subsampled before extraction with methanol in an ultrasonic bath. All samples for organic contaminant analysis were then analysed using an Agilent 6890 series II GCMS instrument operated in SCAN mode to provide for forensic qualitative screening, using Wiley W10N11 and pesticide-specific spectral libraries to support data interpretation and identification of contaminants or contaminant groups.

More detailed descriptions of the sample preparation and analytical procedures are presented in Appendix 1.

Results and Discussion

Results for shredded plastic samples and then for ash and soil samples are discussed below to give an overview across all sites. In the following sections, the results are discussed in more detail for the individual sites from which they were collected, together with samples from surface waters where relevant.

For shredded plastic samples, the individual organic chemicals identified through forensic mass spectrometry screening techniques, and the concentrations of metals and metalloids present, are given in Tables 2 and 3. Results for ash and soil samples from the Incirlik and Yenidam sites are given in Tables 4, 6 and 9, with the results for surface water samples from these two sites in Tables 7 and 8. The equivalent results for the Karahan and Kuyumcular sites are given in Tables 5, 10 and 11. More detailed lists of the organic chemicals identified in each sample using forensic screening are provided in Appendix 3, along with the corresponding total ion chromatographs illustrating the complexity of contaminant loadings in those samples.

Following forensic screening of the samples, certain samples were selected (based on the presence of key indicator contaminants) for subsequent quantitative analysis of polycyclic aromatic hydrocarbons (PAHs), chlorinated biphenyls (PCBs) and/or polychlorinated dibenzodioxins/furans (PCDD/Fs). PAH concentrations for those samples are given in Table A2-1 and A2-2, with those for PCBs and PCDD/Fs in Table A2-3 and A2-4, respectively. The sum (total) concentrations for each of these 3 compound groups are also included in Tables 4 and 5, together with the chemicals identified through forensic screening in the same samples.

Shredded plastic samples

Samples of waste plastic from the Karahan, Kuyumcular and Incirlik dumpsites contained a broad range of organic chemicals (Table 2) as well as relatively high concentrations of a range of metals and metalloids (Table 3).

Many of the organic chemicals identified have known uses in plastics manufacture or onward formulation, including a number of phthalate esters and terephthalic acid esters (plasticisers), chlorinated organophosphates (flame retardants), plastic stabilising additives including butylated hydroxytoluene (BHT, an antioxidant) and benzophenone (UV stabiliser), plastic precursor chemicals including styrene (for polystyrene), as well as some chemicals formed from the partial degradation of chemicals used in the manufacture of plastics.

Phthalate esters, commonly refer to as ‘phthalates’, were most commonly found, with many examples identified in all samples, including di-(2-ethylhexyl) phthalate (DEHP) in all samples and di-iso-nonyl phathalates (DiNP) in all but one sample (TK21018). DEHP is widely used as a plasticizer in a variety of products made of polyvinyl chloride (PVC), including in medical devices, furniture, cosmetics, and personal care products (ATSDR 2019). Plasticizer DiNP was introduced as a replacement for DEHP due to toxic effects that DEHP can express to human health, including effects to immune and reproductive systems, as well as developmental effects (ATSDR 2019). Both DEHP and DiNP were historically also the most used plasticizers in children’s soft PVC products (Bouma & Schakel 2001). However, the use of DEHP and DiNP and four other phthalates (DBP, DiDP, DnOP, and BBP) were banned in children’s toys within EU by an EU Directive (2005/84/EC) due to their adverse effects to human health. DEHP

has been also identified by the European Chemicals Agency (ECHA 2014) as a Substance of Very High Concern (SVHC) because of its endocrine disrupting properties in the environment. Phthalates are not bound into plastics, but can readily leach into the local environment (Fierens *et al.* 2012).

Site	**Karahan-2**	**Karahan-3**	**Kuyumcular**	**Incirlik**
Sample code	**TK21013**	**TK21018**	**TK21028**	**TK21035**
STATISTICS FOR ISOLATED AND IDENTIFIED COMPOUNDS				
Number of compounds isolated	80	78	65	104
Number of compounds identified to >90%	42	44	41	61
Percentage identified to >90%	53%	56%	63%	59%
NAME OF COMPOUNDS AND GROUPS IDENTIFIED TO >90%				
HALOGENATED COMPOUNDS				
chlorinated organophosphate		2		
PHTHALATE ESTERS & RELATED COMPOUNDS:				
di-(2-ethylhexyl) phthalate	1	1	1	1
di-isobutyl phthalate			1	
dinonyl phthalate, linear & branched	2		1	2
Dimethyl phthalate	1	1	1	1
other unidentified phthalates	16	10	19	9
terephthalic acid esters	2	2	2	1
isophthalic acid ester	2	1		
OTHERS				
polycyclic aromatic hydrocarbons (PAHs)	1	1	1	3
styrene				1
diphenyl methane derivatives	1			
benzophenone / acetophenone	1			1
butylated hydroxytoluene (BHT)		1		1
butylated hydroxytoluene derivative	1	1	1	1
alkyl phenols	3	5	2	2
alkyl alcohols	2	1	1	2
alkyl aldehydes	2	1	1	2
alkyl amide		2		1
ethylene glycol derivative				1
benzoic acid ester derivative		1		
fatty acid ester	6	10	8	14
hydrocarbons		1	2	14
other compounds	1	3		4

Table 2: Summary of results of organic compounds identified in shredded plastic samples determined by GC/MS.

Other closely related plasticiser chemicals were also commonly found in the samples of shredded plastic analysed in the current study, with terephthalic acid esters identified in all samples and isophthalic acid esters in all but one sample (TK21028). In addition, a chemical released by the partial degradation of DEHP was found in all samples; the alkyl alcohol, 2-ethyl-1-hexanol (González-Márquez *et al.* 2019).

Other plastic-related chemicals were identified in samples from only one or two of the sites, highlighting how different fractions of plastic waste can have different chemical compositions, depending on the mix of plastics they contain. These chemicals included two chlorinated

organophosphates which can be used as flame retardants (found only in sample TK21018, from site Karahan-3), the UV stabiliser benzophenone (in sample TK21013, from Karahan-2) and the antioxidant BHT (in sample TK21035, collected from the Incirlik site), though other alkyl phenols that are closely related to BHT were found in all samples.

For metals and metalloids, those elements found at notable concentrations were similar across all three sites from which plastic waste was collected, with antimony, cadmium, copper, tin and zinc, and to a lesser extent lead and molybdenum, commonly found at relatively high concentrations. For waste plastic from the Karahan-2 site (TK21013), however, copper and lead concentrations were considerably lower than other samples. Overall, concentrations of these metals and metalloids were generally lower than those found in samples of shredded plastic wastes recently collected from dumpsites in Malaysia (GRL 2019).

Site	**Karahan-2**				**Karahan-3**				**Kuyumcular**				**Incirlik**			
Sample code	**TK21013**				**TK21018**				**TK21028**				**TK21035**			
Subsample	/1	/2	/3	mean	/1	/2	/3	mean	/1	/2	/3	mean	/1	/2	/3	mean
Antimony	5.6	17.2	44.1	22.3	31.5	11.4	14.6	19.2	27.5	45.9	36.1	36.5	10.8	24.7	27.8	21.1
Arsenic	1.2	0.7	1.1	1.0	1.5	1.4	1.4	1.4	3.9	5.2	3.8	4.3	2.9	1.7	1.6	2.1
Barium	62	42	66	57	173	191	160	175	281	305	140	242	116	270	223	203
Beryllium	0.08	<0.05	0.09	0.08	0.09	0.07	0.12	0.09	0.18	0.26	0.21	0.22	0.18	0.19	0.20	0.19
Cadmium	3.13	1.27	2.62	2.34	1.26	18.0	1.64	6.97	5.94	4.13	7.94	6.00	2.84	3.37	5.05	3.75
Chromium	18.9	13.5	20.3	17.6	91.1	52.3	51.9	65.1	41.9	28.5	28.1	32.8	65.3	32.8	141	79.7
Cobalt	2.2	1.8	2.0	2.0	4.0	3.4	3.5	3.7	3.6	3.9	7.1	4.8	4.0	2.8	2.8	3.2
Copper	26.2	15.8	23.3	21.8	99.4	113	101	104	170	68.4	73.6	104	231	2030	126	796
Lead	20.9	15.6	21.7	19.4	61.2	57.0	66.2	61.5	57.2	48.0	58.4	54.5	14.7	12.6	13.1	13.5
Manganese	100	49	91	80	82	77	83	81	406	121	219	249	1330	732	836	966
Mercury	1.0	0.6	0.4	0.7	1.1	0.2	0.6	0.6	0.8	1.6	0.4	0.9	0.6	0.5	0.7	0.6
Molybdenum	0.5	0.3	0.6	0.5	2.2	1.5	1.6	1.8	13.3	15.2	15.6	14.7	3.1	1.6	1.8	2.2
Nickel	12.0	9.1	13.8	11.6	37.8	24.3	24.5	28.9	47.5	47.9	42.0	45.8	30.9	22.4	22.4	25.2
Strontium	34.0	17.1	35.1	28.7	43.0	43.4	50.6	45.7	52.9	61.1	53.5	55.8	113	59.2	60.0	77.4
Tin	24.6	11.4	73.5	36.5	12.6	67.7	10.2	30.2	36.0	27.6	21.9	28.5	169	199	321	230
Titanium	39	29	51	40	74	73	72	73	122	109	101	111	66	51	57	58
Vanadium	4.6	3.0	4.8	4.1	6.9	7.0	6.4	6.8	47.5	40.9	36.9	41.8	12.2	7.4	7.6	9.1
Zinc	215	140	215	190	418	438	467	441	283	189	802	425	313	290	325	309

Table 3: Concentrations of metals and metalloids (mg/kg dry weight) in subsamples of shredded plastic, together with the mean (average) values for each sample

Though lower than for many other metals, concentrations of cadmium (up to 18 mg/kg in one subsample of TK21018) were noteworthy as this toxic metal is commonly found in the environment at very low concentrations, typically below 1 mg/kg in soils and sediments (Alloway 1990, ATSDR 2012, Salomons & Forstner 1984). Similarly, concentrations of antimony and tin are also commonly low in the environment, typically below 2 mg/kg and 10 mg/kg respectively in uncontaminated soils.

Despite these samples being composed of visibly heterogeneous mixes of different plastic fragments, in the majority of cases the concentrations for each metal/metalloid in the three separate subsamples analysed from each sample were similar. There were, however, some notable exceptions for all sites. For example, one of the three subsamples analysed from the sample of shredded plastic collected

from the Incirlik site (TK21035/subsample 2) contained a far higher concentration of copper (2030 mg/kg) compared to the other two subsamples from the same mixed plastic sample. Similar cases were also seen at the Kuyumcular site (eg zinc in TK21028/subsample 3) and the two Karahan sites (eg tin in TK21013/subsample 3 and TK210218/subsample 2). These results show that, despite mechanical shredding, concentrations of individual metals or metalloids can vary considerably between different portions of the disposed plastic, even between subsamples collected from within a small area of the total accumulation of plastic waste on site.

A wide range of metals and metalloids, including those identified in the plastic samples analysed in this study, are known to occur in various types of plastics, either remaining from the polymer manufacturing processes, or from their intentional use as additives in plastic formulations, such as fillers, stabilisers, pigments or flame retardants (Hahladakis et al. 2018, Jaffe & East 2007, Matthews 1996). Cadmium and lead are toxic metals that can persist in the environment long after release, and are able to accumulate in the body following repeated exposures. Lead can cause irreversible damage to the nervous system, including its development in children, and can also affect the blood system, kidneys and reproduction (ATSDR 2020). Long-term exposure to cadmium can cause damage to the kidneys and bones, and cadmium has been classified as carcinogenic to humans (ATSDR 2012, IARC). High levels of exposure to copper and zinc can lead to possible toxic effects, including gastrointestinal distress (ATSDR 2004a, 2005b) and, where copper enters surface waters, it can have toxic effects on aquatic organisms, many of which are very sensitive to copper even at very low levels (ATSDR 2004a).

When plastic is burned, metals and metalloids contained within the plastic tend to remain in the ash residue, though some losses to the atmosphere can also occur. During the combustion process, metal and metalloid compounds can be converted into different chemical forms which are often more mobile in the environment compared to the original compounds present in the plastic. These compounds can then leach from the ashes over time, contaminating the underlying soil, in addition to the physical spreading of the ashes themselves under the action of wind, rain or disturbance by humans or animals.

Although many of the organic chemicals within the plastics may be destroyed during combustion under these type of conditions, even at low temperatures, some contribute to the formation of new compounds, including compounds with highly hazardous properties, including chlorinated dioxins and furans if there is a source of chlorine in the plastic or its additives.

Ash and soil samples

For each site, many of the paired samples (i.e the two soil samples, or the two ash samples from a site) showed very similar patterns of organic chemical contamination, with only slight variation in the relative abundance of individual chemicals. As an example, the total ion chromatograms for two ash samples from the Yenidam site (TK21006 and TK21007) are shown overlapped in Fig. 2a below (along with an expanded section of both chromatograms in Fig. 2b). The detailed interpretation of the GC/MS data, therefore, was conducted on one of the pair of samples in such cases. For more details see Appendix 3.

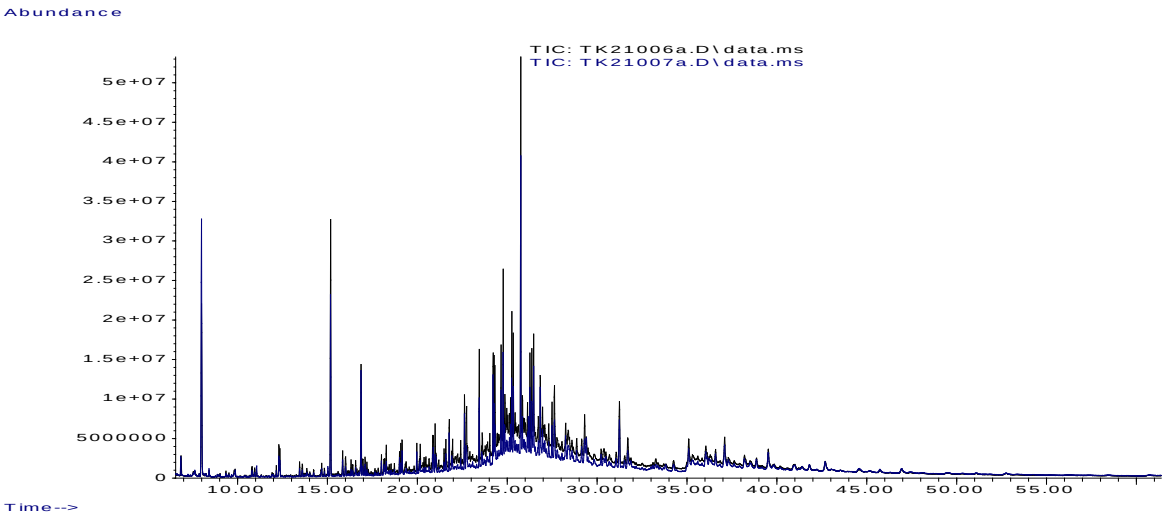

Figure 2a. Overlapped GC/MS full chromatograms of paired samples TK21006 (black) and TK21007 (blue)

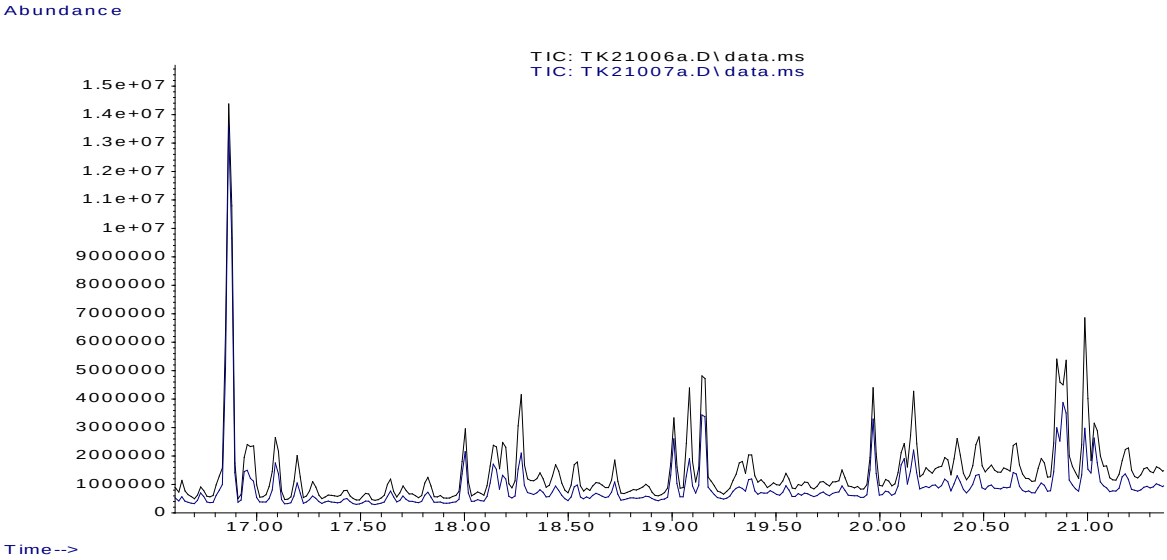

Figure 2b. A section of overlapped GC/MS chromatograms (between 17 and 21 min) of paired samples TK21006 (black) and TK21007 (blue)

For all sites, a wide range of hazardous organic chemicals were identified in samples of ash and underlying soil, particularly for the Incirlik site. The range of chemicals identified were different to those identified in samples of plastic waste from these sites, and were dominated by compounds that can be generated during combustion of materials such as mixed plastic waste. These included chlorinated compounds that can be generated during the combustion of chlorinated materials, such as the plastic polyvinyl chloride (PVC).

Certain groups of chemicals that can arise from combustion were common to all sites, including polycyclic aromatic hydrocarbons (PAHs) and chlorinated benzenes. This included penta- and hexachlorobenzene in all soil samples (no soil was collected from the Yenidam site) as well as in ash from the Yenidam and Incirlik sites. PAHs are commonly found as products of incomplete combustion

(IARC 2010). PAHs are prevalent pollutants in both terrestrial and aquatic environment that can cause a wide range of toxic effects on wildlife, and which can be harmful to human health. A number of PAHs have been classified either as known human carcinogens (Group 1) or as probably or possibly carcinogenic to humans (Group 2A or 2B) by the International Agency for Research on Cancer (IARC 2010).

Chlorinated benzenes (from di- to hexachlorinated) were identified in a number of samples in this study. One of the sources of the emission of these chemicals to the environment, and particularly of hexachlorobenzene, is their formation during combustion of chlorine-containing materials such as PVC (EEA 2005) or during thermal destruction of PCBs (Ahling & Lindskof 1978). Individual chlorinated benzenes have a range of hazardous properties to human health and the environment (ATSDR 2006, 2014, 2015). Hexachlorobenzene (HCB), which was identified at all but the Kuyumcular site, is a persistent chemical that can bioaccumulate in the food chain and is toxic to a wide range of organisms, including humans. It is also listed as a persistent organic pollutant under the Stockholm Convention in Annex A (Elimination) (Stockholm Convention 2019) and as one of the air pollutants under the UNECE Convention on Long-range Transboundary Air Pollution (Air Convention) (EEA 2021). A number of additional chlorinated and brominated compounds were also found in soil at the Incirlik site.

Other aromatic hydrocarbons were also prevalent at all sites, particularly in the samples of ash, included biphenyl, triphenyl and quarterphenyl derivatives, as well as alkylated benzenes. Some of these chemicals (e.g., 1,1':3',1''-terphenyl, 5'-phenyl- also known as 1,3,5-triphenylbenzene, and quaterphenyl and its derivatives) have been found among the chemicals emitted during co-combustion of two types of plastics, namely polyethylene (PE) and polyethylene terephthalate (PET) (Tomsej *et al.* 2018). The authors of that study suggested that 1,3,5-triphenylbenzene, which has been identified in 10 samples in the current study, could be used as a marker to trace polyethylene (PE) plastics combustion.

Alkylated benzenes are most commonly found in the environment due to their presence in petroleum products (Overton 1994). Other components of petroleum products, including a range of aliphatic hydrocarbons, were extensively found across all the sites. Some of those compounds may, of course, arise in soil due to natural causes. However, aliphatic hydrocarbons detected in soils in this study were dominated by long chain representatives of this class of chemicals, which is typical for oil or oil-related products (Ilechukwu *et al*. 2019).

In contrast, these compounds were generally absent or present in far lower numbers (for PAHs and aliphatic hydrocarbons) in samples of control soil samples for all sites, which were collected from nearby agricultural land not directly impacted by the dumpsites.

On the basis of the organic chemical forensic analysis, subsequent analyses were carried out on certain samples, to quantify the concentrations of PAHs, and the chlorinated chemical groups polychlorinated biphenyls (PCBs) and polychlorinated dibenzodioxins/furans (PCDD/Fs). Both PCBs and PCDD/Fs can be generated during the combustion of chlorinated materials, including chlorinated plastics such as PVC. Summary data are included in Tables 4 and 5, together with the results from forensic screening of those samples, with the full quantitative data for PAHs, PCBs and PCDD/Fs given in Appendix 2.

Site	Incirlik			Yenidam		
Sample code	**TK21029**	**TK21031**	**TK21033**	**TK21006**	**TK21008**	**TK21010**
Sample type	soil	ash	soil (control)	ash	soil (control)	sediment
STATISTICS FOR ISOLATED AND IDENTIFIED COMPOUNDS BY QUALITATIVE ANALYSIS						
Number of compounds isolated	242	270	29	233	49	245
Number of compounds identified to >90%	96	98	3	75	11	67
Percentage identified to >90%	40%	36%	10%	32%	22%	27%
NAME OF COMPOUNDS AND GROUPS IDENTIFIED TO BY QUALITATIVE ANALYSIS >90%						
HALOGENATED COMPOUNDS						
di- to tetrachlorinated benzenes	9	8		5		1
penta- & hexachlorinated benzene	2	2		2		
PCBs (mono- to dichlorinated)	6	2		2		
DDT degradation products (p,p'-DDE)			1		1	
benzenamine, 2,4,6-trichloro-	1					
benzenes, chloroethenyl-	2					
benzene, bromo-	1					
benzene, bromodichloro-	1					
p-terphenyl, 4-chloro-	1					
OTHER GROUPS						
polycyclic aromatic hydrocarbons (PAHs) and derivatives	13	6	2	6	3	5
terpenes, terpenoids & their derivatives						4
biphenyl & its derivatives	3	6		4		
terphenyl and its derivatives	5	2		4		
quaterphenyl & its derivatives	2			2		
styrene	1					
other aromatic hydrocarbons		1		1		1
1H-indole & its derivatives						1
1H-indene derivatives	1	2		2		
alkylated benzenes	11	18		9		22
aliphatic hydrocarbons	32	49		34	6	26
furans & benzofurans	3			3		
butylated hydroxytoluene (BHT)						1
alkyl thiols						1
steroids and precursors					1	2
other compounds	2	2		1		3
QUANTITATIVE RESULTS						
sum 16 EPA-PAH (ug/kg dw)[(a)]	3280	9930	10.9	5790	90.2	11900
sum 18 PCBs, by mass (ng/kg dw)[(a)]	157930	39200	-	5615	5.3	-
PCB TEQ concentration (ng/kg dw)[(a)]	2050	650	-	64.4	0.00044	-
PCDD/F TEQ concentration (ng/kg dw)[(a)]	22600	8180	-	455	0.059	-

Table 4: Summary of results of organic compounds analysis in samples determined by GC/MS, as well as summary of quantitative data for PAHs, PCBs and PCDD/Fs in a subset of samples. (a) sum of concentrations of detected compounds; concentrations are expressed per unit dry weight (dw) of soil or ash

Ash from all sites contained high concentrations of PAHs (2930 – 37700 μg/kg), as did soil at the Incirlik site (3280 μg/kg) and sediment from a creek at the Yenidam site (11900 μg/kg), far exceeding levels in the control samples (which were all below 100 μg/kg). Soil PAH concentrations for other sites were far lower than that at the Incirlik site, but were nonetheless still higher than those in the respective soil control samples. For all samples, naphthalene and phenanthrene were the dominant PAHs, with their combined concentrations constituting between 52% and 92% of the total PAH

concertation in each sample. This may indicate the input of these PAHs as a result of plastics combustion at a relatively low temperature, which is known to lead to formation of more volatile PAHs (3-4 rings) (Tomsej *et al.* 2018).

