POPs stockpile Merkim site, Kocaeli, Turkey

Detailed site survey/assessment, operational planning, environment/safeguards assessment, training and supporting technical supervision related to the removal of POPs

Task 2: Site Description Survey and Assessment Report

23 January 2017

Tauw

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Responsibility

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Contents

Appendices

1 Introduction

This report presents the third technical report containing the outcomes of the site description survey and assessment which was executed between the first and 17th of November 2016. The report is in line with the Technical Proposal for the assignment 'Provision of services for detailed site survey / assessment, operational planning, environmental / safeguards assessment, training, and supporting technical supervision related to the removal of the POPs stockpile and environmentally sound clearing and restoration of the Merkim site in Kocaeli, Turkey under the scope of POPs legacy Elimination on POPs Release Reduction Project' - UNDP-TUR-RFP-PROJ(POPs)-2016/01.

1.1 General

The overall objective of the Tauw assignment is to complete a detailed assessment of obsolete and POP-pesticides waste at the Merkim site as input for the key technical, operational planning and environmental management documentation required to undertake the elimination of POP-pesticides stockpiles (to be done within the scope of current GEF project financing) and prepare for the clean-up/restoration of the Merkim POP-pesticides stockpile site in Kocaeli, Turkey (to be done by the owner after completion of the stockpile elimination). This assignment should provide the necessary input to optimize global environmental benefits by eliminating the POP-pesticide stocks at the Merkim site.

The derived objectives of this assignment are to provide the beneficiary with:

- Detailed estimate of waste quantities of POP-pesticides in the Merkim warehouse
- Operational design to clean the Merkim warehouse
- Tender specifications for the contracting activities required to repackage, remove and dispose obsolete and POP-pesticide wastes and associated residual waste from the Merkim warehouse in an environmentally sound manner
- Detailed quantity estimates of hazardous and non-hazardous future demolition wastes of the Merkim warehouse itself
- Operational design to cleaning and demolition of the Merkim warehouse itself
- A general recommended scope for the soil and ground water remediation for the Merkim site as required for potential future use

The additional project objectives are to have:

- Environmental assessment documentation to meet national regulatory and international safeguards requirements
- Required training programs for Merkim site works
- On-site technical supervision during implementation of Merkim site works

1.2 Site Description Survey and Assessment Report

This Task concerns the detailed survey of the Merkim site. The objective of this Task 2 is to accurately define the site layout and the quantities and types of the obsolete and POP-pesticides stockpiles and waste. The approach of Task 2 consists of four distinguished Sub-Tasks. The Task 2 output is the input for Task 3 and subsequently to the UNDP tender for the stockpile elimination activities including the final disposal.

Task 2 has the following sub-tasks:

- Sub-Task 2.1 Inventory of the stockpile the warehouse and its surroundings
  - The objective of this Task is ‘fully defining the physical dimensions of the structures and site boundaries and, location of the subject stockpiles’
- Sub-Task 2.2 Definitive analytical characterization of the stockpiled material
  - The objective of this Sub-Task is to obtain sufficient information on the nature, composition and properties of the waste present at the site
- Sub-Task 2.3 Estimating the extent of associated high concentration residual hazardous waste
  - Objective of this task is to assess the quantity of construction materials in relation to POP pesticides
- Sub-Task 2.4 Site Description Survey and Assessment Report
  - Objective of this task is to document in a clear and inclusive manner the outcomes of this Task 2

Fieldworks preparation for Task 2 started in the end of October with the start of the on-site works on the 1st of November 2016. The site works were finished on the 17th of November. Laboratory analyses were finalized by the 18th of January 2017.

1.3 Structure Site Description Survey and Assessment Report

Following this introduction in Chapter 1, Chapter 2 presents the site history and the geography of the site and its direct surroundings. The site geology, hydrology and climate are elaborated in Chapter 3. An overview of the previously executed site investigations is provided in the next Chapter 4. Chapter 5 provides a summary of Turkish and international legislation regarding hazardous wastes and includes sampling protocols. The results of the site survey are presented in Chapter 6 with the following chapter containing the analytical results in tabular form.