Site	**Kara-han**	**Karahan-2**			**Karahan-3**		**Kuyumcular**		
Sample code	**TK21012**	**TK21014**	**TK21015**	**TK21016**	**TK21019**	**TK21021**	**TK21023**	**TK21025**	**TK21027**
Sample type	soil (con)	soil	soil	ash	ash	soil	soil	ash	soil (con)
STATISTICS FOR ISOLATED AND IDENTIFIED COMPOUNDS									
Number of compounds isolated	49	165	29	273	295	122	14	255	80
Number of compounds identified to >90%	22	35	27	90	73	39	11	55	4
Percentage identified to >90%	45%	21%	93%	33%	25%	32%	79%	22%	5%
NAME OF COMPOUNDS AND GROUPS IDENTIFIED TO >90%									
HALOGENATED COMPOUNDS:									
di- to tetrachlorinated benzenes		3	5	3	5	8	5	4	
Penta- and hexachlorinated benzene		1	2			2	1		
OTHER GROUPS:									
polycyclic aromatic hydrocarbons (PAHs) and derivatives		5	3	21	2	7	3	2	
terpenes, terpenoids & their derivatives	1		2						
biphenyl & derivatives		1	1	5	1	1		2	
terphenyl and derivatives		1		4	1	1	1	1	
styrene						1			
other aromatic hydrocarbons		2	1	1		1			
1H-indole & derivatives			1	1					
1H-indene derivatives				1					
alkylated benzenes				15	10	1	1	16	
aliphatic hydrocarbons	20	20	11	37	54	15		30	3
furans & benzofurans						1			
steroids and precursors	1					1			
Other compounds		2	1	2					1
QUANTITATIVE RESULTS									
sum 16 EPA-PAH (ug/kg dw)[(a)]	ND	267	-	3770	2930[(b)]	239	335	6010[(c)]	27.9
sum 18 PCBs, by mass (ng/kg dw)[(a)]	-	-	-	-	16583[(b)]	-	-	-	-
PCB TEQ concentration (ng/kg dw)[(a)]	-	-	-	-	213[(b)]	-	-	-	-
PCDD/F TEQ concentration (ng/kg dw) (a)	-	-	-	-	2890[(b)]	-	-	-	-

Table 5: Summary of results of organic compounds analysis in samples of ash, soil, and (con)troll soil determined by GC/MS, as well as summary of quantitative data for PAHs, PCBs and PCDD/Fs in a subset of samples. (a) sum of concentrations of detected compounds; (b)- value for TK21020, ash from the same site; (c)- value for TK21026, ash from the same site; ND-none detected

Regulations in Turkey set a number of threshold pollutant limit values for soil at land currently used, or intended for future use, for residential purposes. The individual limits are based on the potential

route of exposure to the chemical contaminant, including via ingestion, as well as the potential for contamination of groundwater (TMoEUA 2010). Limits are set for a range of organic chemical contaminants as well as a range of metals and metalloids.

For PAHs, the levels of three compounds measured in the current study were higher than corresponding residential use limits set in Turkey:

- Benzo(a)pyrene concentrations were above limits established in Turkey in four samples, with two of them, TK21016 and TK21031, containing higher concentrations than both values set for absorption through soil ingestion and skin contact (60 μg/kg) and due to groundwater contamination (100 μg/kg). Benzo(a)pyrene concentration in sample TK21016 was 6 and 3.6 times higher, respectively, and in sample TK21031 - 2.3 and 1.4 higher, respectively, than the corresponding limit values;
- Benzo(b)fluoranthene concentration in sample TK2106 was 1.2 times the limit set due to absorption through soil ingestion and skin contact (600 μg/kg);
- Dibenzo(a,h)anthracene concentration was 1.3 times the limit set due to absorption through soil ingestion and skin contact (600 μg/kg) also in sample TK21016.

Even if the sites identified are not intended for future residential use, this comparison nonetheless serves to illustrate that soils at those sites are contaminated to significant levels with toxic and persistent organic pollutants or relevance for both human and wildlife exposure.

PCBs and PCDD/Fs were quantified in ash samples collected from three of the sites investigated in the current study (Yenidam, Karahan-3 & Incirlik), together with soil from the Incirlik site for which forensic analysis indicated a greater prevalence of chlorinated chemicals compared to soil samples from other sites. High levels of both PCBs and PCDD/Fs were found in all samples, especially in both the ash and soil samples from the Incirlik site, though not in the control soil sample (TK21008). Of the three sites, levels of PCBs and PCDD/Fs were notably lower in ash from the Yenidam site.

The total concentration of PCBs in soil from the Incirlik site was 30 000 times that in the soil collected from the respective control site located less than 1km away, suggesting the presence of a specific localised source of PCB contamination at the waste site. Although not directly comparable, total concentrations in ashes ranged from approximately 1000 times (Yenidam) to over 7000 times (Incirlik) the control soil level. For PCBs and PCDD/Fs, concentrations are often expressed in toxic equivalency (TEQ) concentrations. TEQs are a weighted quantity based on the toxicity of each individual member of that group of chemicals. In a similar way to the mass concentrations, the highest TEQs for PCBs were found at the Incirlik site, and the TEQ values for all samples from these three sites were far higher than that for the control soil sample.

Limit values set for PCB contamination in Turkey remain based on analysis against certain commercial mixture standards rather than for TEQs for individual PCBs. For example:

- for the commercial PCB mixture Aroclor 1016 (6 000 000 ng/kg and 900 000 ng/kg for ingestion/dermal contact and for potential groundwater contamination, respectively), which consists of a number of PCB congeners with trichlorinated PCBs as a main contributor (about 55%), but also contains mono-, di-, tetra-, and pentachlorinated congeners (ATSDR 2001);
- and for all other commercial PCB mixtures (that also contain higher chlorinated PCB congeners) excluding Aroclor 1016 - at 200 000 ng/kg and 30 000 ng/kg, respectively.

It is, therefore, not possible to make a direct comparison between the levels of PCBs detected in the current study (as individual PCB congeners) and the limit values set in Turkey. Although a very approximate comparison may be made by taking into account the known composition of those commercial PCB mixtures composition, such comparisons must be interpreted with caution. For example, compared to the limit values for Aroclor 1016 (which consists only of tri- to penta-CBs), the summed concentrations for these congeners fell below those limits in all of the samples analysed for PCBs in the current study (though it is important to note that only 10 congeners from the tri- to penta-CB range were specifically quantified in the current study, whereas commercial Aroclor standard mixtures may contain 50 or more individual congeners (UNEP Chemicals 1999)). In contrast, comparison of the total PCBs concentrations (summed for all 18 congeners analysed in the current study, from tri- to heptaCBs) with the standard for commercial PCB mixtures other than Aroclor 1016 (i.e. those that also contain more highly chlorinated congeners) revealed that two of the samples, TK21029 and TK21031 (both from Incirlik), contained summed PCB concentrations that were 5.2 and 1.3 times higher than the limit value (30000 ng/kg) set in Turkey for potential groundwater contamination. In any case, whatever the limitations to these comparisons, the results demonstrate clearly that there were (or had in the past been) significant sources of PCB contamination at several of the sites investigated in the current study.

For chlorinated dioxins and furans (PCDD/Fs), soil from the Incirlik site contained the highest TEQ value amongst all samples, being almost 400 000 times that of the associated control soil sample. TEQ values in the ash samples from all sites were lower than in this soil sample, especially for the Yenidam site, but were nonetheless still indicative of high levels of contamination with these toxic and persistent chemicals. Again, while not directly comparable, the TEQs in the ash samples ranged from just under 8000 times (TK21006 from the Yenidam site) to almost 140 000 times (TK21031 from the Incirlik site) the PCDD/Fs TEQ for the respective control soil sample from the site. The profile of individual PCDD/Fs was similar across all samples, with hepta- and octa-chlorinated PCDDs being the predominant contributors in this group of pollutants, which may suggest that they are originated from similar sources.

There is no PCDD/Fs TEQ-based limit for soil in Turkey. The only one PCDD congener specified in the regulation in Turkey is 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-TCDD) (on a weight basis), with the limits set for both ingestion and dermal contact, as well as for the potential contamination of groundwater (TMoEUA 2010) with the values of 4 μg/kg and 2 μg/kg in soil, respectively. In comparison to values detected in the current study, those were exceeded in all four samples analysed for 2,3,7,8-TCDD (among other congeners) (in the soil sample TK21029 and in the three ash samples TK21006, TK21020 and TK21031), while the concentration of this compound was below the detection limit in the control sample (TK21008, <0.197 μg/kg) (see Table A2-4). The biggest difference observed between the measured concentration of 2,3,7,8-TCDD and the limit of this compound set in Turkey was in the soil sample TK210029 which, with a concentration of 1050 μg/kg, was over 260 times higher than the limits for ingestion/dermal contact and 525 times that for potential groundwater contamination.

In addition to the organic chemical contamination at the five sites, high concentrations of a wide range of metals were found in samples of ash at all sites. Notably high concentrations of copper, lead, molybdenum, tin and zinc were found in ash from one or more site, in most cases above 1000 mg/kg (0.1% by weight), with one sample from the Karahan-3 site (TK21020) having a copper concentration

of 23 500 mg/kg (2.35 % by weight). Antimony and cadmium were also prominent in ash from one or more sites, at concentrations lower than those in sample TK21020 but still at relatively high concentrations compared to levels typically found in the environment. This range of metal/metalloids reflects those identified at relatively high concentrations in the waste plastic samples (TX21013, TX21018, TX21028, TX21034), strongly suggesting a link between the two.

For each of these metals, the concentrations in the ash samples were similar to, or higher than (far higher in some cases), the equivalent concentrations in the samples of plastic analysed from the same sites. This pattern is consistent with these metals/metalloids concentrating in ashes following the burning of plastics at the sites. The pattern was less clear for antimony; some antimony compounds are considerably more volatile than those of other metals, and greater emission of antimony to the atmosphere could be expected during the burning of plastics containing antimony compounds (ATSDR 2019).

Though ashes are composed of a very different type of material to soil, a comparison of their metal concentrations with those typical of uncontaminated soil can provide useful context. Concentrations in individual samples of ash varied considerably both within and between sites. Across all ash samples, the highest concentration of copper was almost 1000 times the upper end of the concentration range typically found in uncontaminated soil, with those of lead and zinc around 100 times the upper end of their respective ranges. For antimony, cadmium and tin, the highest ash concentration in each case was between 10 and 50 times their respective upper concentrations commonly reported for uncontaminated soils (Alloway 1990, ATSDR 2004a, 2005a, 2005b, 2012, 2019, 2020, Salomons & Forstner 1984).

As was the case for organic contaminants, control soil samples collected from agricultural land located close to each of the dumpsites (but not immediately impacted by activities at the site) did not show levels of contamination comparable to those seen at the dumpsites themselves, with concentrations of metals or metalloids within typical background soil concentration ranges.

In many cases, the concentrations in soil from a dumpsite were up to 10 times the corresponding level in soil from the control location for that site, though far high differences were seen for individual metals/metalloids at certain sites. Soil samples from the Karahan-2 contained antimony, cadmium and zinc at levels between 10 and 35 times that in the control sample, and those from the Kuyumcular site contained cadmium and molybdenum at between 30 and almost 200 times the respective control sample. Soil from the Incirlik site, however, was contaminated to an even greater extent, with concentrations of all the notable metals/metalloids at over 10 times their respective control sample levels, including concentrations of copper at between 40 and 90 times, tin at between 80 and 140 times, and those of antimony at around 500 times the respective concentrations in the control soil.

In most (though not all) soil samples collected from the waste sites in the current study, the patterns of metal/metalloid contamination were similar to those found in the overlying ashes. The similarities in contamination between ash and underlying soil were most notable at the Incirlik site, where all metals/metalloids at high levels in the ashes were also found at concentrations elevated above background soil levels, and in most cases at very similar, or even higher, concentrations to those found in the overlying ash.

Of the key metal/metalloid contaminants identified at these sites, those at the Incirlik site were most notable in relation to Turkish soil limits. The concentrations of antimony in the Incirlik site soil samples (49.2-60.4 mg/kg) were higher than the limit set in relation to risk from absorption through soil ingestion and skin contact (31 mg/kg), and up to 30 times the limit related to groundwater contamination (2 mg/kg). In addition, the concentrations of copper (616-1320 mg/kg) and lead (136-275 mg/kg) were up to 2 times the respective limits related to groundwater contamination (514 mg/kg copper; 135 mg/kg lead). Soil samples from the Kuyumcular site contained molybdenum at concentrations up to 18 times the limit related to groundwater contamination (14 mg/kg), while one sample from the Karahan-2 site (TK21015) contained antimony slightly above the groundwater contamination limit (TMoEUA 2010).

A number of other metals and metalloids in soil samples from the various sites were also present at concentrations higher than the respective Turkish soil limits related to groundwater contamination, including barium, beryllium and nickel, though this study has not indicated contamination with these metals and metalloids due to the use of the sites from the disposal and burning of plastic wastes.

Despite the relatively high concentrations of cadmium, tin, and to a lesser extent zinc, in soil samples from one or more of the sites when compared to concentrations typically reported for uncontaminated soils, none of these metals were present above any of the Turkish threshold pollutant limit values for residential soil as those limit values are set relatively high compared to background levels for these metals compared to those found in one or more soil sample at concentrations higher than their respective soil limit in Turkey.

Discussion of results for each individual site

The results for samples of ash and soil from individual sites, together with those for surface water and sediment samples where relevant, are discussed in more detail in the sections below.

Incirlik

Both ash and soil samples from the Incirlik site contained a very wide range of organic chemicals, with the highest number identified amongst all samples from all sites. These samples including the greatest prevalence of chlorinated chemicals across all sites, including the broadest range of chlorinated benzenes in both ash and soil samples, and the most PCBs identified by forensic screening, especially in the soil.

In addition, the soil sample collected from this site contained a number of other chlorinated and brominated chemicals which were not found in any other sample, not even in the ash sample from this site. This pattern of contamination in the soil suggests the disposal at some time of other types of chemical wastes at this site, alongside waste plastic.

Both ash and soil samples contained many aromatic hydrocarbons, particularly biphenyl, triphenyl and quarterphenyl derivatives, as well as alkylated benzenes, together with extensive contamination with aliphatic hydrocarbons (with a similar pattern to those found at other sites). In addition, styrene was identified in the soil sample, a chemical used in the manufacture of the plastic polystyrene, and which can be released during polystyrene combustion (Ergut *et al.* 2007) including at the relatively low temperatures of open burning conditions (at about 200^{o}C and higher) (Gurman *et al*. 1987).

The total concentration of 16 PAHs in the ash sample was within the range for ash samples from other sites. Though lower than in the ash, the soil sample concentrations (TK21029; 3280 μg/kg) was approximately ten times higher than the soil concentrations at the other sites. As for all sites, naphthalene and phenanthrene were the dominant PAHs in the ash and soil samples from this site, although their combined concentrations were a somewhat lower fraction of the total PAH concentration (52-53%) compared to ash and soil samples from other sites where these two PAHs contributed between 62-92% of the total PAH concentration.

The levels of PCBs and PCDD/Fs in the ash and soil samples from the Incirlik site were the highest amongst all samples analysed, being even higher in the soil sample than in the ash. As noted above, the total PCB concentration in soil from the Incirlik site was 30 000 times that in the control soil, with the TEQ soil concentration being almost 5 million times that of the control soil, indicating a greater prevalence of more toxic PCBs in soil from the Incirlik site compared to the control, in addition to the far higher concentration by mass.

For the ash sample, the relative contributions of individual PCBs to the total concentration were similar to those for ash samples from other sites, with PCB-77 and PCB-126 being the major components in each case. Soil from the Incirlik site has a somewhat different profile, in that PCB-77 and PCB-126 were not the predominant PCB, although were nonetheless present as major constituents of the mixture.

Similarly, soil from the Incirlik site had the highest TEQ value for PCDD/Fs amongst all samples, being almost 400 000 times that for the control soil sample. The TEQ for the ash was approximately a third of that in the soil, though was the highest value for all ash samples in which PCDD/Fs were quantified. The profile of individual PCDD/Fs in the ash and soil samples were similar to those for other ash samples from other sites

As noted above, the Incirlik site was also the most contaminated of all the sites investigated for metals and metalloids. For both ash and soil samples, the highest concentrations of many metals/metalloids were found in samples from this sites. Despite the high degree of similarity in organic contaminant composition between the two ash samples collected at this site (TK21031 and TK21032), as indicated by the close overlap of their total ion chromatograms, these two ash samples nonetheless showed quite different compositions in terms of metals and metalloids, with concentrations of many of these elements being higher in sample TK21031 than in TK21032 (see Table 6). This ash sample had the highest concentrations of lead and tin for ash samples from all sites, as well as some of the highest antimony and copper concentrations. Though not directly comparable, typical concentrations in uncontaminated soil provide a useful reference. The concentration of lead in this ash was over 100 times typical concentrations in uncontaminated soil, while those of tin, antimony and copper were between 20 and 70 times their respective typical background soil levels.

Metals and metalloids found at elevated levels in ash from this site followed a similar pattern to that for the plastic waste samples, with the exception of lead. Plastic from this site contained the highest concentrations of copper and tin across all plastic samples, reflecting the results for ash samples.

Site	Incirlik				
Sample code	**TK21033**	**TK21029**	**TK21030**	**TK21031**	**TK21032**
Sample type	Soil (control)	Soil	Soil	ash	ash
Antimony	<0.1	60.4	49.2	79.2	6.2
Arsenic	7.2	3.6	4.0	3.1	3.6
Barium	164	871	1175	1510	502
Beryllium	1.2	0.3	0.3	0.3	0.6
Cadmium	0.25	7.12	4.55	5.28	1.98
Chromium	73.9	129	134	42.8	64.5
Cobalt	13.2	9.5	8.6	5.2	7.1
Copper	15.0	1320	616	2220	351
Lead	14.7	275	136	3400	85.7
Manganese	517	478	355	189	258
Mercury	1.4	0.4	1.1	0.9	0.5
Molybdenum	0.2	3.5	2.6	3.0	2.8
Nickel	92.1	45.2	51	21.6	37.6
Strontium	78.2	161	139	180	167
Tin	1.1	142	89.6	201	28.5
Titanium	463	982	667	1080	538
Vanadium	46.3	14.9	23	13.2	19.8
Zinc	41	885	596	652	709

Table 6: Concentrations of metals and metalloids (mg/kg dry weight) in samples of soil or ash from a dumpsite in Incirlik, Yüregir, Turkey

As seen across all sites, absolute concentrations of metals/metalloids in the ashes were generally higher than the respective concentration in plastic from the same site, as would be expected where these are concentrated in the ash as plastic is burned. The one difference between the Incirlik site and the other locations, was that the concentration of antimony was also somewhat higher in the most contaminated ash sample compared to those found in associated plastic samples.

As commonly found in the study, metal and metalloid contamination of underlying soil samples at the Ircirlik site reflected that for ash samples, including the higher levels in the soil sample (TK21029) that was collected from below the more contaminated ash sample (TK21031). This soil sample contained the highest concentrations of lead and tin found in soil samples from all sites, together with the second highest concentrations of copper and zinc, following a very similar pattern seen in the overlying ash. Unlike at the Yenidam and Karahan sites, however, a number of metals and metalloids were found at even higher concentrations in underlying soil samples than in the associated ash sample, including antimony, cadmium, copper, tin and zinc. The higher concentrations in soil compared to the ash may be due to other wastes containing higher metal or metalloid concentrations having previously been dumped and/or burned at this site, or possibly due to the accumulation of metal or metalloid in soil over time due to leaching from ashes generated by repeated dumping and burning of plastics wastes at this site.

Compared to the control soil sample from nearby agricultural land, the copper and tin concentrations were up to approximately 100 times higher in soil from this site, while those of lead and zinc were

approximately 20 times higher. Though present at a lower concentration in the soil compared to copper and tin, the level of antimony was over 600 times that in the control soil.

A large cement factory located close to the Ircirlik site is a potential source of contamination to land in the vicinity due to deposition of contaminants emitted to the atmosphere. The control soil sample was collected approximately 2 km to the northwest of the cement facility, approximately twice the distance compared to the dumpsite and in a similar direction. Given the relative locations of the dumpsite and the control soil sampling location, and the absence of contamination in the control soil, the data suggest that deposition of contaminants emitted from the cement facility is unlikely to have made a significant contribution to the levels of contamination recorded at the dumpsite.

Surface water collected from a pond within this site (TK21034) contained a number of phthalate esters, a group of organic chemical groups found in waste plastic from all sites, as well as two chlorinated organophosphates (see Table 7) that were found in one of the plastic samples in this study, though not the plastic sample from this site. In addition, an alkyl-diol (2,4,7,9-tetramethyl-5-decyne-4,7-diol) that is used to provide antifoaming and surfactant properties in a wide range of products (and is toxic to aquatic life, ECHA 2021) was also identified. Another organophosphorus compound, triethyl phosphate, was also identified in this sample. This compound has a number of uses including as a plasticizer in resins, plastics and gums (USA EPA 2006).

Site	**Incirlik**	**Yenidam**	
Sample code	**TK21034**	**TK21005**	**TK21009 (control)**
Sample type	surface water	creek water	creek water
STATISTICS FOR ISOLATED AND IDENTIFIED COMPOUNDS			
Number of compounds isolated	25	52	29
Number of compounds identified to >90%	9	22	9
Percentage identified to >90%	36%	42%	31%
NAME OF COMPOUNDS AND GROUPS IDENTIFIED TO >90%			
HALOGENATED COMPOUNDS			
chlorinated organophosphate	2	2	2
PHTHALATE ESTERS & RELATED COMPOUNDS:			
dibutyl / diisobutyl phthalate	2	2	2
dimethyl / diethyl phathalates	2	2	1
OTHERS:			
oxygenated polycyclic aromatic hydrocarbons		1	
triethyl phosphate	1		
BHT and derivatives		1	
benzophenone derivative		1	
5-Decyne-4,7-diol, 2,4,7,9-tetramethyl-	1	1	1
alkyl phenols		3	1
alkyl amide		1	
phenyl sulfone/sulfonamides		2	1
diethylene glycol derivative		1	
benzoic acid ester derivative	1		
fatty acid ester			1
pesticides & fungicides		3	
other compounds		2	

Table 7: Summary of results of organic compounds analysis in samples determined by GC/MS in sample of creek water from the Yenidam site and surface water from the Incirlik site

The pond water sample did not contain any of the quantified metals and metalloids at dissolved concentrations above typical ranges for uncontaminated surface waters (Flem et al. 2018). Concentrations were slightly higher in the unfiltered portion (see Table 8), indicating an additional loading of metals with metals bound to suspected particles, but not to levels indicative of notable contamination.

Site	**Yenidam, Creek**				**Incirlik, pond**	
Sample code	**TK21005**		**TK21009**		**TK21034**	
Location	within dumpsite		upstream of dumpsite		pond within dumpsite	
	Filt	W	Filt	W	Filt	W
Antimony	0.6	0.6	0.4	0.4	0.8	0.9
Arsenic	1.0	1.3	1.2	1.9	1.8	2.4
Barium	100	145	74.8	76.7	31.2	36.4
Beryllium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium	<0.05	0.07	<0.05	0.07	<0.05	0.14
Chromium	<0.5	1.6	<0.5	1.5	1.0	1.9
Cobalt	0.1	0.5	0.2	0.4	<0.1	<0.1
Copper	5.6	10.1	3.4	5.0	0.2	1.3
Lead	0.3	3.8	0.8	1.1	0.3	2.3
Manganese	7.4	40.0	4.1	11.3	<0.5	1.0
Mercury	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Molybdenum	8.6	9.7	1.3	1.4	6.5	7.8
Nickel	3.6	15.6	3.7	9.3	3.1	8.7
Strontium	476	532	391	392	282	338
Tin	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Titanium	<1	5	<1	2	<1	<1
Vanadium	1.3	1.8	1.9	3.4	9.0	10.8
Zinc	19	41	12	17	<2	7

Table 8: Concentrations of metals and metalloids (µg/l) in (Filt)ered and (W)hole, unfiltered, samples of creek water from the Yenidam and surface water from the Incirlik plastic waste dumpsites in Turkey

Yenidam

As for other sites, ash from the Yenidam site contained a wide range of organic chemical contaminants, with many examples of chlorinated benzenes (including penta- and hexachlorobenzene), a diverse mix of aromatic hydrocarbons (including PAHs, biphenyl, triphenyl and quarterphenyl derivatives, and a range of alkylated benzenes) and numerous long chain aliphatic hydrocarbons. No soil sample was collected from the Yenidam site.

The total summed concentration of 16 PAHs in the ash sample was within the range for ash samples from other sites. Although not directly comparable, the total concentration in the ash was over 60 times that in the control soil samples associated with this site, with two PAHs (naphthalene and phenanthrene) comprising 64% of the total PAH concentration.

The levels of PCBs and PCDD/Fs in the ash sample collected from the Yenidam site were the lowest amongst all samples analysed, though nonetheless were still indicative of contamination by these

toxic, persistent & bioaccumulative compounds. The PCB mass concentration and the PCDD/Fs TEQ value were over 1000 times and almost 8000 times their respective levels in the control soil sample associated with this site. For both chemical groups, the relative contributions from individual congeners were similar to those for other sites, with PCB-77 and PCB-126 once again being the major components of the PCB mixture.

Site	**Yenidam**				
Sample code	**TK21006**	**TK21007**	**TK21008**	**TK21010**	**TK21011**
Sample type	ash	ash	Soil (control)	Sediment	Sediment
Antimony	87.3	64.9	0.1	3.0	0.4
Arsenic	4.2	3.0	12.5	6.7	6.2
Barium	313	861	140	252	272
Beryllium	0.4	0.2	1.5	0.5	0.6
Cadmium	3.22	4.86	0.53	2.66	1.58
Chromium	49.2	48.0	129	107	90.2
Cobalt	34.7	31.8	20.6	12.6	12.5
Copper	686	7250	25.2	156	129
Lead	163	395	37.3	147	167
Manganese	229	327	549	215	214
Mercury	0.6	0.2	0.4	0.7	0.4
Molybdenum	12.5	13.8	0.4	2.1	2.0
Nickel	141	39.0	215	131	124
Strontium	249	238	79.6	109	105
Tin	70.5	102	1.4	3.0	3.9
Titanium	742	854	597	337	359
Vanadium	32.9	19.5	64.3	34.8	34.5
Zinc	2525	1370	59	427	361

Table 9: Concentrations of metals and metalloids (mg/kg dry weight) in samples of ash, soil and sediment from a dumpsite in Yenidam, Seyhan, Turkey

Concentrations of most metals and metalloids were similar in the two samples of ash from this site (and were broadly similar to the ranges found in ashes across all sites), although one ash sample contained a notably higher concentration of copper (TK21007; 7250mg/kg) compared to the other.

Together with one sample from the Incirlik site, ash from this site contained particularly high concentrations of antimony, which is likely to reflect the types of plastic burned at these sites. A compound of antimony (antimony trioxide, Sb_2O_3) is commonly used as a catalyst in the manufacture of PET, a polyester polymer, which commonly contains antimony residues as a result (Jaffe & East 2007, Lacasse & Baumann 2004).

Soil collected from agricultural land 1 Km east of the site did not contain metals or metalloids above typical background soil levels. Due to tha nature of the site, it was not possible to collect a sample of soil from the Yenidam site, and no shredded plastic was present at the site at the time samples were collected.

Water from a creek that flows through the dumpsite (TK21005) contained a similar range of organic chemicals to those in surface water from the Incirlik site (TK21034), including the same phthalate esters, chlorinated organophosphates and alkyne-diol. These chemicals were, however, also identified in the control water sample from the creek at a location upstream of the Yenidam dumpsite (TK21009), suggesting that upstream sources may be additional, or sole, sources of these chemicals to the creek, and their presence in the creek may be unrelated to activities at the dumpsite in Yenidam.

A derivative of the antioxidant BHT was also identified in creek water within the dumpsite, though not in the sample from the upstream control location. Although this chemical was not found in any of the samples of ash or soil in this investigation, BHT and BHT derivatives were identified in plastic wastes from all sites. Diethylene glycol dibenzoate, a plasticizer used in polyvinyl acetate (PVA) emulsions and for PVC coatings, among other applications, was also detected in sample TK21005, but not in the control or any other samples in this study.

The creek water sample contained slightly elevated concentrations of dissolved copper, manganese and molybdenum, compared to the equivalent concentrations in the upstream control sample (TK21009). Background concentration of soluble metals in uncontaminated surface waters can vary significantly between locations. Levels are typically below 10 µg/l for copper and molybdenum, though can be lower in some locations. Concentration of manganese can vary from around 1 up to many 100s µg/l. (ATSDR 2004a, Flem *et al.* 2018, Smedley & Kinniburgh 2017).

In freshwater environments, many metals and metalloids, along with many organic chemicals which show poor water solubility, commonly accumulate in sediment over time. The two samples of sediment from the creek (TK21010-11) were both collected from the same location, though no sediment could be obtained from the creek at the upstream control location for comparison.

An organic chemical identified in the sediment, BHT, is closely related to the BHT derivative found in creek water within the dumpsite (TK21005). Other organic chemicals identified in the sediment, however, were characteristic of the ranges of chemicals identified in ash and soil samples from all sites, rather than those found in surface water or plastic samples. These included a dichlorobenzene, a number of PAHs (including the most commonly identified examples, naphthalene and phenanthrene) and a wide range of alkyl benzenes and long chain hydrocarbons

Concentrations of metals and metalloids in the sediments were broadly consistent between the 2 samples. Concentrations of copper, lead and zinc were up to 5 times typical background levels for freshwater sediments, with those of antimony, cadmium and molybdenum being just above the upper end of the ranges typically found in uncontaminated sediments (ATSDR 2004a, 2005b, 2019, 2020, Salomons & Forstner 1984, Smedley & Kinniburgh 2017). The range of metals and metalloids found above typical background concentrations reflected those present at high levels in the ash samples from this site, with the exceptions of tin, which was not found at an elevated level in either sediment, and antimony, which was only found at a slightly elevated concentration in one sample (TK21010).

Given the industrial nature of the area surrounding the site, the possibility cannot be excluded that other industrial sources of these contaminants upstream from the dumpsite, including other plastics storage and recycling facilities in the area, may have contributed to the contamination found in the creek sediment.

Karahan

Soil samples from both the Karahan-2 and Karahan-3 sites contained chlorinated benzenes (including penta- and hexachlorobenzene) and a diverse mix of both aromatic and long chain aliphatic hydrocarbons, in common with other sites. In contrast with the Incirlik and Yenidam sites, however, only a small number of biphenyl and triphenyl compounds were identified, and no quaterphenyl compounds. Similarly, only a single alkyl benzene was identified in one soil sample, from the Karahan-3 site, together with styrene, a product of incomplete combustion of polystyrene.

Ash samples from both Karahan sites investigated in this study showed contaminant patterns similar to those in ashes from the other sites, although with a narrower range of chlorinated benzenes (not including penta- and hexachlorobenzene.

The total concentration of 16 PAHs was similar in soil samples from both Karahan sites, and although these levels were considerably lower than in soil from the Incirlik site, they were nonetheless still indicative of localised sources of contamination, especially given that no PAHs were detected in the control soil sample associated with the Karahan sites. In addition, samples of ash from both these sites contained particularly high PAH concentrations, especially that from the Karahan-2 site which had the highest level found in all samples (TK21016; 37 700 μg/kg), approximately 140 times that in the underlying soil sample

These forensic screen results and the PAH data suggest that, for these two sites at Karahan, considerably less transfer of organic chemical contaminants had occurred from ashes to the underlying soils at the locations from where the samples were collected. The Karahan-3 site had only recently been used as a dumpsite, which may explain tower transfer to soil at this site, though the reason for the situation at the Karahan-2 site is not clear.

The total PCB concentration in the ash, both mass concentration and TEQ, was near the middle of the range across all sites, as was the total TEQ concentration for PCDD/Fs, with the profiles of individual PCBs and of individual PCDD/Fs being similar to those for ash samples from other sites.

For each of the Karahan-2 and Karahan-3 sites, concentrations of most metals and metalloids were similar between the two samples of ash from each site, though there were two exceptions where the concentration of a metal was notably higher in one ash sample; for zinc at the Karahan-2 site and copper at the Karahan-3 site. Concentrations of most key metals and metalloids were generally higher in ash samples from the Karahan-2 site compared to those from Karahan-3, the one exception being a very high copper concentration in one of the ash samples from Karahan-3 (TK21020).

For both Karahan sites, the notable metals and metalloids in the ash samples followed a similar pattern to those found at relatively high concentrations in the samples of plastic from the same site, especially for the Karahan-3 site. Plastic samples from the Karahan-2 site had relatively high concentrations of antimony, tin and to a lesser extent cadmium and zinc. Concentrations in the ashes were generally higher than those in plastic from the same site, especially for samples from the Karahan-2 site, as would be expected where these metals/metalloids are concentrated in the ash as plastic is burned. The one exception was antimony, for which plastic samples had higher concentrations than the ashes, which may be due to losses to the atmosphere during combustion.

Site	Control	Karahan-2				Karahan-3			
Sample code	**TK21012**	**TK21014**	**TK21015**	**TK21016**	**TK21017**	**TK21019**	**TK21020**	**TK21021**	**TK21022**
Sample type	Soil	Soil	Soil	Ash	Ash	Ash	Ash	Soil	Soil
Antimony	<0.1	0.8	3.3	13.3	9.4	9.1	12.0	0.5	0.3
Arsenic	9.2	5.3	10.5	3.6	3.8	4.7	3.8	4.4	5.1
Barium	144	101	121	1880	1310	472	407	205	190
Beryllium	0.7	0.5	0.4	0.2	0.3	0.3	0.2	0.6	0.3
Cadmium	0.31	1.25	4.48	30.8	33.3	10.7	8.44	0.43	0.39
Chromium	88.9	46.9	103	146	131	178	112	90.0	63.7
Cobalt	11.5	7.9	7.8	6.3	9.1	9.2	12.3	8.8	8.9
Copper	17.8	22.4	51.1	269	146	302	23500	32.7	31.0
Lead	13.6	60.9	130	894	722	136	125	57.0	51.8
Manganese	325	277	289	488	249	261	433	294	297
Mercury	1.3	0.9	0.3	0.4	0.2	0.4	0.7	0.3	0.3
Molybdenum	0.8	0.3	0.8	19.7	18.6	3.1	2.3	0.5	0.7
Nickel	110	61.5	87.5	72.7	47.4	66.0	95.0	98.6	98.3
Strontium	181	72.6	80.2	103	82.9	198	140	94.5	94.7
Tin	0.8	2.7	2.5	86.5	67.4	22.2	25.8	1.5	1.4
Titanium	416	332	334	577	379	653	837	344	341
Vanadium	51.5	33.3	35.6	17.7	17.8	29.4	50.8	29.0	32.3
Zinc	46	354	912	4240	1180	882	1870	111	104

Table 10: Concentrations of metals and metalloids (mg/kg dry weight) in samples of soil or ash from dumpsites in Karahan, Cukurova Turkey

Ash collected at the Karahan-2 site contained the highest concentrations of cadmium in ashes collected across all sites (at over 30 mg/kg in both samples), as well some of the highest concentrations of lead. The levels of cadmium and lead were over 15 and 30 times typical uncontaminated soil concentrations, respectively. In addition, one ash sample (TK21016) also contained the highest zinc concentration found in ash samples across all sites.

At the Karahan-3 site, in addition to the very high copper concentration in one ash sample, both ash samples from this site also contained high cadmium concentrations. Concentrations of the remaining key metals/metalloids were generally lower in the two ash samples from the Karahan-3 site compared to the other sites. With the exception of molybdenum, concentrations were, however, still higher than those typically found in uncontaminated soil, by between 5 and 10 times in most cases.

Following a similar pattern seen in the ash and plastic samples, at least one sample of underlying soil at the Karahan-2 site contained antimony, cadmium, copper, lead, tin and zinc at concentrations above those found in the control soil sample from nearby agricultural land. One sample contained antimony, cadmium and zinc at concentrations between 14 and 33 times those in the control soil. A similar situation was also found at the Karahan-3 site, though with lower levels of contamination in the soil samples, as might be expected with the generally lower concentrations in ash at this site. Overall, concentrations in the soil samples were somewhat lower than those in the overlying ash samples.

Kuyumcular

The range of organic chemicals identified in the soil sample from the Kuyumcular site was similar to that for the two Karahan sites, with the exception that no aliphatic hydrocarbons were identified in the Kuyumcular soil (see Table 5). The total concentration of 16 PAHs in the soil sample was also similar to that for the two soils from the Karahan sites, being 12 times that of the control soil sample associated with the Kuyumcular site.

This comparison was also reflected in the ash sample, which contained a similar, though slightly lower, range of organic chemicals to ash from the two Karahan sites. Furthermore, as seen at the Karahan sites, the sample of ash from the Kuyumcular site also had higher PAH concentrations than those in the underlying soil, with the total concentration 18 times that of the soil. Due to the more limited range of chlorinated compounds identified in samples from the Kuyumcular site, the concentrations of PCBs and PDFF/Fs were not quantified in these samples.

Site	**Kuyumcular**				
Sample code	**TK21027**	**TK21023**	**TK21024**	**TK21025**	**TK21026**
Sample type	Soil (control)	Soil	Soil	ash	ash
Antimony	0.3	0.6	1.0	11.1	11.7
Arsenic	6.3	27.8	23.6	9.7	8.1
Barium	100	538	456	352	503
Beryllium	0.8	2.5	1.6	0.6	0.5
Cadmium	0.39	20.2	14.3	5.96	6.10
Chromium	62.7	109	86	257	375
Cobalt	10.1	12.5	11.4	11.8	10.8
Copper	17.0	34.7	30	192	226
Lead	12.4	24.1	22	120	163
Manganese	282	228	239	367	443
Mercury	1.2	1.4	1.1	0.8	0.9
Molybdenum	1.4	255	185	41.2	34.9
Nickel	90.8	345	292	132	189
Strontium	96.2	384	319	216	229
Tin	3.3	1.8	1.5	45.9	54.1
Titanium	326	684	578	359	385
Vanadium	41.1	431	360	88.7	78.8
Zinc	61	362	308	767	1550

Table 11: Concentrations of metals and metalloids (mg/kg dry weight) in samples of soil or ash from a dumpsite in Kuyumcular, Seyhan, Turkey

As for other sites, the two ash samples had a similar composition of metals and metalloids, with concentrations also generally similar to those found at the 2 sites in Karahan (though somewhat lower for cadmium and lead). Ash samples from this site contained the highest concentrations of molybdenum across all sites. Concentrations of the notable metals/metalloids in the ash samples were between 3 and 10 times those reported for typical uncontaminated soils.

As with the Karahan sites, the range of metals and metalloids at relatively high concentrations in the ash samples followed the same pattern as those in the waste plastic samples, with the exception of antimony.

Soil samples from the Kuyumcular site contained a range of metals and metalloids at higher concentrations that those in the control soil from nearby agricultural land, though the range of metals and metalloids did not match the pattern found in the ash samples, in contrast to other sites.

The soils contained high concentrations of cadmium, molybdenum and to a lesser extent zinc, reflecting high levels also found in overlying ash samples. In contrast, however, the soil samples did not contain relatively high concentrations of antimony, copper, lead or tin. In addition, certain other metals and metalloids were found at relatively high concentrations in the soil samples, including arsenic, barium, nickel and vanadium. These results suggest that other types of wastes may have also been disposed of previously at this site, alongside the types of plastics that were collected.

Reflecting the notable concentrations of molybdenum in the ash samples, soil samples from this site also had the highest concentrations of molybdenum across all sites, at over 100 times those in the control soil sample. The soil samples also contained the second highest cadmium soil concentrations, after those found in soil from the Karahan-2 site, at 40-50 times that in the control soil. Unlike the situation at the Karahan sites, however, in many cases the concentrations of individual metals in the soil samples were higher than those in the overlying ashes, including for molybdenum and cadmium.

This may be due to accumulation over time of metals and metalloids in underlying soil from ashes, but could also be due to the disposal of other types of wastes at this site.

Conclusions

This investigation has demonstrated the contamination of the local environments at five sites in Adana Province, Turkey, with hazardous chemical pollutants likely arising principally from the disposal and burning of waste plastics.

The plastics wastes themselves were found to contain a range of hazardous organic chemicals as well as metals and metalloids. Where such plastics have been burned, the ash residues at the sites were contaminated with additional organic chemical pollutants which can be generated during the combustion of plastics (i.e. as products of incomplete combustion, especially at relatively low temperatures achieved in open waste burning operations), as well as many of the metal and metalloid contaminants found in the plastics, which can be expected to be in forms that are more mobile in the environment compared to those in the source plastics. The organic chemical pollutants included compounds that are toxic, highly persistent (resistant to degradation in the environment) and which can, in many cases, bioaccumulate if they enter food. Some of these persistent organic pollutants were found at very high concentrations in these samples, thereby representing hotspots of contamination which could contribute substantially to localised or more widespread exposure of environmental media, wildlife and even humans over time. Similar patterns of contamination was found in many of the soils underlying the ashes, indicating the transfer of chemical pollutants from post-combustion residues into soil at these dumpsites.

According to information received since the samples for this study were collected, waste plastic and post-combustion ashes have recently been removed from the dumpsites, though underlying

contaminated soils are reported to remain in place. Given the evidence presented above that these soils represent an accumulated reservoir of toxic and persistent contaminants, it is clear that they will require urgent investigation and remediation in order to prevent the spread of those contaminants to the wider environment. It must also be clarified by the responsible authorities whether contaminated ashes from the sites have been transferred to a nearby municipal waste landfill, and whether the storage or final disposal methods used at receiving sites are suitable for such materials, given that they are highly contaminated with complex mixtures of hazardous chemicals, including in some cases polychlorinated dibenzodioxins/furans (PCDD/Fs.

Any future disposal and burning of waste plastics at informal dumpsites in Turkey needs to be prevented to avoid contamination of such dumpsites with hazardous chemicals. Furthermore, the production and use of plastic needs to be addressed more broadly, to avoid the use of hazardous chemicals during manufacture, and also to reduce and ultimately eliminate the generation of vast quantities of plastic waste, including through the phasing out of single use plastics.

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Appendix 1: Details of methodologies

For ash, soil and sediment samples, in the majority of cases the sample was collected from a single location into two separate bottles. On arrival at the laboratory the two subsamples were combined, the material fully homogenised and then split into two subsamples; one subsample was used for forensic screening analysis of organic chemical contaminants and for quantitation of metal and metalloid concentrations, with the other subsample sent to an external laboratory for quantitative analysis of certain organic chemical contaminants. The exceptions to this was for samples TK21016-17 and TK21019-20, for which the material was collected in a single bottle. The same homogenisation and subsampling process was applied. Sample TK21019 was collected into two separate bottles, though one of the bottles broke during transport to the laboratory, and the remaining sample in the intact bottle was treated in the same way as other samples for which the material was collected in a single bottle.

Analysis for extractable organic compounds

Preparation

10 µg of deuterated naphthalene was added as an Internal Standard (IS) to each portion of sample that was subject to extraction.

Solid sample extraction: approximately 10 g of each sample (wet weight) was extracted employing an Accelerated Solvent Extraction (ASE) technique, using a Dionex ASE-350, with a mixture of pentane and acetone (3:1), and at a temperature of 100^{o}C. Obtained extracts were concentrated to a volume of 1ml with a stream of clean nitrogen.

All samples were treated with a solution of TBA reagent in water. Some samples required a sulphuric acid cleaning processes due to the emulsion created by particles in the matrix (mainly samples received in ash form).

The pentane phase was collected and eluted through a Florisil column, using a 95:5 pentane:toluene mixed eluent resulting in about 30ml of the extract. The cleaned extract was concentrated to a final volume of 1ml. 10 µg of Bromonaphthalene was added to each extract as a second IS prior to GC-MS analysis.

Water sample extraction: approximately 500ml of sample were prepared using solid phase extraction technique with Dionex AutoTrace workstation. The eluting solvents were ethyl acetate followed by a mixture of pentane and toluene 95:5. Obtained extracts were concentrated to a volume of 1ml with a stream of clean nitrogen and analysed with GC/MS.

Shredded plastic samples: Blender was used to minimize each particle's size. Each sample was then homogenized and passed through a 2mm sieve. The dust and particles <2mm were then collected and analysed separately from those particles >2mm (1g and 5g used respectively). All samples were extracted with methanol, sonicated, submitted to a florisil cleaning procedure and analysed with GC/MS. Results from the <2mm particles and >2mm particles subsamples for each sample, were combined previous to being reported.

GC/MS analysis

For the total organic compounds screening, samples were analysed using an Agilent 6890 Series II GC with Restek Rtx-17Sil column (30m, 0.25mm ID, 0.25 µm film thickness) linked to an Agilent 5975B Inert MSD operated in EI mode and interfaced with an Agilent Enhanced Chem Station data system. Total Ion

chromatograms (TIC) were obtained. The GC oven temperature program employed was as follows: an initial temperature of 40^{0}C, raised to 260^{0}C at 10^{0}C/min, then to 295^{0}C at 50^{0}C/min (held for 10 min), then to 325^{0}C at 50^{0}C /min (held for 25 min), finally raised to 330^{0}C at 50^{0}C/min (held for 1 min). The carrier gas was helium, supplied at 1ml/min.

The identification of the compounds was carried out by matching spectra obtained during analysis against both the Wiley W10N11 and Pesticides Libraries. In addition, the presence of chemicals in certain chemical groups was further investigated using other techniques available in ChemStation software (e.g., peak purity and specific ion extraction), including PBDES, PAHs, halogenated compounds, and phthalates.

Quality control

A number of extraction and solvent blanks (1 for every 5 samples extracted) were also analysed to ensure the detection of any possible contamination resulting from sample handling in the laboratory. Any background contaminants detected in blanks were subtracted from the chromatograms obtained for the samples before mass spectra interpretation.

Analysis for metals

Preparation

For water samples, a representative portion of each whole water sample was acidified by the addition of concentrated nitric acid to give a final concentration of 5% v/v, to obtain total metal concentrations. Separately, a portion of each whole sample was filtered through a 0.45 micron filter and then acidified in the same way to enable determination of dissolved metal concentrations. 25 ml of each acidified sample was digested firstly overnight at room temperature, then using microwave-assisted digestion with a CEM MARS Xpress system, with a temperature ramp to 180^{o}C over 15 minutes followed by holding at 180^{o}C for a further 15 minutes. Cooled digests were filtered and made up to 25 ml with deionised water.

For soil, sediment & ash samples, a representative portion of each sample was air dried to constant weight, homogenised, sieved through a 2mm mesh and then ground to a powder using a pestle and mortar. Approximately 0.25 g of the ground sample was accurately weighed and digested with 5.0 ml concentrated nitric acid and 0.5 ml concentrated hydrochloric acid, firstly overnight at room temperature then using microwave-assisted digestion with a CEM MARS Xpress system with temperature ramping: heating to 180^{o}C over 20 minutes and held at 180^{o}C for 20 minutes. Following cooling, each digest solution was filtered and made up to 25 ml with deionised water. Prior to analysis, each digest solution was diluted 1:4 using deionised water.

For shredded plastic samples, a representative portion of each sample was air dried to constant weight and homogenised as far as possible. Three separate subsamples of approximately 0.5 g were accurately weighed from each sample and digested with 5 ml concentrated nitric acid and 0.5 ml concentrated hydrochloric acid, firstly overnight at room temperature then using microwave-assisted digestion with a CEM MARS Xpress system with temperature ramping: heating to 100^{o}C over 10 minutes, held at 100^{o}C for 60 minutes, cooled and excess pressure released; heating to 125^{o}C over 10 minutes, held at 125^{o}C for 20 minutes, cooled and excess pressure released; heating to 150^{o}C over 10 minutes, held at 150^{o}C for 20 minutes, cooled and excess pressure released. 2 ml of hydrogen peroxide (30%) was added for 1 hour at room temperature, followed by heating to 180^{o}C over 10 minutes then held at 180^{o}C for 30

minutes. Following cooling, each digest solution was filtered and made up to 25 ml with deionised water. Prior to analysis, each digest solution was diluted 1:4 using deionised water.