A full inventory of all contaminated materials is given in Chapter 8 with the subsequent chapter containing the official waste classification. The last Chapter 10 contains conclusions and recommendations on the collection and disposal of hazardous wastes and building materials.

2 Site Background

This chapter provides a detailed site history and geographic characteristics of the site. It is an update of the information provided in the Inception Report.

2.1 Site characteristics

The Merkim site is approximately 8,000 m^2 in size and consists of 6 interlinked warehouses surrounded by unpaved outer areas. The entire site is enclosed by a 3 m high barbed wire fence in good condition. As of 2016 there is one main entrance to the interlinked warehouses, all other entry points have been sealed off. The outside walls and doors, except the main entrance, of the warehouse are sealed with foam concrete to reduce odour nuisance in the surrounding.

Of the 6 interlinked warehouses, 4 have the same configuration (20 x 30 m) with ceilings of approximately 7 m in height. The two Northern most warehouses are smaller (20 x 20 m) in size. Some confusion exists on the warehouse numbering. Numbers painted on the outside of the warehouses go from 1 to 5. In previous reports warehouses have been numbered from 1 to 6. The difference is caused by the separation of warehouse 1 and 2 into two separate warehouses, where the outside painting considers them as one warehouse. In our reporting we continued the numbering with 6 warehouses to avoid confusion with previous investigations.

The following table (table 2.1) provides details on the individual warehouses.

Table 2.1 Description of warehouses

Ware-house	Width (m)	Length (m)	Height (m)*	Area (m^2)	Description	Picture
1	10	16.5	3.5**	165	Northern most warehouse. It has a flat roof of asbestos, on metal rafters. Walls are cement blocks with part of the Northeast wall missing and replaced by corrugated iron sheets. Warehouse 1 has concrete floors. Entrance to the warehouse through demolished wall with warehouse 2	

Ware-house	Width (m)	Length (m)	Height (m)*	Area (m^2)	Description	Picture
1b	6.3	5.2	4.6**	32.8	Small building next to warehouse 1. It has a slanted roof of asbestos. Walls are cement blocks. In the middle of the building is a pit of 3.6 x 2.6 m and 1 m deep. The pit is partially filled with construction wastes and partially with POP pesticides. A disused phone or electricity pole is present in the corner.	
1c	6.3	5.2	3.5***	32.8	Small building that is empty and completely closed. It is not accessible through any door as the building has been sealed. It has a flat roof of asbestos, on metal rafters. There is a small closed corner which presumable has no roof as light comes in.	
2	20	20	8.1	400	Second warehouse from the North, configuration of warehouse is similar to warehouses 3 - 6 but size is somewhat smaller. It has a slanted roof made of asbestos, on metal rafters. Walls are cement blocks with reinforced concrete frame. A groundwater extraction well is present in the centre of the warehouse (see figure 2.1). The well is poorly covered and has a diameter of 80 cm and a depth of minimum 11.5 m. A small pit, probably the old pump basin, is present next to the well. The pit is filled with POP pesticides.	

Ware-house	Width (m)	Length (m)	Height (m)*	Area (m^2)	Description	Picture
3	20	30	Side 5.5 Ridge 8.5	600	Second most Northern warehouse. This is the only warehouse with access to the outside through a 4 x 4 m metal sliding door with an normal door persons to enter. Warehouse is completely sealed and no daylight enters. It has a slanted roof made of asbestos, on metal rafters. Walls are cement blocks with reinforced concrete frame. Warehouse has concrete floor made of slabs. Between warehouse 3 and 4 is a narrow corridor made of asbestos sheets and corrugated iron roof. This corridor has been built on a concrete floor but has been heightened with soil contaminated with pure pesticides and asbestos as the floor is some 10-15 cm lower than in warehouse 3 and 4.	
4	20	30	Side 5.5 Ridge 8.5	600	Third most Southern warehouse. It has a slanted roof made of asbestos on metal rafters. Walls are cement blocks with reinforced concrete frame. Warehouse has concrete floors in generally good condition. It has one sealed 4 x 4 m metal door on the west side.	
5	20	30	Side 5.5 Ridge 8.5	600	Second most Southern warehouse. Has similar configuration as warehouse 4.	

Ware-house	Width (m)	Length (m)	Height (m)*	Area (m^2)	Description	Picture
6	20	30	Side 5.5 Ridge 8.5	600	Most Southern warehouse. Has similar configuration as warehouse 4. Warehouse has a 4 x 4 m metal access doors on the East side	
Total				3,030.6		

* Approximate height

After careful measurements it was concluded that the warehouses are slightly bigger than what was reported in previous investigations and the inception report of this mission. The detailed measurements of the warehouses are given in the cross-sectional drawings in appendix 8.

Three active groundwater extraction wells are present at the site. One well is located just North of the site entrance (see figure 2.1), the second well is at the entrance to the decontamination unit area (between warehouse 3 and 4) and the third well is in the Southern end of the site. The wells are closed circuit wells made of steel. Extracted water is used for processing at the Koruma Klor Alkali San. ve Tic. A.Ş chemical factory. Inside warehouse 2 a non-operational old groundwater extraction well is also present.

Figure 2.1 Water extraction well (left) and indoor well in warehouse 2 (right)

A small underground storage (presumably an old septic tank) is located outside building 1c. Pictures of the buildings and main site features are included in the photo report (appendix 1).

All buildings have been sealed with Polyurethane foam mixed with cement to limit airborne particulate and odours. During the visit in November 2016 the roof and gutters of the buildings were leaking. Especially at the edges of the various warehouses the roof and gutters have been completely rotten, effectively leading to nearly all rainfall falling on the roof to flow into the warehouse and onto the wastes.

On a separate note, based on our experiences during the field works we consider this building a fire hazard. The main reasons for this are:

- Unkempt outdoor green areas with dead foliage and pine needles that, during dry periods, can easily catch fire
- Presence of empty paper bags inside especially warehouse 4 and 5 that, in combination with the open roof, can catch fire easily
- Previous fire incidents due to faulty electric wiring
- Difficult access through warehouse 3 as the main sliding door can only be opened by machinery and not by hand

2.2 Geography

The site is situated in the Sirintepe Region of Derince town in Kocaeli province, Western Turkey. Derince is a coastal town on the Northern shore of Izmit Bay (see figure 2.2). The official address of the site is Deniz mah. Petrol Office street Derince-Kocaeli, cadastral annotation is layout no:73, Plot no:50, Parcel no: 34.

Approximate height of the site is 4 – 5 m above sea level. The site itself is located in an oxbow of the entry road to an industrial zone (see figure 2.3). The area is relatively flat, slightly sloping towards Izmit bay which is some 250 m to the South. The closest hills are some 2 km North of the site. Directly North of the site is the high speed railroad Istanbul - Eskisehir, to the West is a new Mosque for the workers of nearby industrial facilities and a restaurant for tanker drivers. To the South and the West of the site are Petrol Ofisi tank storage areas, to the East of the site is the Shell Derince Dolum Tesisi tank storage and Koruma Klor Alkali San. ve Tic A Ş chemical factory. The nearest settlement is Deniz(sea) hometown that is approximately 350 m to the northeast. The planning status of the site is Industrial Land, there are no land use restrictions for the area.

An background maps map of the area are attached in appendix 11.

Figure 2.2 Regional setting of site in Derince Municipality, Kocaeli, Turkey (source google maps, 20 October 2016, North is to the top of the picture)

Figure 2.3 Merkim Industries Warehouse Site and its direct surroundings (source google maps, 20 October 2016, North is to the top of the picture)

2.3 Site history

The warehouse (currently known as Merkim warehouse) was constructed in the sixties. Originally it was part of the Koruma Klor Alkali San. ve Tic A.Ş. chemical factory that produced agricultural pesticides, insecticides including DDT and Lindane (HCH) and caustic soda. Limited information is available on the exact activities that took place in the warehouse during this period. Based on the configuration of the warehouse, it likely included bagging and storage of non-liquid pesticides or their by-products.