Analysis

Prepared sample digests were analysed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) using an Agilent 7900 Spectrometer utilizing a collision cell with helium as the collision gas to minimize polyatomic interferences. Multi-element standards, matrix matched to the samples, at concentrations of 1, 10, 100 and 1000 μg/l respectively, other than for mercury (1, 2, 5, 20 μg/l respectively) were used for instrument calibration. Analysis employed in-line addition of an internal standard mix at 100 μg/l (Scandium, Germanium, Yttrium, Indium and Terbium). Any sample exceeding the calibration range was diluted accordingly, in duplicate, and re-analysed.

Quality control

One sample of water, sediment and ash, and two soil samples, were prepared for ICP analysis in duplicate and analysed to verify method reproducibility. A blank sample was also prepared with each set of samples (water, solids, shredded plastic). For water samples, a mixed metal quality control solution of 80 μg/l for each metal, other than mercury at 4 μg/l, was digested and analysed in an identical manner. To check method efficiency for solid samples, three certified reference material (CRM) were prepared in an identical manner, namely LGC6189, leachable metals in river sediment certified by the Laboratory of the Government Chemist, UK; CRM7004, loam with elevated analyte levels certified by the Czech Meteorological Institute; LGC6180, pulverised fuel ash by the Laboratory of the Government Chemist, UK

Calibration of the ICP-MS was validated by the use of quality control standards at 80 μg/l and 800 μg/l (4 μg/l and 16 μg/l for mercury) prepared in an identical manner but from different reagent stocks to the instrument calibration standards.

Further details on analytical procedures and quality controls can be provided on request.

Appendix 2: Quantitative data for polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and polychlorinated dibenzodioxins/furans (PCDD/Fs)

Site	Incirlik			Yenidam		
Sample code	TK21033	TK21029	TK21031	TK21008	TK21010	TK21006
Type	soil (control)	soil	ash	soil (control)	sediment	ash
Naphthalene	< 10,0	657	2540	< 10,0	10700	2000
Acenaphthylene	< 10,0	10.3	223	< 10,0	20.3	142
Acenaphthene	< 10,0	< 10,0	42.1	< 10,0	16.6	17.6
Fluorene	< 10,0	133	784	< 10,0	76.1	300
Phenanthrene	10.9	1060	2930	20.5	294	1740
Anthracene	< 10,0	95.8	354	< 10,0	43.3	130
Fluoranthene	< 10,0	310	649	24.8	185	347
Pyrene	< 10,0	188	442	16.5	178	221
Benz(a)anthracene	< 10,0	175	388	< 10,0	47.2	113
Chrysene	< 10,0	291	520	12.6	66.5	186
Benzo(b/j)fluoranthene	< 10,0	210	515	15.9	79.9	262
Benzo(k)fluoranthene	< 10,0	17.5	58.4	< 10,0	24.9	34.9
Benzo(a)pyrene	< 10,0	42.9	139	< 10,0	45.7	62.3
Dibenz(a,h)anthracene	< 10,0	13.5	34.9	< 10,0	< 10,0	25.3
Indeno(1,2,3-cd)pyrene	< 10,0	34.4	139	< 10,0	42.2	97.3
Benzo(ghi)perylene	< 10,0	45.9	175	< 10,0	54.9	113
Sum 16 EPA-PAH	10.9	3280	9930	90.2	11900	5790

Table A2-1: Concentrations of polycyclic aromatic hydrocarbon (PAHs) (μg/kg dry weight) in samples of soil, ash or sediment from dumpsites in Yenidam and Karahan, in the vicinity of Adana, Turkey

Site	Karahan					Kuyumcular		
	control	Karahan-2		Karahan-3				
Sample code	TK21012	TK21014	TK21016	TK21021	TK21020	TK21027	TK21023	TK21026
Type	soil (control)	soil	ash	soil	ash	soil (control)	soil	ash
Naphthalene	< 10,0	159	20700	97.4	1130	15.7	195	1940
Acenaphthylene	< 10,0	< 10,0	1620	< 10,0	69.9	< 10,0	13	155
Acenaphthene	< 10,0	< 10,0	257	< 10,0	< 10,0	< 10,0	< 10,0	33.9
Fluorene	< 10,0	17.6	1410	12.8	135	< 10,0	22.4	407
Phenanthrene	< 10,0	50.6	6130	67.5	718	12.2	76.3	1770
Anthracene	< 10,0	< 10,0	979	< 10,0	70	< 10,0	< 10,0	191
Fluoranthene	< 10,0	12.6	1370	21.4	186	< 10,0	16.3	408
Pyrene	< 10,0	< 10,0	1230	18.5	121	< 10,0	12.3	296
Benz(a)anthracene	< 10,0	< 10,0	710	< 10,0	91.9	< 10,0	< 10,0	142
Chrysene	< 10,0	16.8	1390	10.7	119	< 10,0	< 10,0	210
Benzo(b/j)fluoranthene	< 10,0	10.4	712	10.7	135	< 10,0	< 10,0	180
Benzo(k)fluoranthene	< 10,0	< 10,0	148	< 10,0	14.8	< 10,0	< 10,0	32.5
Benzo(a)pyrene	< 10,0	< 10,0	367	< 10,0	35.8	< 10,0	< 10,0	77.3
Dibenz(a,h)anthracene	< 10,0	< 10,0	75	< 10,0	11.6	< 10,0	< 10,0	15
Indeno(1,2,3-cd)pyrene	< 10,0	< 10,0	265	< 10,0	36.3	< 10,0	< 10,0	73.5
Benzo(ghi)perylene	< 10,0	< 10,0	356	< 10,0	54.6	< 10,0	< 10,0	83.5
Sum 16 EPA-PAH	-	267	37700	239	2930	27.9	335	6010

Table A2-2: Concentrations of polycyclic aromatic hydrocarbon (PAHs) (µg/kg dry weight) in samples of soil, ash or sediment from dumpsites in Yenidam and Karahan, in the vicinity of Adana, Turkey

Site	Incirlik		Yenidam		Karahan-3
Sample code	TK21029	TK21031	TK21008	TK21006	TK21020
Type	soil	ash	soil (control)	ash	ash
PCB 77	14200	6990	4.08	1390	2770
PCB 81	14600	2790	< 0,854	366	955
PCB 105	15900	4490	< 8,54	439	1500
PCB 114	6320	1440	< 1,03	137	559
PCB 118	13000	4370	< 30,7	450	1470
PCB 123	7470	1180	1.17	75.7	336
PCB 126	17400	5920	< 1,12	572	1950
PCB 156	11400	3180	< 4,82	306	1380
PCB 157	13500	2320	< 0,985	147	824
PCB 167	6610	1470	< 2,41	131	511
PCB 169	10200	1850	< 2,63	229	552
PCB 189	18800	3200	< 0,876	210	1270
PCB 28	< 7960	< 7810	< 89.8	358	627
PCB 52	< 5920	< 5810	< 66.8	103	103
PCB 101	< 9510	< 9330	< 107	151	132
PCB 138	< 6990	< 6860	< 78.8	154	501
PCB 153	< 11300	< 11000	< 127	143	286
PCB 180	8530	< 2860	< 32.8	253	857
Sum of listed PCBs by mass	157930	39200	5.25	5615	16583
WHO(2005)-PCB TEQ total	2050	650	0.000444	64.4	213

Table A2-3: Concentrations of polychlorinated biphenyls (PCBs) (ng/kg dry weight) in samples of soil or ash from dumpsites in the vicinity of Adana, Turkey

Site	Incirlik		Yenidam		Karahan-3
Sample code	TK21029	TK21031	TK21008	TK21006	TK21020
Type	soil	ash	soil (control)	ash	ash
2,3,7,8-TetraCDD	1050	418	< 0,197	26.8	132
1,2,3,7,8-PentaCDD	7820	2890	< 0,263	116	868
1,2,3,4,7,8-HexaCDD	10900	2770	< 0,525	108	1010
1,2,3,6,7,8-HexaCDD	33500	7420	< 0,525	311	2640
1,2,3,7,8,9-HexaCDD	19200	4520	< 0,525	184	1690
1,2,3,4,6,7,8-HeptaCDD	223000	37200	0.902	1870	13500
OctaCDD	329000	45500	3.18	2260	16100
2,3,7,8-TetraCDF	1760	1170	0.4	216	674
1,2,3,7,8-PentaCDF	2270	1710	< 0,482	195	681
2,3,4,7,8-PentaCDF	6340	4230	< 0,482	371	1740
1,2,3,4,7,8-HexaCDF	6670	3960	< 0,438	254	1440
1,2,3,6,7,8-HexaCDF	6290	3900	< 0,438	229	1340
1,2,3,7,8,9-HexaCDF	< 839	< 172	< 0,438	< 17,8	< 198
2,3,4,6,7,8-HexaCDF	11300	5980	< 0,438	348	2620
1,2,3,4,6,7,8-HeptaCDF	41400	18100	0.913	962	6150
1,2,3,4,7,8,9-HeptaCDF	1540	913	< 0,416	61.8	445
OctaCDF	8430	3640	< 3,50	222	1460
WHO(2005)-PCDD/F TEQ total	22600	8180	0.0591	455	2890
Sum TetraCDD	523000	138000	15.9	6580	58100
Sum PentaCDD	635000	172000	7.06	5140	64900
Sum HexaCDD	922000	176000	3.71	6410	76100
Sum HeptaCDD	456000	80100	1.95	4030	31400
OctaCDD	329000	45500	3.18	2260	16100
Sum TetraCDF	114000	75700	10.1	7160	30400
Sum PentaCDF	110000	71100	4.55	4690	25800
Sum HexaCDF	78700	47000	1.73	2400	16100
Sum HeptaCDF	50300	23500	0.913	1280	8590
OctaCDF	8430	3640	< 3,50	222	1460
Sum Tetra- bis OctaCDD	2860000	611000	31.8	24400	247000
Sum Tetra- bis OctaCDF	361000	221000	17.3	15700	82400
Sum Tetra- bis OctaCDD/F	3230000	832000	49.1	40200	329000

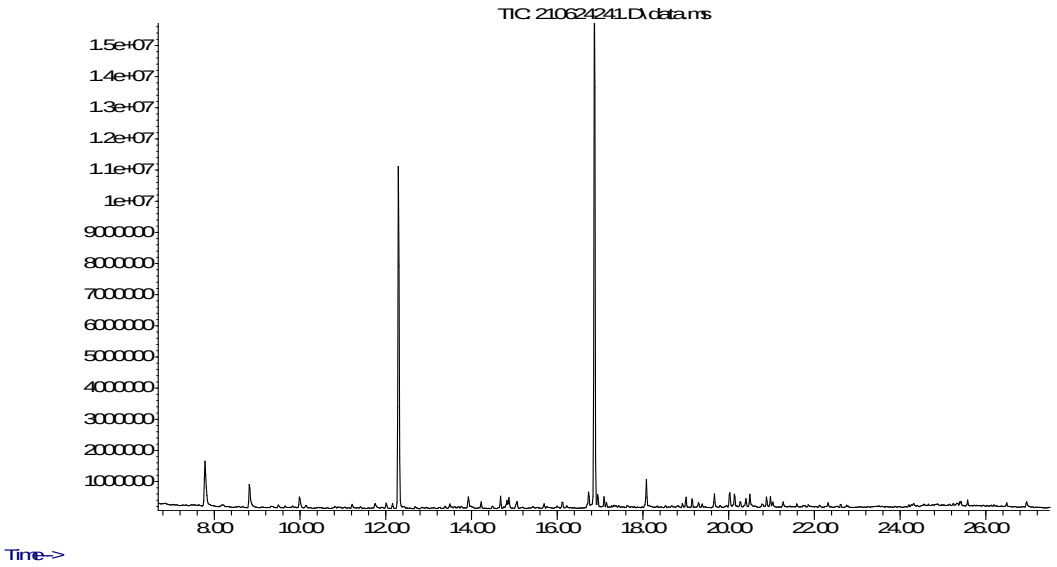
Table A2-4: Concentrations of polychlorinated dibenzodioxins/furans (PCDD/Fs) (ng/kg dry weight) in samples of soil or ash from dumpsites in the vicinity of Adana, Turkey

Appendix 3: Detailed semi-volatile organic (sVOCs chromatograms and analytical screening data

Chromatograms (showing the section containing peaks) and detailed screening data arising from GC-MS analysis of all samples are presented below.

Semi-volatile organic analysis results (sVOCs)

Sample code	TK21005
Location	Yenidam, Seyhan, Adana, Turkey
Sample type	Water
Date	16.04.2021
Description	Creek within dumpsite



Number of compounds isolated: 52

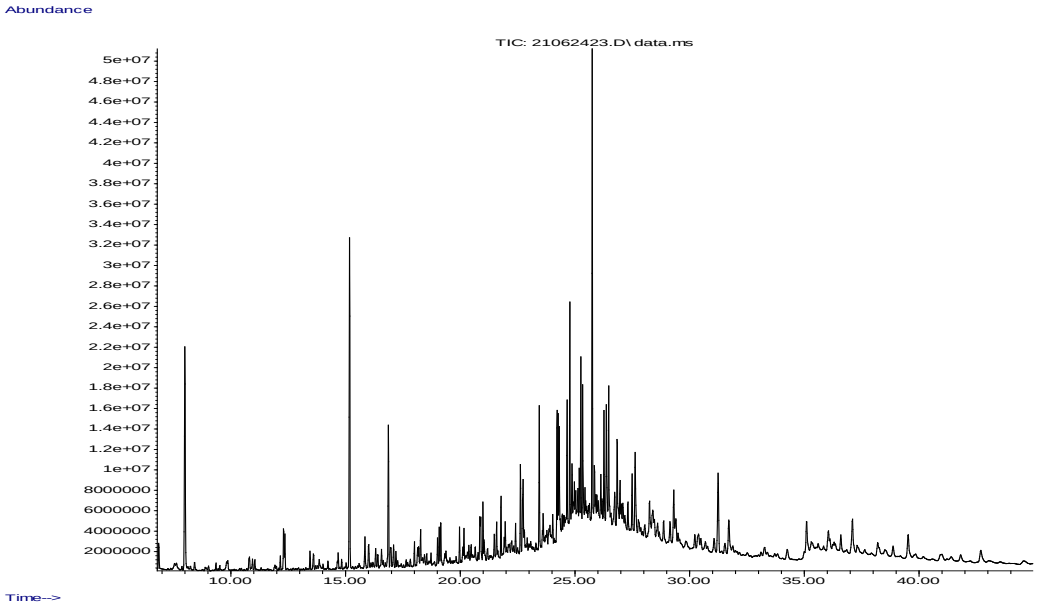
Compounds identified to better than 90%:

In total ion chromatogram (TIC)

CAS#	**Name**
000131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester
000084-66-2	1,2-Benzenedicarboxylic acid, diethyl ester
000084-74-2	1,2-Benzenedicarboxylic acid, dibutyl ester
000084-69-5	1,2-Benzenedicarboxylic acid, diisobutyl ester
000539-80-0	2,4,6-Cycloheptatrien-1-one
000126-86-3	5-Decyne-4,7-diol, 2,4,7,9-tetramethyl-
082304-66-3	7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione
000301-02-0	9-Octadecenamide, (z)-
001077-56-1	Benzenesulfonamide, n-ethyl-2-methyl-
000080-39-7	Benzenesulfonamide, n-ethyl-4-methyl-
066067-43-4	Benzophenone, 3-ethyl-
000615-22-5	Benzothiazole, 2-(methylthio)-
000120-55-8	Diethylene glycol dibenzoate
024324-17-2	Fluorene-9-methanol

000096-76-4 Phenol, 2,4-bis(1,1-dimethylethyl)-
000128-39-2 Phenol, 2,6-bis(1,1-dimethylethyl)-
000728-40-5 Phenol, 2,6-bis(1,1-dimethylethyl)-4-nitro-
060207-90-1 Propiconazole
107534-96-3 Tebuconazole
002303-17-5 Triallate
013674-84-5 Tris(2-chloroisopropyl)phosphate
001067-98-7 Tris(3-chloroisopropyl)phosphate

Sample code	TK21006
Location	Yenidam, Seyhan, Adana, Turkey
Sample type	Ash
Date	16.04.2021
Description	Within dumpsite



Number of compounds isolated: 233

Compounds identified to better than 90%:

CAS# Name

Halogenated compounds

002051-60-7 1,1'-Biphenyl, 2-chloro-
002051-61-8 1,1'-Biphenyl, 3-chloro-
000087-61-6 Benzene, 1,2,3-trichloro-
000120-82-1 Benzene, 1,2,4-trichloro-
000095-50-1 Benzene, 1,2-dichloro-
000541-73-1 Benzene, 1,3-dichloro-
000106-46-7 Benzene, 1,4-dichloro-
000118-74-1 Benzene, hexachloro-
000608-93-5 Benzene, pentachloro-

PAHs and derivatives

000602-55-1 Anthracene, 9-phenyl-
000091-20-3 Naphthalene
004630-07-3 Naphthalene, 1,2,3,5,6,7,8,8a-octahydro-

000581-42-0 Naphthalene, 2,6-dimethyl-
000091-57-6 Naphthalene, 2-methyl-
000085-01-8 Phenanthrene

Aliphatic hydrocarbons

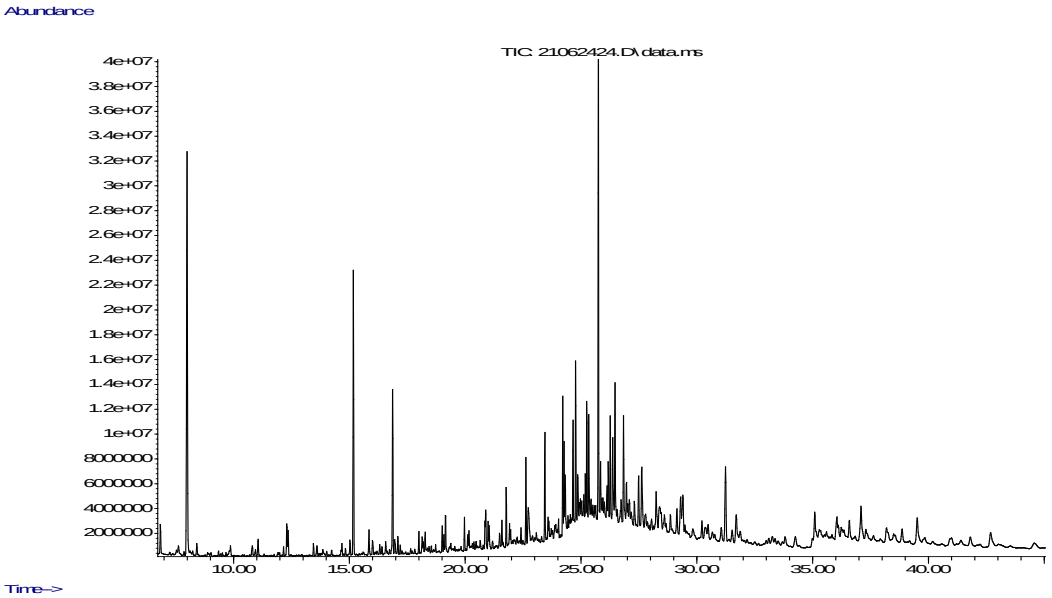
007206-19-1 (3E)-3-Octadecene
000112-41-4 1-Dodecene
002437-56-1 1-Tridecene
000000-00-0 2-Methyltricos-3-ene
041446-68-8 3-Tetradecene
000629-97-0 Docosane
000112-40-3 Dodecane
000112-95-8 Eicosane
000629-94-7 Heneicosane
000630-04-6 Hentriacontane
000593-49-7 Heptacosane
000629-78-7 Heptadecane
000544-76-3 Hexadecane
000000-00-0 *n*-Pentacos-3-ene
000630-03-5 Nonacosane
000629-92-5 Nonadecane
000630-02-4 Octacosane
000593-45-3 Octadecane
000629-62-9 Pentadecane
000629-99-2 Pentasane
000646-31-1 Tetracosane
000629-59-4 Tetradecane
000638-68-6 Triacontane
000638-67-5 Tricosane
001120-21-4 Undecane
000000-00-0 High molecular weight aliphatic hydrocarbon, 9 compounds

Other compounds

000092-52-4 1,1'-Biphenyl
001812-51-7 1,1'-Biphenyl, 2-ethyl-
000643-93-6 1,1'-Biphenyl, 3-methyl-
000644-08-6 1,1'-Biphenyl, 4-methyl-
001166-19-4 1,1':3',1'':4'',1'''-Quaterphenyl
000135-70-6 1,1':4',1'':4'',1'''-Quaterphenyl
000084-15-1 1,1':2',1''-Terphenyl
000092-06-8 1,1':3',1''-Terphenyl
001165-53-3 1,1':3',1''-Terphenyl, 4'-phenyl-
000612-71-5 1,1':3',1''-Terphenyl, 5'-phenyl-
005394-86-5 1H-Indene, 1-(phenylmethylene)-
000767-59-9 1H-Iindene, 1-methyl-
000526-73-8 Benzene, 1,2,3-trimethyl-
000095-63-6 Benzene, 1,2,4-trimethyl-
000098-83-9 Benzene, (1-methylethenyl)-
000768-49-0 Benzene, (2-methyl-1-propenyl)-
001081-75-0 Benzene, 1,1'-(1,3-propanediyl)bis-
001587-04-8 Benzene, 1-methyl-2-(2-propenyl)-
000099-87-6 Benzene, 1-methyl-4-(1-methylethyl)-
000100-42-5 Benzene, ethenyl-
001078-71-3 Benzene, heptyl-
000271-89-6 Benzofuran
000645-49-8 *cis*-Stilbene
005989-27-5 *D*-Limonene

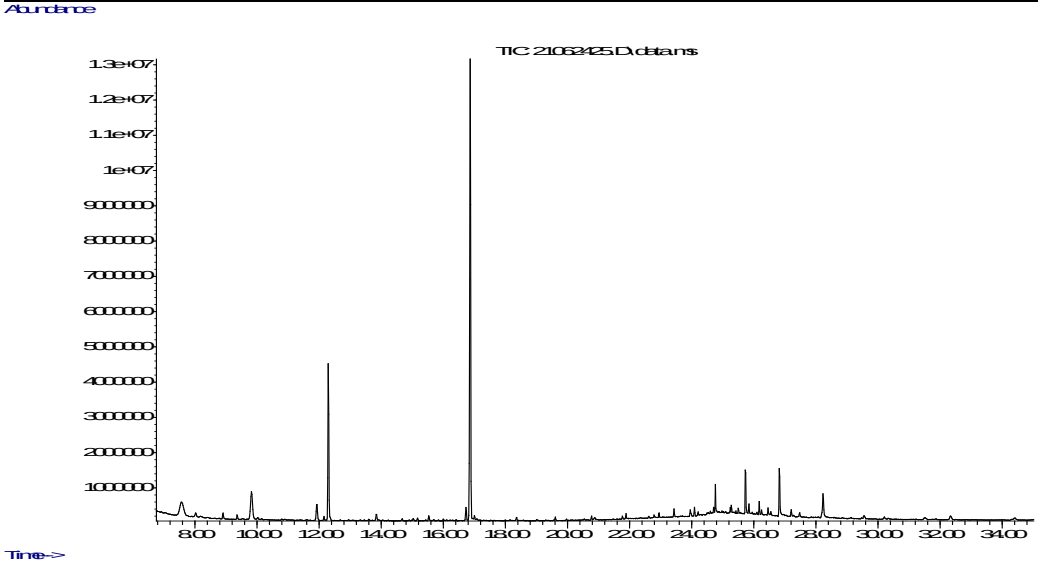
000132-64-9 Dibenzo-furan
000955-83-9 Furan, 2,5-diphenyl-

Sample code	TK21007
Location	Yenidam, Seyhan, Adana, Turkey
Sample type	Ash
Date	16.04.2021
Description	Within dumpsite (different location to TK21006)



Sample was not subject to detailed interpretation because chromatogram appeared identical to that of sample TK21006

Sample code	TK21008
Location	Yenidam, Seyhan, Adana, Turkey
Sample type	Soil
Date	16.04.2021
Description	Control soil – agricultural field

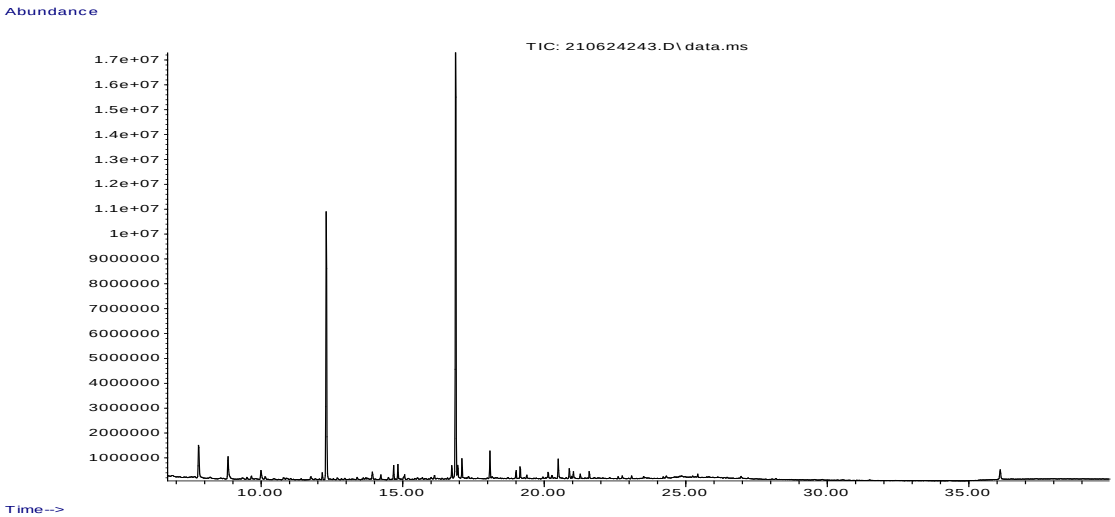


Number of compounds isolated: 49

Compounds identified to better than 90%:

CAS#	Name
Halogen containing compounds	
000072-55-9	*p,p'*-DDE
PAHs and derivatives	
000206-44-0	Flouranthene
000129-00-0	Pyrene
000085-01-8	Phenanthrene
Aliphatic hydrocarbons	
000630-01-3	Hexacosane
000000-00-0	High molecular weight aliphatic hydrocarbon, 5 compounds
Other compounds	
007683-64-9	Supraene

Sample code	TK21009
Location	Yenidam, Seyhan, Adana, Turkey
Sample type	Water
Date	16.04.2021
Description	Control water. Creek upstream of dumpsite, within an industrial area



Number of compounds isolated: 29

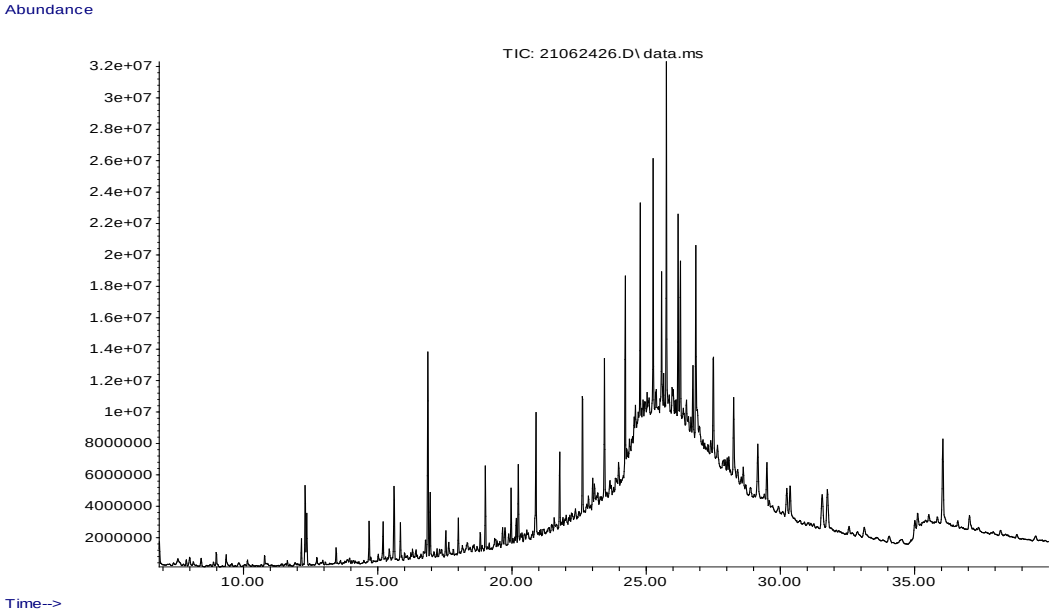
Compounds identified to better than 90%:

In total ion chromatogram (TIC)

CAS#	Name
000084-66-2	1,2-Benzenedicarboxylic acid, diethyl ester
000084-74-2	1,2-Benzenedicarboxylic acid, dibutyl ester
000084-69-5	1,2-Benzenedicarboxylic acid, diisobutyl ester

000126-86-3 5-Decyne-4,7-diol, 2,4,7,9-tetramethyl-
000127-63-9 Benzene, 1,1'- sulfonylbis-
000628-97-7 Hexadecanoic acid, ethyl ester
000096-76-4 Phenol, 2,4-bis(1,1-dimethylethyl)-
013674-84-5 Tris(2-chloroisopropyl)phosphate
001067-98-7 Tris(3-chloroisopropyl)phosphate

Sample code	TK21010
Location	Yenidam, Seyhan, Adana, Turkey
Sample type	Sediment
Date	16.04.2021
Description	Creek within the dumpsite



Number of compounds isolated: 245

Compounds identified to better than 90%:
CAS# Name
Halogen containing compounds
000106-46-7 Benzene, 1,4-dichloro-

PAHs and derivatives
000085-01-8 Phenanthrene
000206-44-0 Fluoranthene
000129-00-0 Pyrene
002809-64-5 Naphthalene, 1,2,3,4-tetrahydro-5-methyl-
000091-20-3 Naphthalene

Aliphatic hydrocarbons
000593-45-3 Octadecane
000629-92-5 Nonadecane
000629-94-7 Heneicosane
000638-67-5 Tricosane
000629-99-2 Pentacosane

000593-49-7	Heptacosane
000629-97-0	Docosane
000112-40-3	Dodecane
000112-95-8	Eicosane
000630-01-3	Hexacosane
000544-76-3	Hexadecane
000629-62-9	Pentadecane
000646-31-1	Tetracosane
000629-59-4	Tetradecane
001120-21-4	Undecane
000629-50-5	Tridecane
000000-00-0	High molecular weight aliphatic hydrocarbon, 10 compounds

Terpenes & Terpenoids

039029-41-9	.gamma.-Cadinene
000483-76-1	.delta.-Cadinene
000500-00-5	Cyclohexane, 4-methyl-1-(1-methylethyl)-
005989-54-8	Cyclohexane, 1-methyl-4-(1-methylethenyl)-

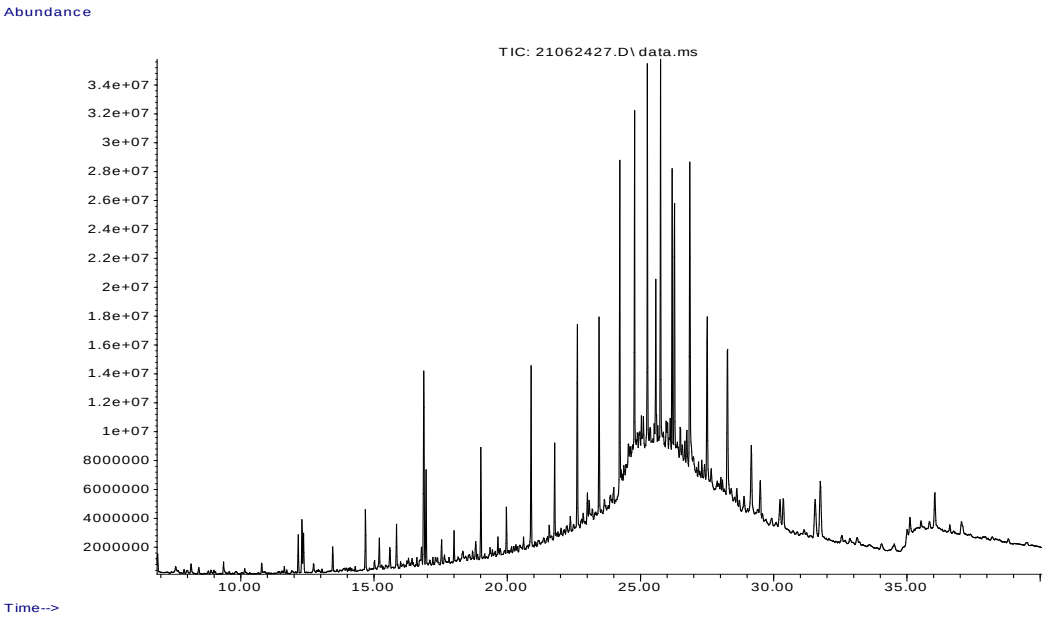
Alkyl benzenes

000095-47-6	Benzene, 1,2-dimethyl-
000100-42-5	Benzene, ethenyl-
000098-82-8	Benzene (1-methylethyl)-
000103-65-1	Benzene, propyl-
000108-67-8	Benzene, 1,3,5-trimethyl-
000095-63-6	Benzene, 1,2,4-trimethyl-
000098-83-9	Benzene, (1-methylethenyl)-
025155-15-1	Benzene, methyl(1-methylethyl)-
000526-73-8	Benzene, 1,2,3-trimethyl-
000135-98-8	Benzene (1-methylpropyl)-
000488-23-3	Benzene, 1,2,3,4-tetramentyl-
004536-87-2	Benzene, (1-ethylnonyl)-
002719-62-2	Benzene, (1-pentylheptyl)-
002719-61-1	Benzene, (1-methylundecyl)-
004534-49-0	Benzene, (1-pentyloctyl)-
004534-50-3	Benzene, (1-butylnonyl)-
002719-63-3	Benzene, (1-butyloctyl)-
004537-15-9	Benzene, (1-butylheptyl)-
002400-00-2	Benzene, (1-ethyldecyl)-
004536-88-3	Benzene, (1-methyldecyl)-
000535-77-3	Benzene, 1-methyl-3-(1-methylethyl)-
004536-86-1	Benzene, (1-propyloctyl)-

Other compounds

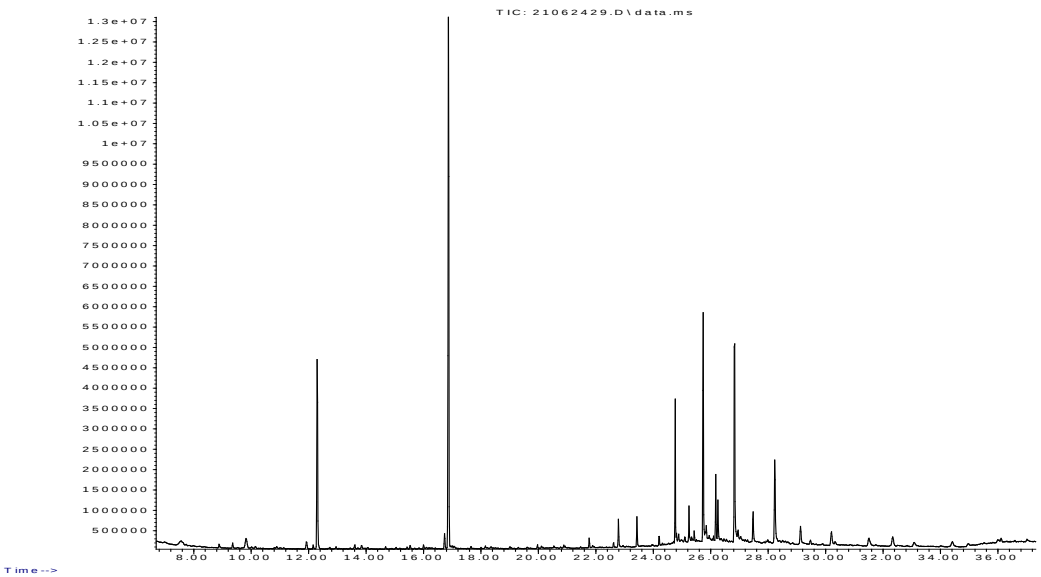
000112-55-0	1-Dodecanethiol
000101-84-8	Diphenyl ether
006566-19-4	10,18-Bisnorabieta-5,7,9(10),11,13-pentaene
003910-35-8	1H-Indene, 2,3-dihydro-1,1,3-trimethyl-3-phenyl-
006362-80-7	2,4-Diphenyl-4-methyl-1-pentene
004757-69-1	1H-Indole, 2-methyl-3-phenyl-
000000-00-0	5.alpha.-Cholestane-3.beta.,4.alpha.-diol
000128-37-0	Butylated hydroxytoluene
000111-02-4	Squalene

Sample code	TK21011
Location	Yenidam, Seyhan, Adana, Turkey
Sample type	Sediment
Date	16.04.2021
Description	Creek within the dumpsite



Sample was not subject to detailed interpretation because chromatogram appeared identical to that of sample TK21010

Sample code	TK21012
Location	Karahan, Cukurova, Adana, Turkey
Sample type	Soil
Date	15.04.2021
Description	Control soil - agricultural field

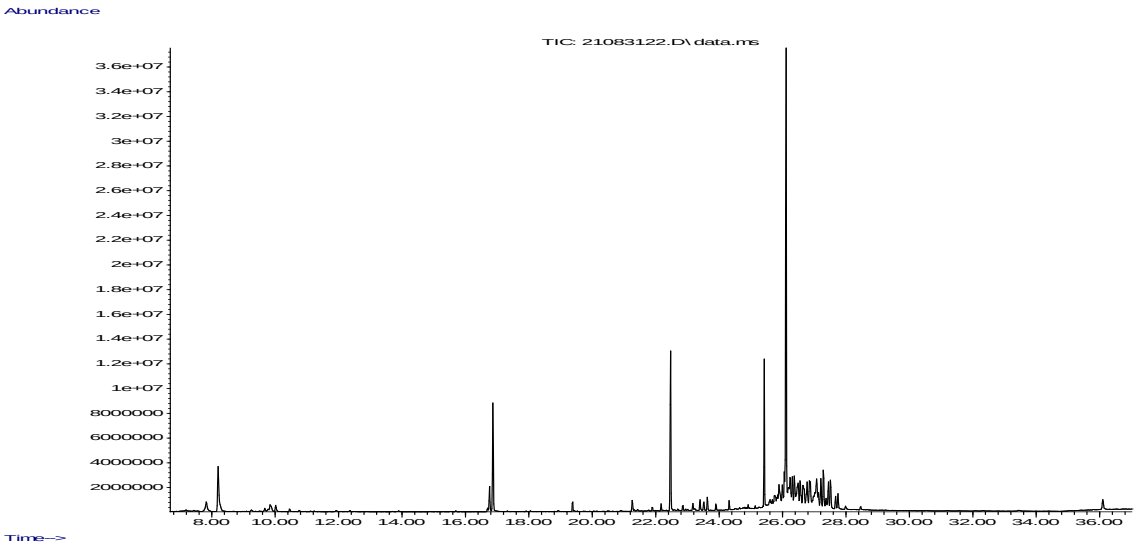


Number of compounds isolated: 49

Compounds identified to better than 90%:

CAS#	Name
PAHs and derivatives	
053584-60-4	3-Ethyl-5a,5b,8,8,11a,13b-hexamethylicosahydro-1H-cyclopenta[a]chrysene
Aliphatic hydrocarbons	
000112-95-8	Eicosane
000629-94-7	Heneicosane
000629-92-5	Nonadecane
000630-01-3	Hexacosane
000646-31-1	Tetracosane
000638-67-5	Tricosane
000629-97-0	Docosane
000593-49-7	Heptacosane
000000-00-0	High molecular weight aliphatic hydrocarbon, 12 compounds
Other compounds	
007683-64-9	Supraene

Sample code	TK21013
Location	Karahan, Cukurova, Adana, Turkey
Sample type	Shredded plastic
Date	15.04.2021
Description	Karahan-2, within dumpsite



Number of compounds isolated: 80

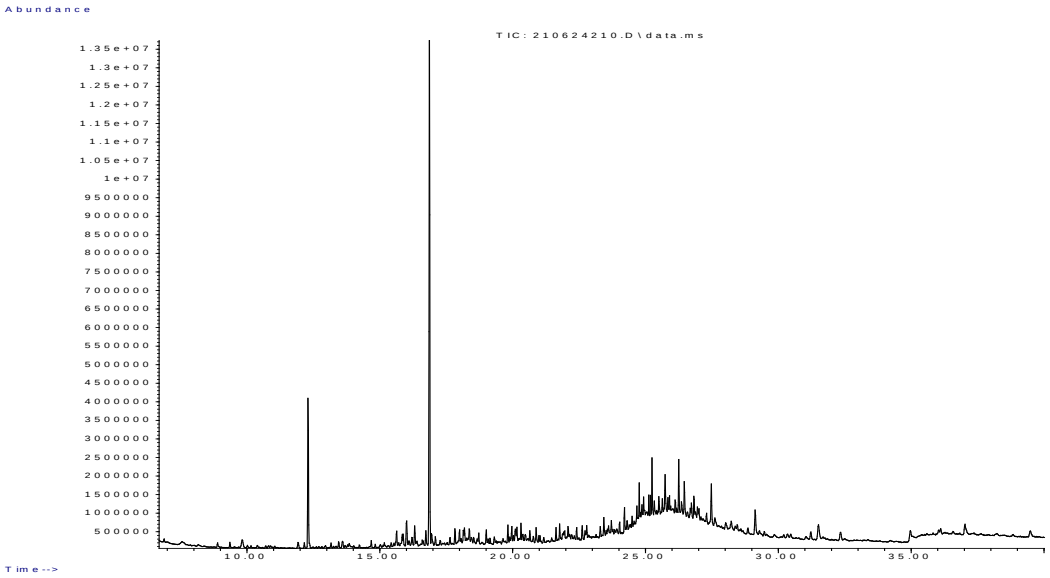
Compounds identified to better than 90%:

In total ion chromatogram (TIC)

CAS#	Name
000084-76-4	1,2-Benzenedicarboxylic acid, dinonyl ester

000117-81-7 1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
000131-11-3 1,2-Benzenedicarboxylic acid, dimethyl ester
020548-62-3 Phthalic acid, bis(7-methyloctyl) ester
000000-00-0 Phthalic acid,4,4-dimethylpent-2-yl isobutyl ester
001459-93-4 1,3-Benzenedicarboxylic acid, dimethyl ester
2000491-76-0 2-Ethylhexyl methyl isophthalate
006422-86-2 1,4-Benzenedicarboxylic acid, 1,4-bis(2-ethylhexyl) ester
000120-61-6 1,4-Benzenedicarboxylic acid, dimethyl ester
000104-76-7 1-Hexanol, 2-ethyl-
000143-08-8 1-Nonanol
003531-24-6 2-Propenenitrile, 3,3-diphenyl-
000142-83-6 2,4-Hexadienal, (e,e)-
002462-85-3 9,12-Octadecadienoic acid, methyl ester
001937-62-8 9-Octadecenoic acid, methyl ester, (E)
006386-38-5 Benzenepropanoic acid, 3,5-bis(1,1-dimethylethyl)-4-hydroxy-, methyl ester
000119-61-9 Benzophenone
000111-82-0 Dodecanoic acid, methyl ester
000112-39-0 Hexadecanoic acid, methyl ester
000124-10-7 Methyl tetradecanoate
000091-20-3 Naphthalene
000124-19-6 Nonanal
005875-45-6 Phenol, 2,5-bis(1,1-dimethylethyl)
000128-39-2 Phenol, 2,6-bis(1,1-dimethylethyl)
000080-05-7 Phenol, 4,4’-(1-methylethylidene)bis
000000-00-0 Quinoline-7-carboxylic acid, 2-phenyl-, methyl ester
000000-00-0 Substituted phthalates, 15 compounds
005129-66-8 Tetradecanoic acid, 12-methyl-, methyl ester

Sample code	TK21014
Location	Karahan, Cukurova, Adana, Turkey
Sample type	Soil
Date	15.04.2021
Description	Karahan-2, within dumpsite

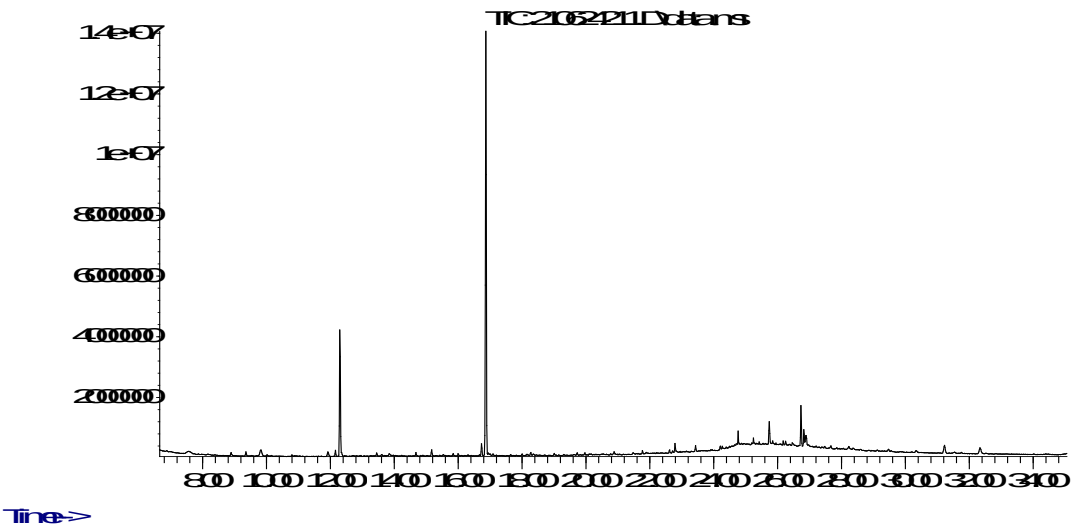


Number of compounds isolated: 165

Compounds identified to better than 90%:

CAS#	Name
Halogen containing compounds	
000087-61-6	Benzene, 1,2,3-trichloro-
000634-90-2	Benzene, 1,2,3,5-tetrachloro-
000634-66-2	Benzene, 1,2,3,4-tetrachloro-
000608-93-5	Benzene, pentachloro-
PAHs and derivatives	
000605-02-7	Naphthalene, 1-phenyl-
000091-57-6	Naphthalene, 2-methyl-
000091-20-3	Naphthalene
000085-01-8	Phenanthrene
000483-65-8	Retene
Aliphatic hydrocarbons	
000630-01-3	Hexacosane
000646-31-1	Tetracosane
000629-97-0	Docosane
000593-49-7	Heptacosane
000638-67-5	Tricosane
000629-94-7	Heneicosane
000000-00-0	High molecular weight aliphatic hydrocarbon, 11 compounds
000000-00-0	Unsaturated aliphatic hydrocarbon (alkenes), 3 compounds
Other compounds	
000612-71-5	1,1':3',1''-Terphenyl, 5'-phenyl-
033100-61-7	Methadone N-oxide
001081-75-0	Benzene, 1,1'-(1,3-propanediyl)bis-
104642-23-1	2,3-dihydro-1H-cyclononal[def]biphenylene
000262-89-5	Dibenzo[a,e]cyclooctene
000000-00-0	1-Propene, 3-(2-cyclopentenyl)-2-methyl-1,1-diphenyl-

Sample code	TK21015
Location	Karahan, Cukurova, Adana, Turkey
Sample type	Soil
Date	15.04.2021
Description	Karahan-2, within dumpsite (different location to TK21014)

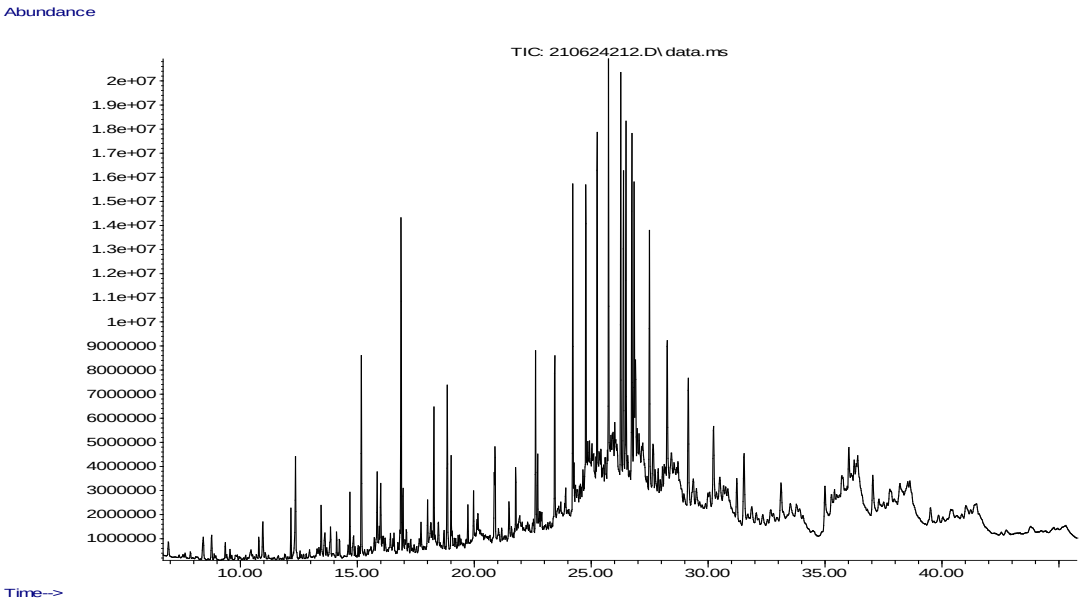


Number of compounds isolated: 29

Compounds identified to better than 90%:

CAS#	Name
Halogenated compounds	
000087-61-6	Benzene, 1,2,3-trichloro-
000120-82-1	Benzene, 1,2,4-trichloro-
000634-66-2	Benzene, 1,2,3,4-tetrachloro-
000634-90-2	Benzene, 1,2,3,5-tetrachloro-
000095-94-3	Benzene, 1,2,4,5-tetrachloro-
000608-93-5	Benzene, pentachloro-
000118-74-1	Benzene, hexachloro-
PAHs and derivatives	
000612-94-2	Naphthalene, 2-phenyl-
000091-20-3	Naphthalene
000085-01-8	Phenanthrene
Aliphatic hydrocarbons	
000629-97-0	Docosane
000112-95-8	Eicosane
000593-49-7	Heptacosane
000629-94-7	Heneicosane
000630-01-3	Hexacosane
000646-31-1	Tetracosane
000638-67-5	Tricosane
000000-00-0	High molecular weight aliphatic hydrocarbon, 4 compounds
Other compounds	
000092-52-4	1,1'-Biphenyl
0004757-6-1	1H-Indole, 2-methyl-3-phenyl-
001081-75-0	Benzene, 1,1'-(1,3-propanediyl)bis-
000262-89-5	Dibenzo [a,e]cyclooctane
000092-06-8	*m*-Terphenyl
000612-71-5	*m*-Terphenyl, 5'-phenyl-

Sample code	TK21016
Location	Karahan, Cukurova, Adana, Turkey
Sample type	Ash
Date	15.04.2021
Description	Karahan-2, within dumpsite (same location as TK21014)



Number of compounds isolated: 273

Compounds identified to better than 90%:

CAS# Name

Halogen containing compounds

000106-46-7 Benzene, 1,4-dichloro-
000087-61-6 Benzene, 1,2,3-trichloro-
000120-82-1 Benzene, 1,2,4-trichloro-

PAHs and derivatives

002444-68-0 Anthracene, 9-ethenyl-
000091-20-3 Naphthalene
001127-76-0 Naphthalene, 1-ethyl-
000090-12-0 Naphthalene, 1-methyl-
002027-17-0 Naphthalene, 2-(1-methylethyl)-
000939-27-5 Naphthalene, 2-ethyl-
000091-57-6 Naphthalene, 2-methyl-
000612-94-2 Naphthalene, 2-phenyl-
000483-65-8 Retene
000832-64-4 Phenanthrene, 4-methyl-
000575-41-7 Naphthalene, 1,3-dimethyl-
000575-43-9 Naphthalene, 1,6-dimethyl-
000581-42-0 Naphthalene, 2,6-dimethyl-
000086-73-7 9H-Fluorene
002523-37-7 9H-Fluorene, 9-methyl-
042332-94-5 Anthracene, 9,10-dihydro-9,9-dimethyl-
000206-44-0 Fluoranthene
000085-01-8 Phenanthrene
000613-12-7 Anthracene, 2-methyl-
000610-48-0 Anthracene, 1-methyl-

003018-20-0 Naphthalene, 1,2,3,4-tetrahydro-1-phenyl-

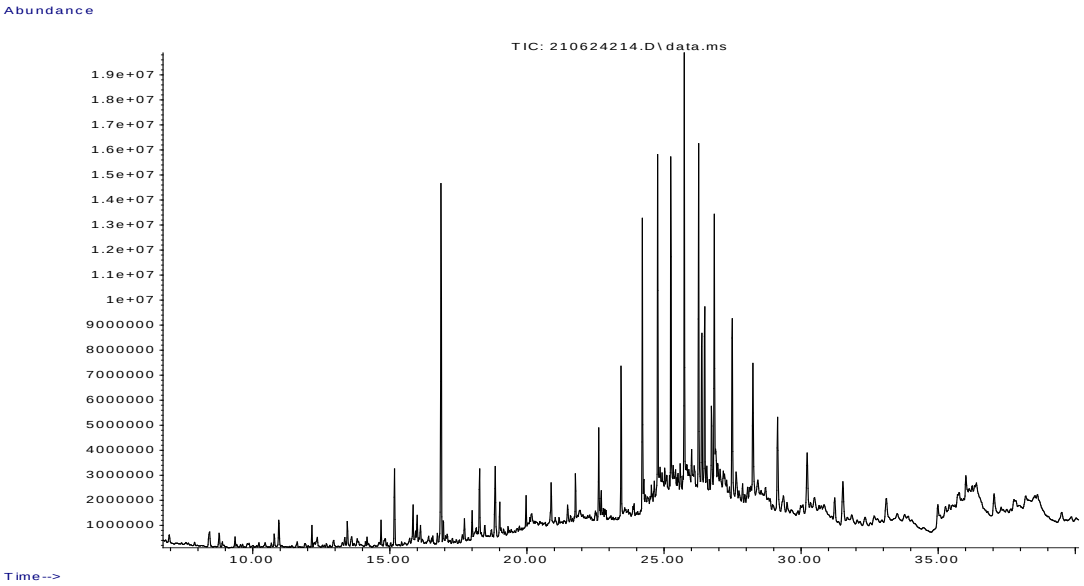
Aliphatic hydrocarbons

000112-40-3 Dodecane
000544-76-3 Hexadecane
000646-31-1 Tetracosane
000630-01-3 Hexacosane
000593-49-7 Heptacosane
000629-59-4 Tetradecane
000629-50-5 Tridecane
001120-21-4 Undecane
000629-78-7 Heptadecane
000593-45-3 Octadecane
000629-92-5 Nonadecane
000112-95-8 Eicosane
000629-94-7 Heneicosane
000629-97-0 Docosane
000638-67-5 Tricosane
000629-99-2 Pentacosane
000629-62-9 Pentadecane
000000-00-0 High molecular weight aliphatic hydrocarbon, 16 compounds
000000-00-0 Unsaturated aliphatic hydrocarbon (alkenes), 4 compounds

Other compounds

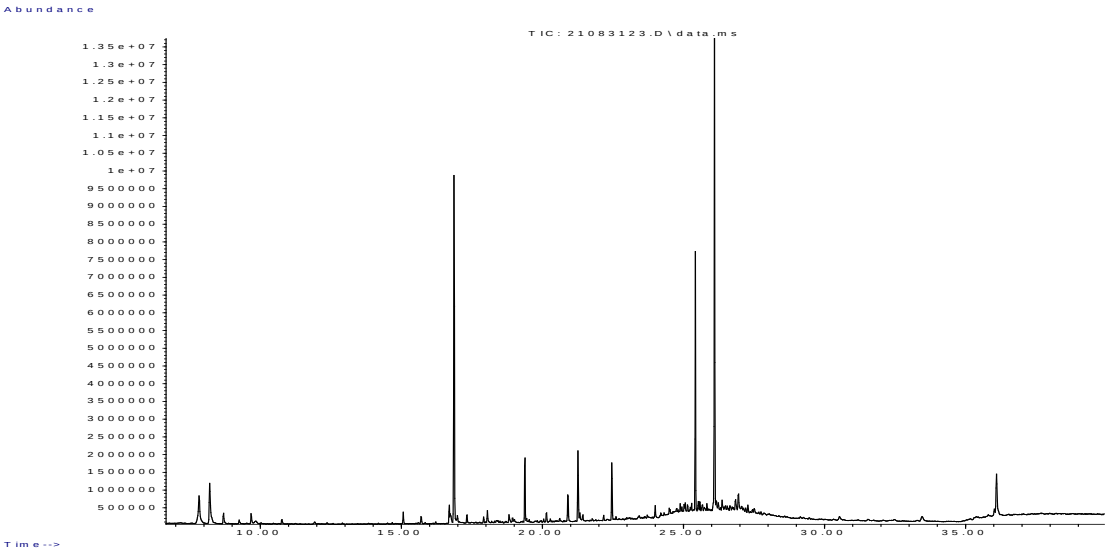
000092-52-4 Biphenyl
000643-93-6 1,1'-Biphenyl, 3-methyl-
007116-95-2 1,1'-Biphenyl, 4-(1-methylethyl)-
000644-08-6 1,1'-Biphenyl, 4-methyl-
000092-06-8 1,1':3',1''-Terphenyl
000612-71-5 1,1':3',1''-Terphenyl, 5'-phenyl-
000092-94-4 1,1':4',1''-Terphenyl
003282-18-6 1,1-Diphenylcyclopropane
004912-92-9 1H-Indene, 2,3-dihydro-1,1-dimethyl-
004757-69-1 1H-Indole, 2-methyl-3-phenyl-
000108-67-8 Benzene, 1,3,5-trimethyl-
004218-48-8 Benzene, 1-ethyl-4-(1-methylethyl)-
000098-82-8 Benzene, (1-methylethyl)-
020071-09-4 Benzene, 1,1'-(1,2-cyclobutanediyl)bis, trans-
001081-75-0 Benzene, 1,1'-(1,3-propanediyl)bis-
000099-62-7 Benzene, 1,3-bis(1-methylethyl)-
001075-38-3 Benzene, 1-(1,1-dimethylethyl)-3-methyl-
003055-14-9 Benzene, 1-methyl-3,5-bis(1-methylethyl)-
000104-51-8 Benzene, butyl-
025155-15-1 Benzene, methyl(1-methylethyl)-
000103-65-1 Benzene, propyl-
027322-34-5 Benzene, triisopropyl-
000577-55-9 Benzene, 1,2-bis (1-methylethyl)-
000101-81-5 Diphenylmethane
000103-29-7 Dibenzyl
001520-44-1 Benzene, 1,1'-(1-methyl-1,3-propanedyil)bis-
000000-00-0 1-Propene, 3-(2-cyclopentenyl)-2-methyl-1,1-diphenyl-
001083-56-6 Benzene, 1,1'-(1,4-butanediyl)bis-
000084-15-1 1,1':2,1''-Terphenyl

Sample code	TK21017
Location	Karahan, Cukurova, Adana, Turkey
Sample type	Ash
Date	15.04.2021
Description	Karahan-2, within dumpsite (same location as TK21015)



Sample was not subject to detailed interpretation because chromatogram appeared identical to that of sample TK21016

Sample code	TK21018
Location	Karahan, Cukurova, Adana, Turkey
Sample type	Shredded plastics
Date	15.04.2021
Description	Karahan-3, within dumpsite



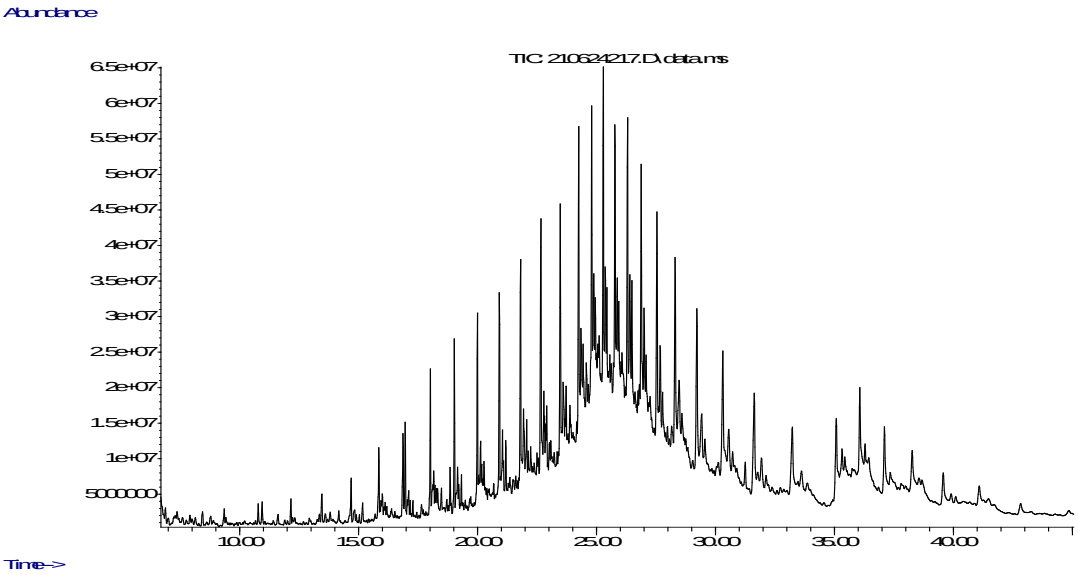
Number of compounds isolated: 78

Compounds identified to better than 90%:

In total ion chromatogram (TIC)

CAS#	Name
000117-81-7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
000131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester
006422-86-2	1,4-Benzenedicarboxylic acid, 1,4-bis(2-ethylhexyl) ester
000120-61-6	1,4-Benzenedicarboxylic acid, dimethyl ester
000000-00-0	2-Ethylhexyl methyl isophthalate
000104-76-7	1-Hexanol, 2-ethyl-
001235-74-1	1-Phenanthrenecarboxylic acid, 1,2,3,4,4a,9,10,10a-octahydro-1,4a-dimethyl-7-(1-methylethyl)-, methyl ester, [1R-(1.alpha.,4a.beta.,10a.alpha.)]
007568-58-3	1-Propene-1,2,3-tricarboxylic acid, tributyl ester
000301-02-0	13-Docosenamide
000112-84-5	13-Octadecenamide, (z)-
000128-37-0	2,6-Bis(1,1-dimethylethyl)-4-methyl phenol
000624-49-7	2-Butenedioic acid (e)-, dimethyl ester
013674-84-5	2-Propanol, 1-chloro-, phosphate (3:1)
137909-40-1	Bis(1-chloro-1-propyl)(3-chloro-1-propyl) phosphate
002462-85-3	9,12-Octadecadienoic acid, methyl ester
001120-25-8	9-Hexadecenoic acid, methyl ester,
001937-62-8	9-Octadecenoic acid, methyl ester, (E)
006386-38-5	Benzenepropanoic acid, 3,5-bis(1,1-dimethylethyl)-4-hydroxy-, methyl ester
002282-84-0	Benzoic acid, 2,4,6-trimethyl,methyl ester
000110-42-9	Decanoic acid, methyl ester
000111-82-0	Dodecanoic acid, methyl ester
000544-76-3	Hexadecane
000112-39-0	Hexadecanoic acid, methyl ester
000103-23-1	Hexanedioic acid, bis(2-ethylhexyl) ester
000124-10-7	Methyl tetradecanoate
000091-20-3	Naphthalene
000124-19-6	Nonanal
007132-64-1	Pentadecanoic acid, methyl ester
000108-95-2	Phenol
000096-76-4	Phenol, 2,4-bis(1,1-dimethylethyl)
000080-05-7	Phenol, 4,4’-(1-methylethylidene)bis
000080-46-6	Phenol, 4-(1,1-dimethylpropyl)-
026746-38-3	Phenol, bis(1,1-dimethylethyl)-
000000-00-0	Substituted phthalates, 10 compounds
005129-66-8	Tetradecanoic acid, 12-methyl-, methyl ester

Sample code	TK21019
Location	Karahan, Cukurova, Adana, Turkey
Sample type	Ash
Date	15.04.2021
Description	Karahan-3, within dumpsite



Number of compounds isolated: 295

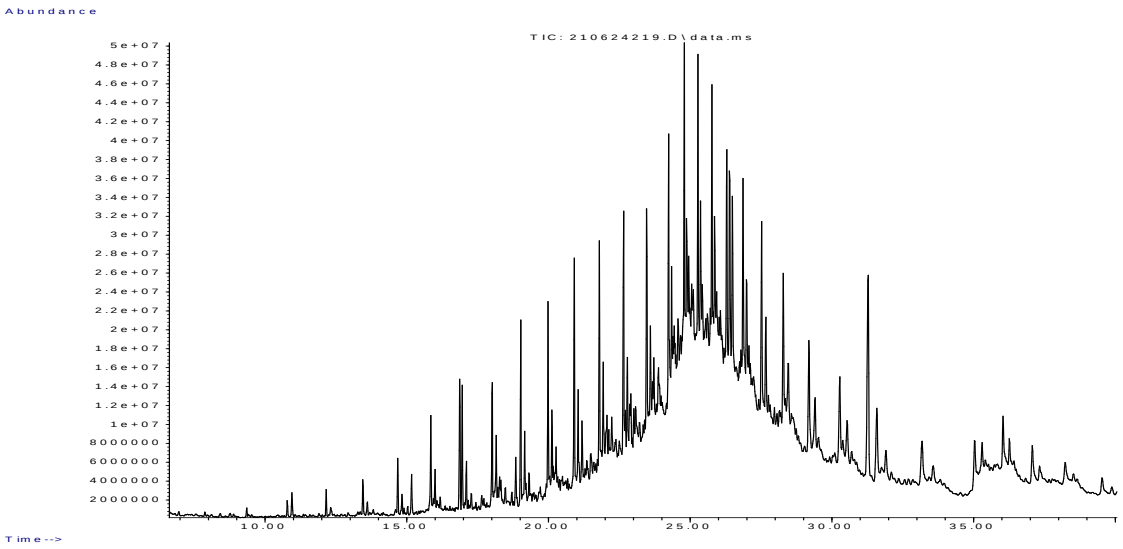
Compounds identified to better than 90%:

CAS#	Name
Halogenated compounds	
000095-50-1	Benzene, 1,2-dichloro-
000541-73-1	Benzene, 1,3-dichloro-
000106-46-7	Benzene, 1,4-dichloro-
000120-82-1	Benzene, 1,2,4-trichloro-
000108-70-3	Benzene, 1,3,5-trichloro-
PAHs and derivatives	
000085-01-8	Phenanthrene
035465-71-5	Naphthalene, 2-phenyl-
Aliphatic hydrocarbons	
074685-33-9	(3E)-3-Icosene
007206-19-1	(3E)-3-Octadecene
007206-21-5	(5E)-5-Octadecene
041446-63-3	(7E)-7-Tetradecene
001599-67-3	1-Docosene
001599-68-4	1-Heneicosene
018835-33-1	1-Hexacosene
000629-73-2	1-Hexadecene
018435-45-5	1-Nonadecene
000112-88-9	1-Octadecene
074685-33-9	3-Eicosene, (e)-
000000-00-0	3-Heptadecene
034303-81-6	3-Hexadecene, (z)-
074685-30-6	5-Eicosene, (e)-
035507-09-6	7-Hexadecene, (z)-
010374-74-0	7-Tetradecene
027519-02-4	9-Tricosene, (z)-
000297-03-0	Cyclotetracosane
000629-97-0	Docosane
000112-40-3	Dodecane
000544-85-4	Dotriacontane
000112-95-8	Eicosane

000629-94-7 Heneicosane
000593-49-7 Heptacosane
000629-78-7 Heptadecane
000630-01-3 Hexacosane
000544-76-3 Hexadecane
000630-03-5 Nonacosane
000629-92-5 Nonadecane
000630-02-4 Octacosane
000593-45-3 Octadecane
000629-62-9 Pentadecane
000646-31-1 Tetracosane
000629-59-4 Tetradecane
000638-68-6 Triacontane
000638-67-5 Tricosane
000629-50-5 Tridecane
000000-00-0 High molecular weight aliphatic hydrocarbons, 16 compounds

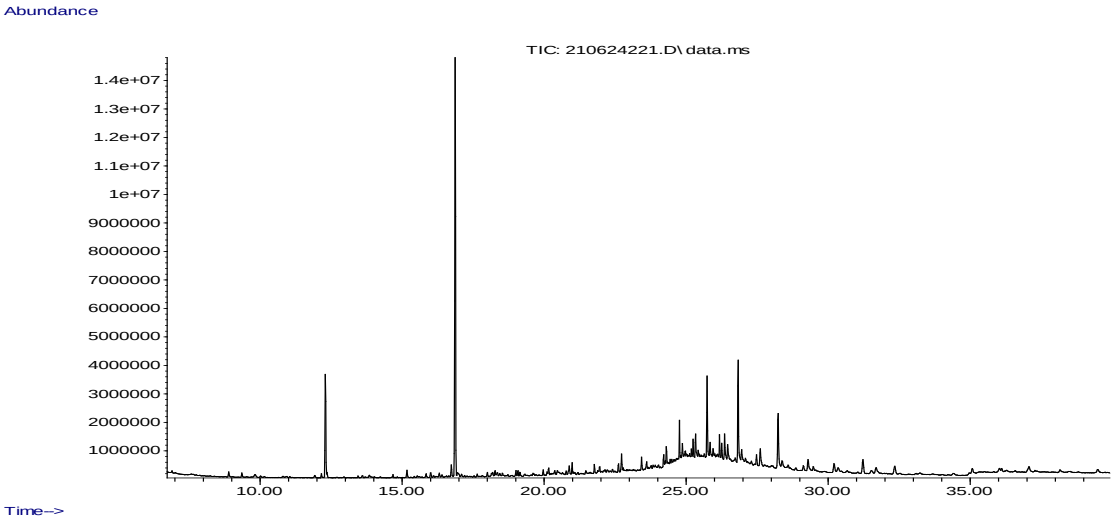
Other compounds
000612-71-5 1,1':3',1''-Terphenyl, 5'-phenyl-
027138-21-2 Benzene, (1,1-dimethylethyl)methyl-
000099-62-7 Benzene, 1,3-bis(1-methylethyl)-
000100-18-5 Benzene, 1,4-bis(1-methylethyl)-
001075-38-3 Benzene, 1-(1,1-dimethylethyl)-3-methyl-
003055-14-9 Benzene, 1-methyl-3,5-bis(1-methylethyl)-
000535-77-3 Benzene, 1-methyl-3-(1-methylethyl)-
000099-87-6 Benzene, 1-methyl-4-(1-methylethyl)-
058502-85-5 Benzene, 2-methyl-1,4-bis(1-methylethyl)-
028122-27-2 Benzene, 3,5-dimethyl-1-(phenylmethyl)-
033991-29-6 Benzene, trimethyl(1-methylethyl)-
000092-52-4 Biphenyl
005638-09-5 Cyclopentane, (4-octyldodecyl)-

Sample code	TK21020
Location	Karahan, Cukurova, Adana, Turkey
Sample type	Ash
Date	15.04.2021
Description	Karahan-3, within dumpsite (different location to TK21019)



Sample was not subject to detailed interpretation because chromatogram appeared identical to that of sample TK21019

Sample code	TK21021
Location	Karahan, Cukurova, Adana, Turkey
Sample type	Soil
Date	15.04.2021
Description	Karahan-3, within dumpsite (same location as TK21019)



Number of compounds isolated: 122

Compounds identified to better than 90%:

CAS# Name

Halogen containing compounds

000095-50-1 Benzene, 1,2-dichloro-
000541-73-1 Benzene, 1,3-dichloro-
000106-46-7 Benzene, 1,4-dichloro-
000087-61-6 Benzene, 1,2,3-trichloro-
000120-82-1 Benzene, 1,2,4-trichloro-
000634-90-2 Benzene, 1,2,3,5-tetrachloro-
000095-94-3 Benzene, 1,2,4,5-tetrachloro-
000634-66-2 Benzene, 1,2,3,4-tetrachloro-
000608-93-5 Benzene, pentachloro-
000118-74-1 Benzene, hexachloro-

PAHs and derivatives

000612-94-2 Naphthalene, 2-phenyl-
004389-09-7 4H-Benz[de]anthracene, 5,6-dihydro-
002444-68-0 Anthracene, 9-ethenyl-
000085-01-8 Phenanthrene
000091-57-6 Naphthalene, 2-methyl-
000483-65-8 Retene
000091-20-3 Naphthalene

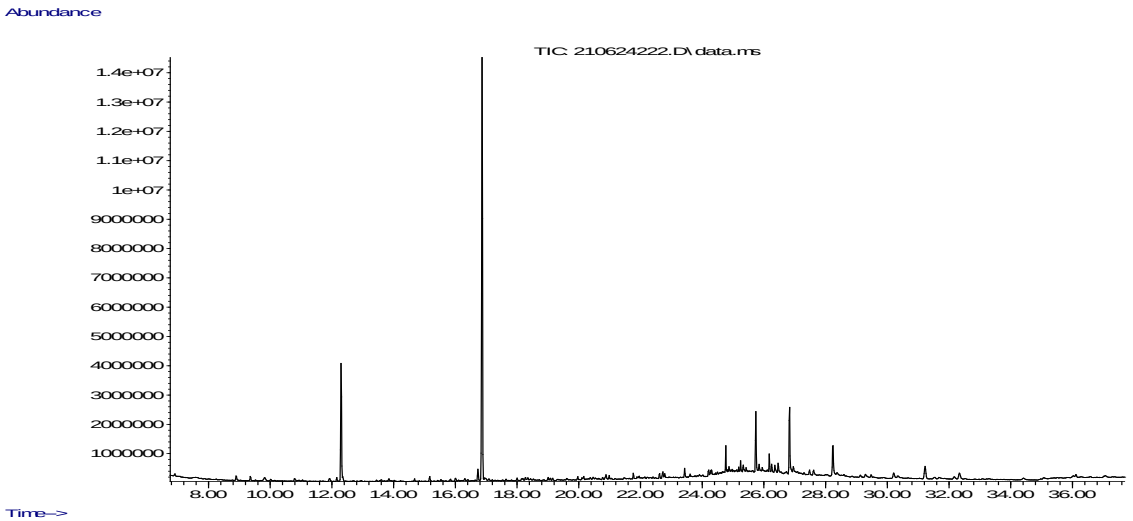
Aliphatic hydrocarbons

000593-45-3 Octadecane
000630-01-3 Hexacosane
000112-95-8 Eicosane
000629-92-5 Nonadecane
000646-31-1 Tetracosane
000629-97-0 Docosane
000593-49-7 Heptacosane
000638-67-5 Tricosane
000629-94-7 Heneicosane
000000-00-0 High molecular weight aliphatic hydrocarbon, 6 compounds

Other compounds

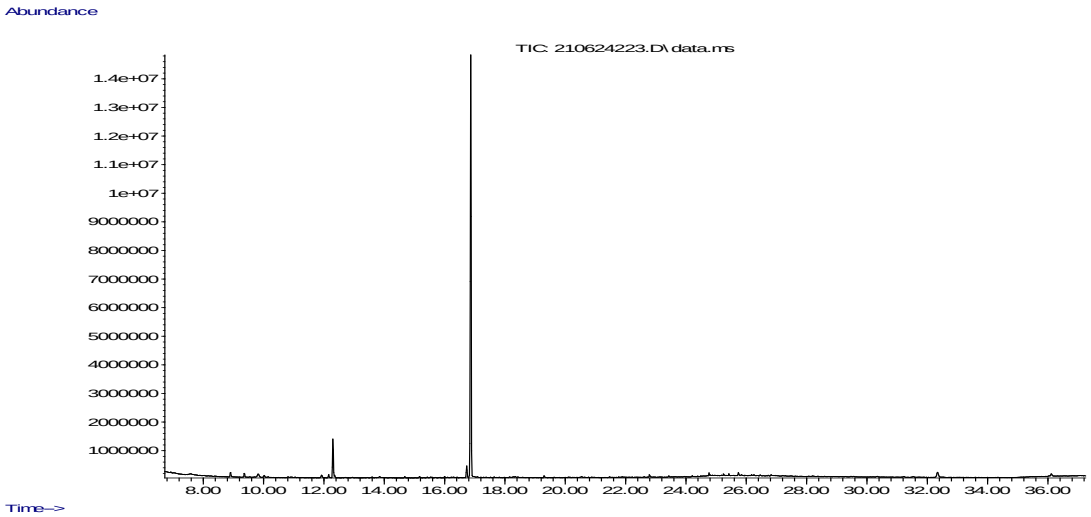
004603-00-3 1,1'-Biphenyl
000612-71-5 1,1':3',1''-Terphenyl, 5'-phenyl-
001081-75-0 Benzene, 1,1'-(1,3-propanediyl)bis-
000092-52-4 Biphenyl
000132-64-9 Dibenzofuran
000111-02-4 Squalene
000100-42-5 Styrene

Sample code	TK21022
Location	Karahan, Cukurova, Adana, Turkey
Sample type	Soil
Date	15.04.2021
Description	Karahan-3, within dumpsite (same location as TK21020)



Sample was not subject to detailed interpretation because chromatogram appeared identical to that of sample TK21021

Sample code	TK21023
Location	Kuyumcular, Seyhan, Adana, Turkey
Sample type	Soil
Date	16.04.2021
Description	Within dumpsite

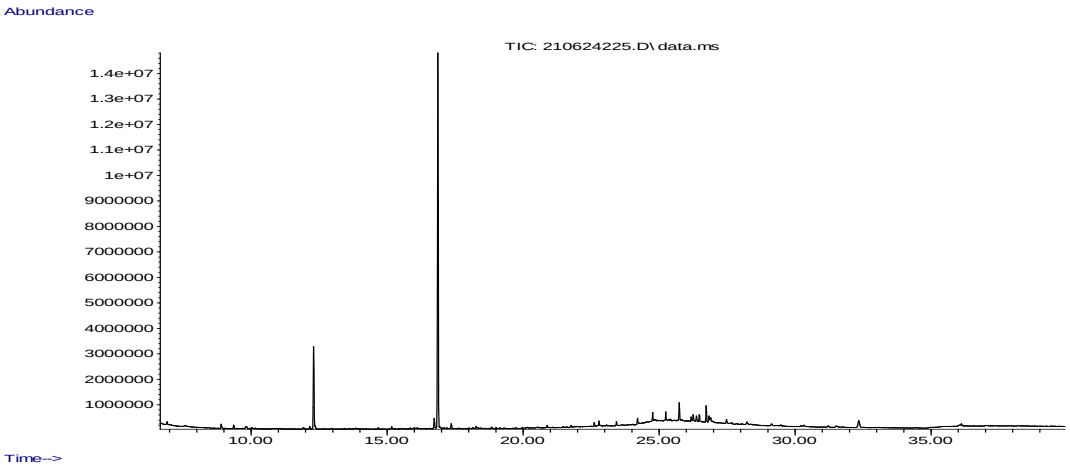


Number of compounds isolated: 14

Compounds identified to better than 90%:

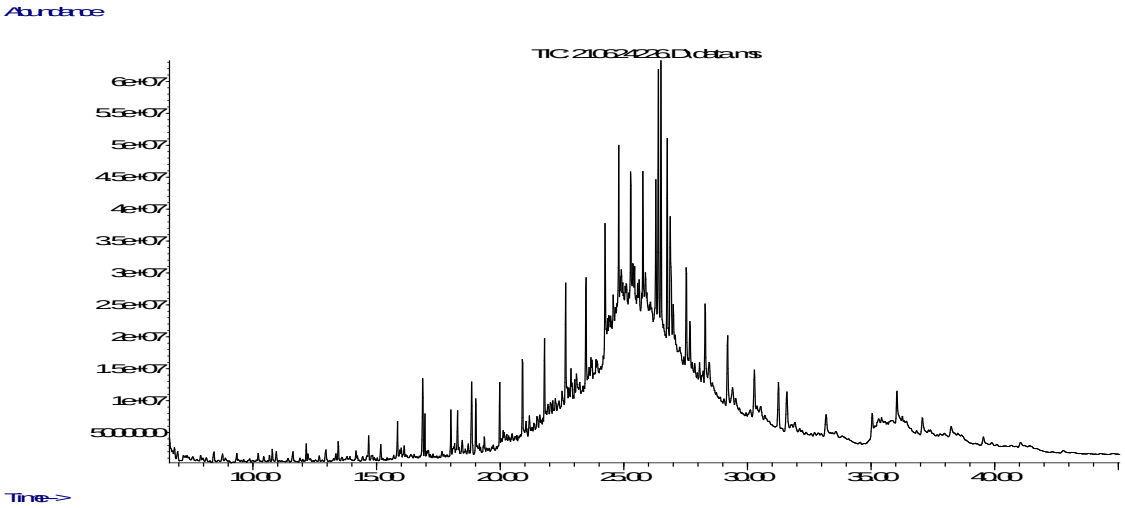
CAS#	**Name**
Halogen containing compounds	
000095-50-1	Benzene, 1,2-dichloro-
000106-46-7	Benzene, 1,4-dichloro-
000087-61-6	Benzene, 1,2,3-trichloro-
000634-90-2	Benzene, 1,2,3,5-tetrachloro-
000634-66-2	Benzene, 1,2,3,4-tetrachloro-
000608-93-5	Benzene, pentachloro-
PAHs and derivatives	
000091-20-3	Naphthalene
000827-54-3	Naphthalene, 2-ethenyl-
000483-65-8	Retene
Other compounds	
001081-75-0	Benzene,1,1'-(1,3-propanediyl)bis-
000612-71-5	1,1':3',1''-Terphenyl, 5-phenyl-

Sample code	TK21024
Location	Kuyumcular, Seyhan, Adana, Turkey
Sample type	Soil
Date	16.04.2021
Description	Within dumpsite (different location to TK21023)



Sample was not subject to detailed interpretation because chromatogram appeared identical to that of sample TK21023

Sample code	TK21025
Location	Kuyumcular, Seyhan, Adana, Turkey
Sample type	Ash
Date	16.04.2021
Description	Within dumpsite (same location as TK21023)



Number of compounds isolated: 255

Compounds identified to better than 90%:

In total ion chromatogram (TIC)
CAS# Name

Halogenated compounds
000095-50-1 Benzene, 1,2-dichloro-
000106-46-7 Benzene, 1,4-dichloro-
000120-82-1 Benzene, 1,2,4-trichloro-
000087-61-6 Benzene, 1,2,3-trichloro-

PAHs and derivatives

035465-71-5 Naphthalene, 2-phenyl-
000605-02-7 Naphthalene, 1-phenyl-

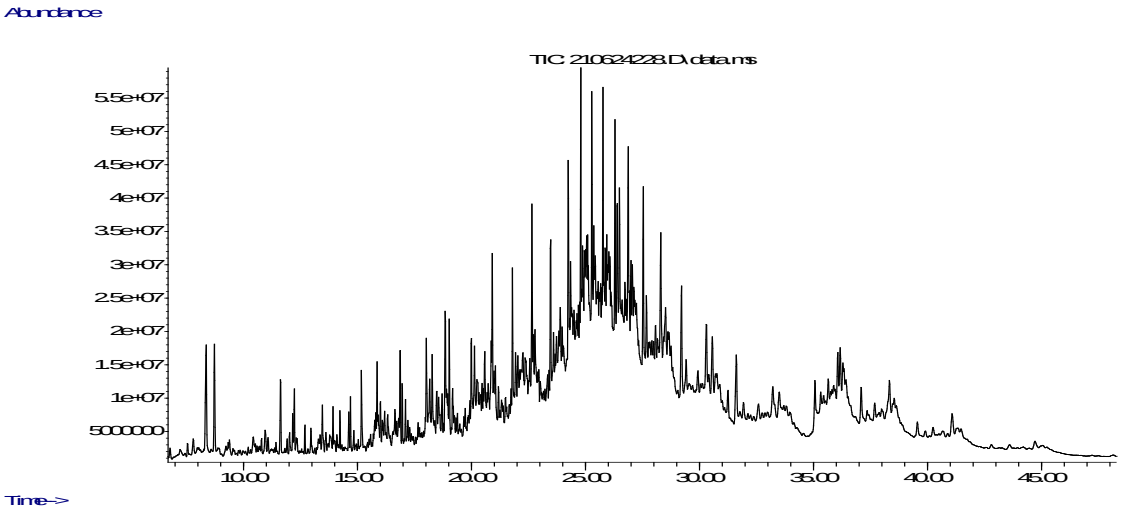
Aliphatic hydrocarbons

001599-67-3 1-Docosene
018835-33-1 1-Hexacosene
000629-73-2 1-Hexadecene
018435-45-5 1-Nonadecene
000000-00-0 12-Methyltricosane
058349-84-1 14-Methyldotriacontane
074685-33-9 3-Eicosene, (e)-
034303-81-6 3-Hexadecene, (z)-
007206-19-1 3-Octadecene, (e)-
007206-21-5 5-Octadecene, (e)-
010374-74-0 7-Tetradecene
000295-48-7 Cyclopentadecane
000629-97-0 Docosane
000112-40-3 Dodecane
000112-95-8 Eicosane
000629-94-7 Heneicosane
000630-04-6 Hentriacontane
000593-49-7 Heptacosane
000629-78-7 Heptadecane
000630-01-3 Hexacosane
000544-76-3 Hexadecane
000629-92-5 Nonadecane
000630-02-4 Octacosane
000593-45-3 Octadecane
000629-99-2 Pentacosane
000629-62-9 Pentadecane
000646-31-1 Tetracosane
000629-59-4 Tetradecane
000638-67-5 Tricosane
000629-50-5 Tridecane

Other compounds

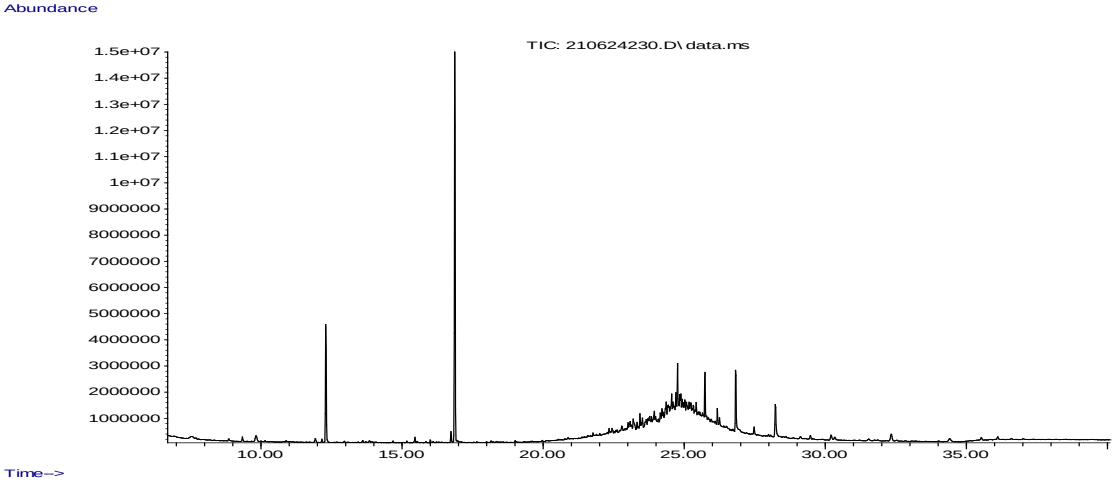
000612-71-5 1,1':3',1''-Terphenyl, 5'-phenyl-
000092-52-4 1,1’-Biphenyl
000084-15-1 1,1’-Biphenyl, 2-phenyl-
001075- 38-3 Benzene, (1,1-dimethylethyl)-3-methyl-
000098-82-8 Benzene, (1-methylethyl)-
001081-75-0 Benzene, 1,1'-(1,3-propanediyl)bis-
000577-55-9 Benzene, 1,2-bis(1-methylethyl)-
000717-74-8 Benzene, 1,3,5-tris(1-methylethyl)-
000099-62-7 Benzene, 1,3-bis(1-methylethyl)-
000100-18-5 Benzene, 1,4-bis(1-methylethyl)-
004920-99-4 Benzene, 1-ethyl-3-(1-methylethyl)-
004218-48-8 Benzene, 1-ethyl-4-(1-methylethyl)-
003055-14-9 Benzene, 1-methyl-3,5-bis(1-methylethyl)-
000099-87-6 Benzene, 1-methyl-4-(1-methylethyl)-
058502-85-5 Benzene, 2-methyl-1,4-bis(1-methylethyl)-
028122-27-2 Benzene, 3,5-dimethyl-1-(phenylmethyl)-
025155-15-1 Benzene, methyl(1-methylethyl)-
027322-34-5 Benzene, triisopropyl-
033991-29-6 Benzene, trimethyl(1-methylethyl)-

Sample code	TK21026
Location	Kuyumcular, Seyhan, Adana, Turkey
Sample type	Ash
Date	16.04.2021
Description	Within dumpsite (same location as TK21024)



Sample was not subject to detailed interpretation because chromatogram appeared identical to that of sample TK21025

Sample code	TK21027
Location	Kuyumcular, Seyhan, Adana, Turkey
Sample type	Soil
Date	16.04.2021
Description	Control soil - orchard

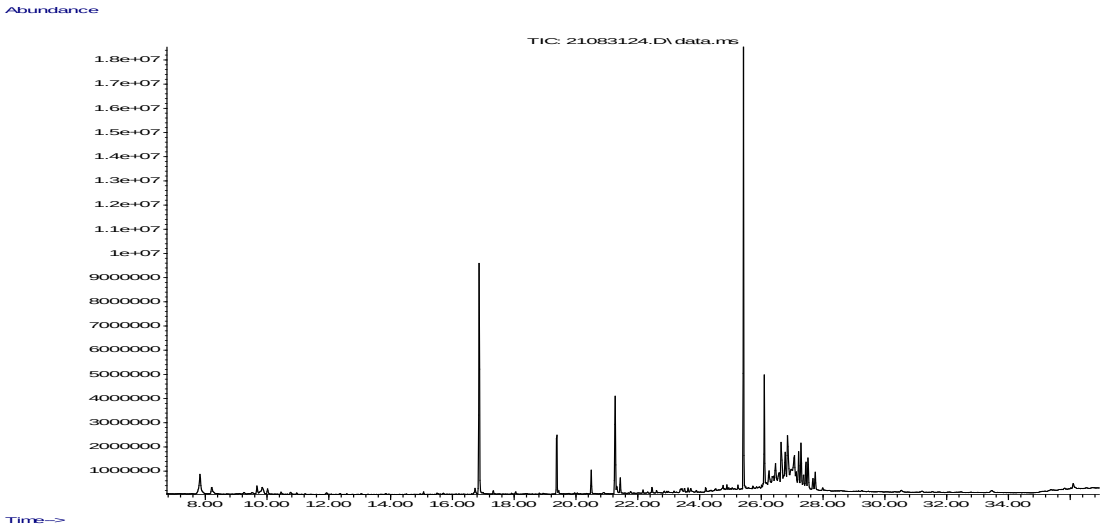


Number of compounds isolated: 80

Compounds identified to better than 90%:

CAS#	Name
000101-84-8	Diphenyl ether
000000-00-0	High molecular weight aliphatic hydrocarbon, 3 compounds

Sample code	TK21028
Location	Kuyumcular, Seyhan, Adana, Turkey
Sample type	Shredded plastics
Date	16.04.2021
Description	Within dumpsite



Number of compounds isolated: 65

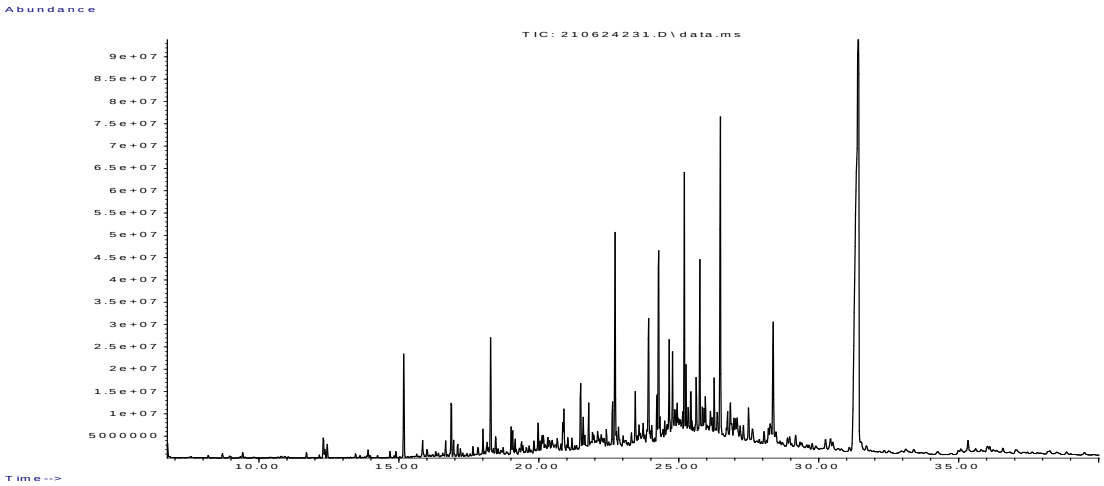
Compounds identified to better than 90%:

In total ion chromatogram (TIC)

CAS#	Name
000117-81-7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
000084-69-5	1,2-Benzenedicarboxylic acid, bis(methylpropyl) ester
000131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester
020548-62-3	Phthalic acid, bis(7-methyloctyl) ester
006422-86-2	1,4-Benzenedicarboxylic acid, 1,4-bis(2-ethylhexyl) ester
000120-61-6	1,4-Benzenedicarboxylic acid, dimethyl ester
000104-76-7	1-Hexanol, 2-ethyl-
002462-85-3	9,12-Octadecadienoic acid, methyl ester
001120-25-8	9-Hexadecenoic acid, methyl ester,
001937-62-8	9-Octadecenoic acid, methyl ester, (E)
006386-38-5	Benzenepropanoic acid, 3,5-bis(1,1-dimethylethyl)-4-hydroxy-, methyl ester
000110-42-9	Decanoic acid, methyl ester
000111-82-0	Dodecanoic acid, methyl ester
000629-78-7	Heptadecane
000112-39-0	Hexadecanoic acid, methyl ester
000124-10-7	Methyl tetradecanoate
000091-20-3	Naphthalene
000124-19-6	Nonanal

000096-76-4 Phenol, 2,4-bis(1,1-dimethylethyl)
000080-05-7 Phenol, 4,4’-(1-methylethylidene)bis
000000-00-0 Substituted phthalates, 19 compounds
005129-66-8 Tetradecanoic acid, 12-methyl-, methyl ester
001120-21-4 Undecane

Sample code	TK21029
Location	Incirlik, Yüregir, Adana, Turkey
Sample type	Soil
Date	15.04.2021
Description	Within dumpsite



Number of compounds isolated: 242

Compounds identified to better than 90%:

In total ion chromatogram (TIC)
CAS# Name

Halogenated compounds
002051-60-7 1,1'-Biphenyl, 2-chloro-
002051-61-8 1,1'-Biphenyl, 3-chloro-
034883-43-7 1,1’-Biphenyl, 2,4’-dichloro-
002050-67-1 1,1’-Biphenyl, 3,3’-dichloro-
034883-41-5 1,1’-Biphenyl, 3,5-dichloro-
038444-87-0 1,1’-Biphenyl, 3,3’,5-trichloro-
000634-93-5 Benzenamine, 2,4,6-trichloro-
000618-34-8 Benzene, (1-chloroethenyl)-
000622-25-3 Benzene, (2-chloroethenyl)-
000095-50-1 Benzene, 1,2-dichloro-
000541-73-1 Benzene, 1,3-dichloro-
000106-46-7 Benzene, 1,4-dichloro-
000087-61-6 Benzene, 1,2,3-trichloro-
000120-82-1 Benzene, 1,2,4-trichloro-
000108-70-3 Benzene, 1,3,5-trichloro-
000634-66-2 Benzene, 1,2,3,4-tetrachloro-
000634-90-2 Benzene, 1,2,3,5-tetrachloro-
000095-94-3 Benzene, 1,2,4,5-tetrachloro-

000608-93-5 Benzene, pentachloro-
000118-74-1 Benzene, hexachloro-
000108-86-1 Benzene, bromo-
000000-00-0 Benzene, bromodichloro-
001762-83-0 *p*-Terphenyl, 4-chloro-

PAHs and dertivatives

000086-73-7 9H-Fluorene
000613-12-7 Anthracene, 2-methyl-
001499-10-1 Anthracene, 9,10-diphenyl-
000779-02-2 Anthracene, 9-methyl-
000602-55-1 Anthracene, 9-phenyl-
000056-55-3 Benz[a]anthracene
000091-20-3 Naphthalene
000090-12-0 Naphthalene, 1-methyl-
000091-57-6 Naphthalene, 2-methyl-
000612-94-2 Naphthalene, 2-phenyl-
000085-01-8 Phenanthrene
000483-65-8 Phenanthrene, 1-methyl-7-(1-methylethyl)-
002531-84-2 Phenanthrene, 2-methyl-

Aliphatic hydrocarbons

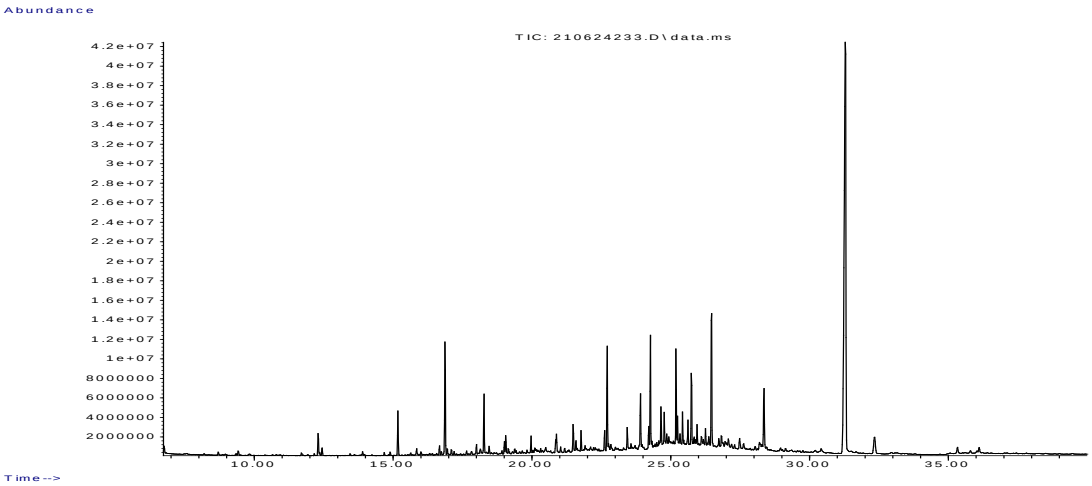
001599-67-3 1-Docosene
000629-73-2 1-Hexadecene
018435-45-5 1-Nonadecene
001472-09-9 Cyclopropane, octyl-
000629-97-0 Docosane
000112-40-3 Dodecane
000112-95-8 Eicosane
000629-94-7 Heneicosane
000629-78-7 Heptadecane
000630-01-3 Hexacosane
000544-76-3 Hexadecane
000629-92-5 Nonadecane
000630-02-4 Octacosane
000593-45-3 Octadecane
000629-99-2 Pentacosane
000629-62-9 Pentadecane
000646-31-1 Tetracosane
000629-59-4 Tetradecane
000638-67-5 Tricosane
000629-50-5 Tridecane
001120-21-4 Undecane
000000-00-0 High molecular weight aliphatic hydrocarbons, 11 compounds

Other cojmpounds

000604-53-5 1,1'-Binaphthalene
000092-52-4 1,1’-Biphenyl
000643-93-6 1,1'-Biphenyl, 3-methyl-
000644-08-6 1,1'-Biphenyl, 4-methyl-
000084-15-1 1,1':2',1''-Terphenyl
001165-53-3 1,1':2',1''-Terphenyl, 4'-phenyl-
001165-58-8 1,1':2',1'':4'',1'''-Quaterphenyl
000092-06-8 1,1':3',1''-Terphenyl
000612-71-5 1,1':3',1''-Terphenyl, 5'-phenyl-
033776-38-4 1,1':3',1''-Terphenyl-3-methyl-
001166-18-3 *m,m*-Quaterphenyl

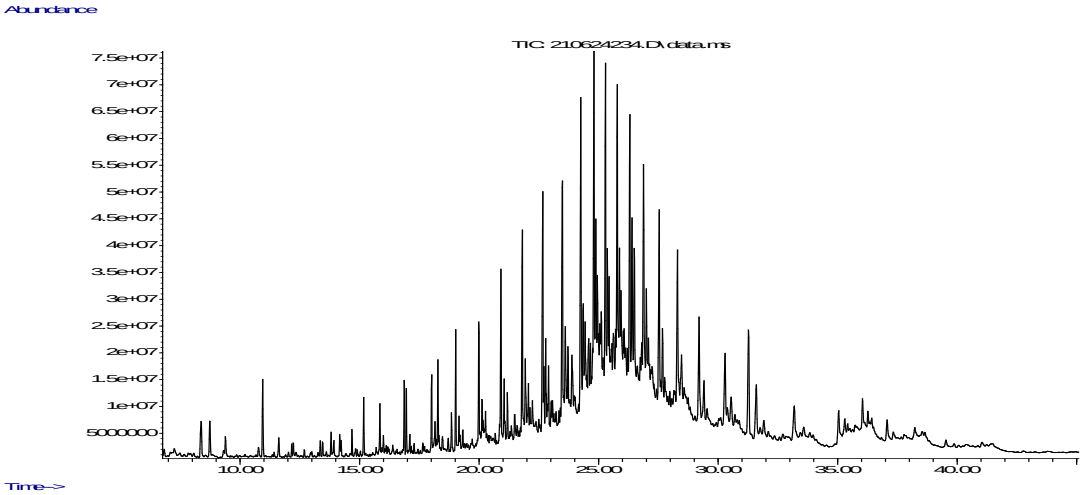
005394-86-5	1H-Indene, 1-(phenylmethylene)-
000098-83-9	Benzene, (1-methylethenyl)-
000103-30-0	Benzene, 1,1'-(1,2-ethenediyl)bis-
001081-75-0	Benzene, 1,1'-(1,3-propanediyl)bis-
001520-44-1	Benzene, 1,1'-(1-methyl-1,3-propanediyl)bis-
000612-00-0	Benzene, 1,1’-ethylidenebis-
000912-61-8	Benzene, 1,2,3,5-tetraphenyl-
000526-73-8	Benzene, 1,2,3-trimethyl-
000099-87-6	Benzene, 1-methyl-4-(1-methylethyl)-
002870-04-4	Benzene, 2-ethyl-1,3-dimethyl-
000123-01-3	Benzene, dodecyl-
002189-60-8	Benzene, octyl-
000271-89-6	Benzofuran
000132-64-9	Dibenzo-furan
000101-81-5	Diphenylmethane
000955-83-9	Furan, 2,5-diphenyl-
184776-33-8	Garciniaxanthone F
000100-42-5	Styrene

Sample code	TK21030
Location	Incirlik, Yüregir, Adana, Turkey
Sample type	Soil
Date	15.04.2021
Description	Within dumpsite (different location to TK21029)



Sample was not subject to detailed interpretation because chromatogram appeared identical to that of sample TK21029

Sample code	TK21031
Location	Incirlik, Yüregir, Adana, Turkey
Sample type	Ash
Date	15.04.2021
Description	Within dumpsite (same location as TK21029)



Number of compounds isolated: 270

Compounds identified to better than 90%:

In total ion chromatogram (TIC)
CAS# Name

Haloganated compounds
002051-60-7 1,1'-Biphenyl, 2-chloro-
002051-61-8 1,1'-Biphenyl, 3-chloro-
000095-50-1 Benzene, 1,2-dichloro-
000541-73-1 Benzene, 1,3-dichloro-
000106-46-7 Benzene, 1,4-dichloro-
000087-61-6 Benzene, 1,2,3-trichloro-
000120-82-1 Benzene, 1,2,4-trichloro-
000634-66-2 Benzene, 1,2,3,4-tetrachloro-
000634-90-2 Benzene, 1,2,3,5-tetrachloro-
000095-94-3 Benzene, 1,2,4,5-tetrachloro-
000608-93-5 Benzene, pentachloro-
000118-74-1 Benzene, hexachloro-

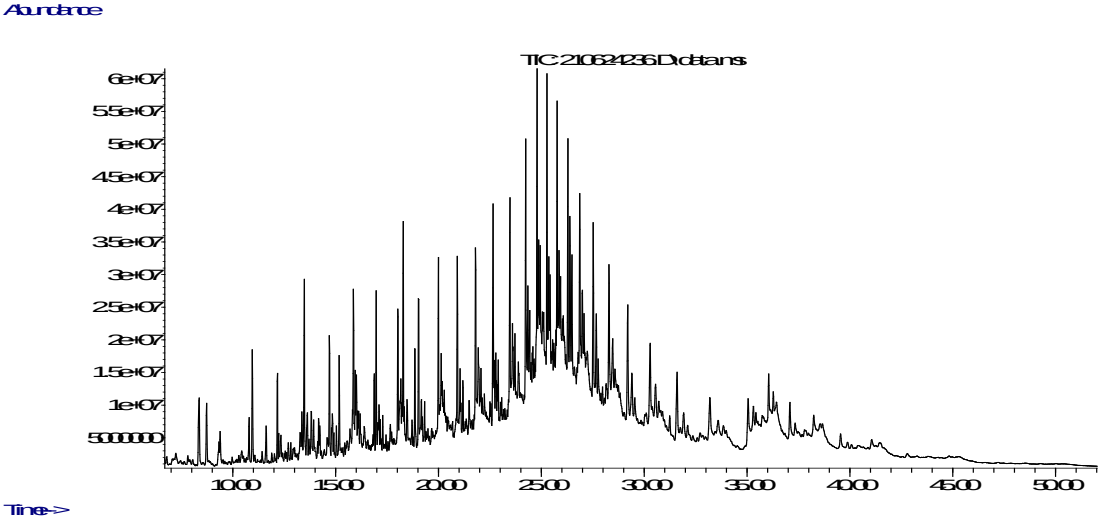
PAHs and derivatives
000086-73-7 9H-Fluorene
000091-20-3 Naphthalene
000613-59-2 Naphthalene, 2-(phenylmethyl)-
000612-94-2 Naphthalene, 2-phenyl-
000483-65-8 Phenanthrene, 1-methyl-7-(1-methylethyl)-
000085-01-8 Phenanthrene

Aliphatic hydrocarbons
074685-33-9 (3E)-3-Icosene
007206-19-1 (3E)-3-Octadecene
074685-30-6 (5E)-5-Icosene

001599-67-3 1-Docosene
018435-45-5 1-Nonadecene
000112-88-9 1-Octadecene
034303-81-6 3-Hexadecene, (z)-
000297-03-0 Cyclotetracosane
000629-97-0 Docosane
000544-85-4 Dotriacontane
000112-95-8 Eicosane
000629-94-7 Heneicosane
000593-49-7 Heptacosane
000629-78-7 Heptadecane
000630-01-3 Hexacosane
000544-76-3 Hexadecane
000630-03-5 Nonacosane
000629-92-5 Nonadecane
000630-02-4 Octacosane
000593-45-3 Octadecane
000629-99-2 Pentacosane
000629-62-9 Pentadecane
000646-31-1 Tetracosane
000638-68-6 Triacontane
000638-67-5 Tricosane
000000-00-0 High molecular weight aliphatic hydrocarbons, 24 compounds

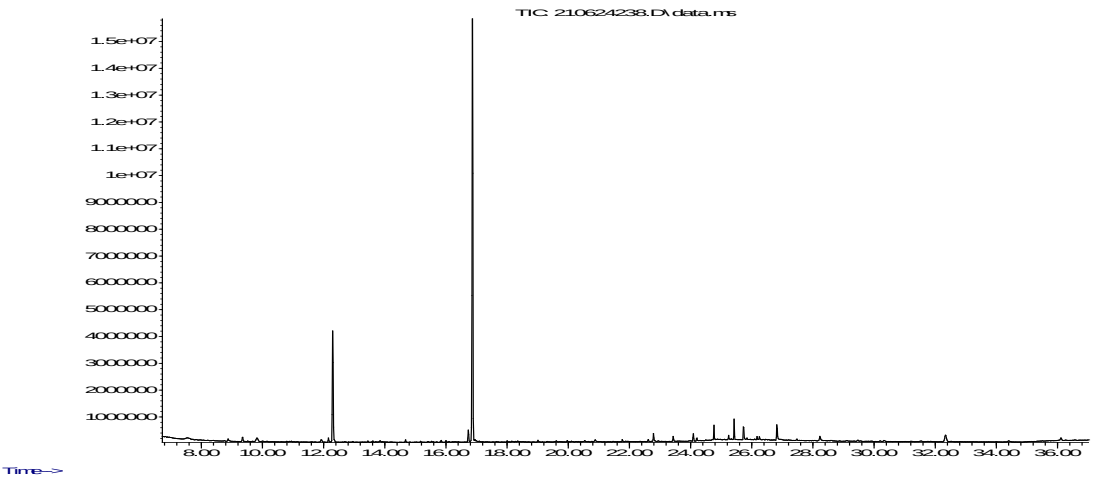
Other compounds
000092-52-4 1,1’-Biphenyl
000643-58-3 1,1'-Biphenyl, 2-methyl-
000084-15-1 1,1'-Biphenyl, 2-phenyl-
000092-06-8 1,1'-Biphenyl, 3-phenyl-
000644-08-6 1,1'-Biphenyl, 4-methyl-
000612-71-5 1,1':3',1''-Terphenyl, 5'-phenyl-
026140-60-3 Terphenyl
003282-18-6 1,1-Diphenylcyclopropane
000112-70-9 1-Tridecanol
005394-86-5 1H-Indene, 1-(phenylmethylene)-
016204-72-1 1H-Indene, 2,3-dihydro-1,1,4-trimethyl-
000256-81-5 5H-Dibenzo[a,d]cycloheptene
000098-82-8 Benzene, (1-methylethyl)-
001081-75-0 Benzene, 1,1'-(1,3-propanediyl)bis-
001083-56-3 Benzene, 1,1'-(1,4-butanediyl)bis-
001520-44-1 Benzene, 1,1'-(1-methyl-1,3-propane)-
000577-55-9 Benzene, 1,2-bis(1-methylethyl)-
000717-74-8 Benzene, 1,3,5-triisopropyl-
000717-74-8 Benzene, 1,3,5-tris(1-methylethyl)-
014411-56-4 Benzene, 1-(1,1-dimethylethyl)-3-ethyl-
001075-38-3 Benzene, 1-(1,1-dimethylethyl)-3-methyl-
004218-48-8 Benzene, 1-ethyl-4-(1-methylethyl)-
000527-84-4 Benzene, 1-methyl-2-(1-methylethyl)-
003055-14-9 Benzene, 1-methyl-3,5-bis(1-methylethyl)-
000099-87-6 Benzene, 1-methyl-4-(1-methylethyl)-
058502-85-5 Benzene, 2-methyl-1,4-bis(1-methylethyl)-
000123-01-3 Benzene, dodecyl-
001459-09-2 Benzene, hexadecyl-
004445-07-2 Benzene, octadecyl-
002131-18-2 Benzene, pentadecyl-
004957-14-6 Methane, di-*p*-tolyl-

Sample code	TK21032
Location	Incirlik, Yüregir, Adana, Turkey
Sample type	Ash
Date	15.04.2021
Description	Within dumpsite (same location as TK21030)



Sample was not subject to detailed interpretation because chromatogram appeared identical to that of sample TK21031

Sample code	TK21033
Location	Incirlik, Yüregir, Adana, Turkey
Sample type	Soil
Date	15.04.2021
Description	Control soil – Agricultural land



Number of compounds isolated: 29

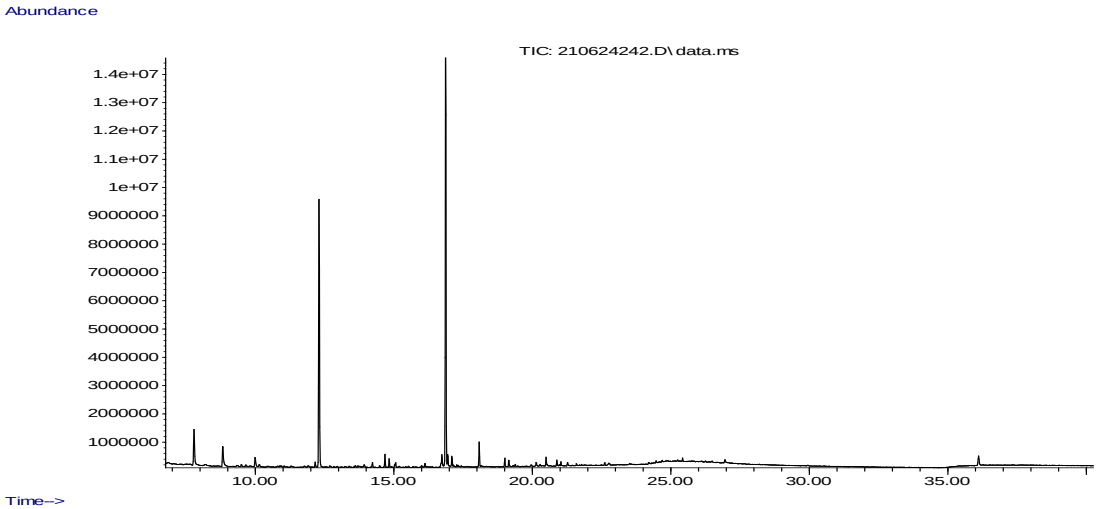
Compounds identified to better than 90%:

CAS# Name

Halogen containing compounds
000072-55-9 p,p'-DDE

PAHs and derivatives
000091-20-3 Naphthalene
000085-01-8 Phenanthrene

Sample code	TK21034
Location	Incirlik, Yüregir, Adana, Turkey
Sample type	Water
Date	15.04.2021
Description	Pond within dumpsite



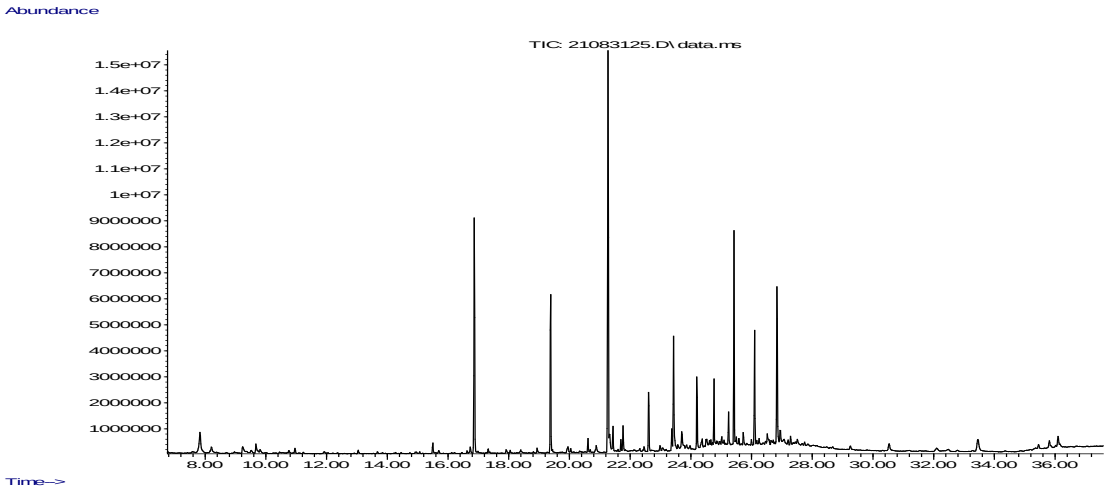
Number of compounds isolated: 25

Compounds identified to better than 90%:

In total ion chromatogram (TIC)
CAS# Name

000131-11-3 1,2-Benzenedicarboxylic acid, dimethyl ester
000084-66-2 1,2-Benzenedicarboxylic acid, diethyl ester
000084-74-2 1,2-Benzenedicarboxylic acid, dibutyl ester
000084-69-5 1,2-Benzenedicarboxylic acid, diisobutyl ester
000126-86-3 5-Decyne-4,7-diol, 2,4,7,9-tetramethyl-
023676-09-7 Benzoic acid, 4-ethoxy-, ethyl ester
000078-40-0 Phosphoric acid, triethyl ester
013674-84-5 Tris(2-chloroisopropyl)phosphate
001067-98-7 Tris(3-chloroisopropyl)phosphate

Sample code	TK21035
Location	Incirlik, Yüregir, Adana, Turkey
Sample type	Shredded plastics
Date	15.04.2021
Description	Within dumpsite



Number of compounds isolated: 92

Compounds identified to better than 90%:

In total ion chromatogram (TIC)

CAS#	**Name**
000117-81-7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
006422-86-2	1,4-Benzenedicarboxylic acid, 1,4-bis(2-ethylhexyl) ester
000084-76-4	1,2-Benzenedicarboxylic acid, dinoyl ester
020548-62-3	Phthalic acid, bis(7-methyloctyl) ester
000131-11-3	Dimethyl phthalate
000104-76-7	1-Hexanol, 2-ethyl-
000143-08-8	1-Nonanol
000301-02-0	13-Docosenamide
000693-54-9	2-Decanone
074327-29-0	4-Oxononanal
000124-19-6	Nonanal
033566-57-3	4-Oxononanoic acid methyl ester
002345-29-1	8-Octadecenoic acid, methyl ester
000301-00-8	9,12,15-Octadecatrienoic acid, methyl ester, (ZZZ)
002462-85-3	9,12-Octadecadienoic acid, methyl ester
001120-25-8	9-Hexadecenoic acid, methyl ester, (Z)
001931-63-1	9-Oxononanoic acid methyl ester
000098-86-2	Acetophenone
000104-66-5	Benzene, 1,1'-[1,2-ethanediylbis(oxy)]bis
006386-38-5	Benzenepropanoic acid, 3,5-bis(1,1-dimethylethyl)-4-hydroxy-, methyl ester
000128-37-0	Butylated hydroxytoluene
000057-88-5	Cholesterol
001740-19-8	Dehydroabietic acid
001731-84-6	Dodecanoic acid, methyl ester
000206-44-0	Fluoranthene
001731-92-6	Heptadecanoic acid, methyl ester
000544-76-3	Hexadecane

002490-49-5	Hexadecanoic acid, 14-methyl-, methyl ester
000112-39-0	Hexadecanoic acid, methyl ester
000000-00-0	High molecular weight aliphatic hydrocarbons, 12 compounds
000124-10-7	Methyl tetradecanoate
000091-20-3	Naphthalene
000629-92-5	Nonadecane
001732-10-1	Nonanedioic acid, dimethyl ester
007132-64-1	Pentadecanoic acid, methyl ester
006386-38-5	Phenanthrene
000096-76-4	Phenol, 2,4-bis(1,1-dimethylethyl)
000080-05-7	Phenol, 4,4’-(1-methylethylidene)bis
000083-47-6	Stigmast-5-en-3-ol
000100-42-5	Styrene
000000-00-0	Substituted phthalates, 9 compounds
005129-66-8	Tetradecanoic acid, 12-methyl-, methyl ester