The warehouse was disentangled from the chemical factory operations in the end of the eighties. In 1985 the factory was sold to new ownership. The current storage site was bought in 1991 by Merkim Industrial Products Co. Since 1991 no industrial activities have taken place at the warehouse. It was officially closed and sealed by the Ministry of Environment in 2003. In the period 2003-2005 empty drums, with the intent of using them for repackaging, have been collected in the warehouse. These drums have been partially filled with POP pesticides since.
In the period 2008-2013 repacking and export of POP wastes took place. Equipment for these efforts is still present inside warehouses 3 and 4. A total of 512.4 tons of POP-pesticides wastes have been repacked and shipped to Germany for incineration. Table 2.2 provides the dates and quantities of the batches repacked and transported for disposal by High Temperature incineration. These efforts were undertaken by Merkim Industrial Products Co.

Table 2.2 Wastes from Merkim site disposed by High Temperature incireation bewteen 2008 - 2013

Date	Quantity (kg)
21-07-2008	20.560
24-07-2008	41.140
24-09-2008	24.800
23-12-2008	104.060
15-01-2009	51.800
8-06-2009	48.480
24-09-2009	23.560
06-10-2011	20.000
27-10-2011	20.000
07-11-2011	18.000
24-07-2012	20.000
22-10-2012	40.000
18-12-2012	40.000
23-01-2013	40.000
Total	**512.400**

In 2013/2014 the outside of the warehouses were sealed using polyurethane foam mixed with concrete (concrete foam or similar product) in an attempt to reduce airborne particulate and the odour coming from the site.

2.4 Background information on production of HCH

The main background information on the production of HC comes from the report 'The legacy of Lindane HCH Isomer Production' John Vijgen International HCH & Pesticides Association, January 2006. Below is a summary from this report on the production process behind HCH.

Raw materials for the production of HCH are benzene and chlorine. Benzene is chlorinated under free radical conditions, and chlorine is 'added' to the 'double bounds' of the benzene ring to create Technical HCH. Technical HCH consists mainly of a mixture of various stereo-isomers, which are designated by Greek letters α, β, γ, δ and ε. The raw product from the chlorination of benzene contains about 14 % γ-HCH and 86 % of inactive isomers, i.e. 65-70 % α, 7-10 % β, approximately 7 % δ, 1-2 % ε-HCH, and 1-2 % other components.

In practice this reaction is carried out by dissolving chlorine into benzene in such a concentration that there is an excess of benzene. The solution is then passed through a thin-layer photo reactor where it is irradiated by intensive light sources having a high ultraviolet content. Because of the excess of benzene the product formed remains dissolved at higher temperatures.

The very strong and disagreeable smell, which is taken up by the crop, makes technical HCH practically useless for use as a pesticide on food crops. To eliminate this unwanted effect the technical HCH was further processed to create Lindane; material that contains 99 % γ-HCH. This was done by extracting technical HCH with methanol at 15-25 º C and the un-dissolved inactive isomers are filtered off. From the remaining solution, which contains nearly all the gamma-HCH originally present in the technical product, methanol is distilled off at 80 -100 º C. Upon cooling, gamma-HCH crystallizes from the concentrated solution. The methanol and the mother liquors are recycled, and the raw gamma-HCH is further purified by a series of crystallization processes until the required purity has been obtained. The production of Lindane created huge amounts of isomers waste. The total quantity of waste was about 8 times the Lindane output.

3 Site geology, hydrology and climate

3.1 Geology

Geologically the town of Derince is situated in the Istanbul Geologic zone which is characterized by a well-developed, un-metamorphosed and little deformed continues Palaeozoic sedimentary succession extending from the Ordovician to the Carboniferous. It is overlain with a major unconformity by Permian to Lowermost Triassic continental red beds. The flat area directly next to the coast where the site is located is classified as anthropogenic, alluvium, terrestrials, sedimentary rock. Most likely it is a late Pleistocene marine terrace or Quaternary alluvial deposit consisting of sand and silt. Raising of these flat areas was a common practice in the region.

Located on the Northern shore of Izmit bay, the town of Derince is close the North-Anatolian-Fault (NAF) which is situated in the deepest part of the bay. The North Anatolian fault line is an active fault line with the last major earthquake occurring in 1999 (Izmit Earthquake with 7.6 moment magnitude). The site is classified as present within the 1st degree earthquake zone meaning it is directly affected by earthquakes.

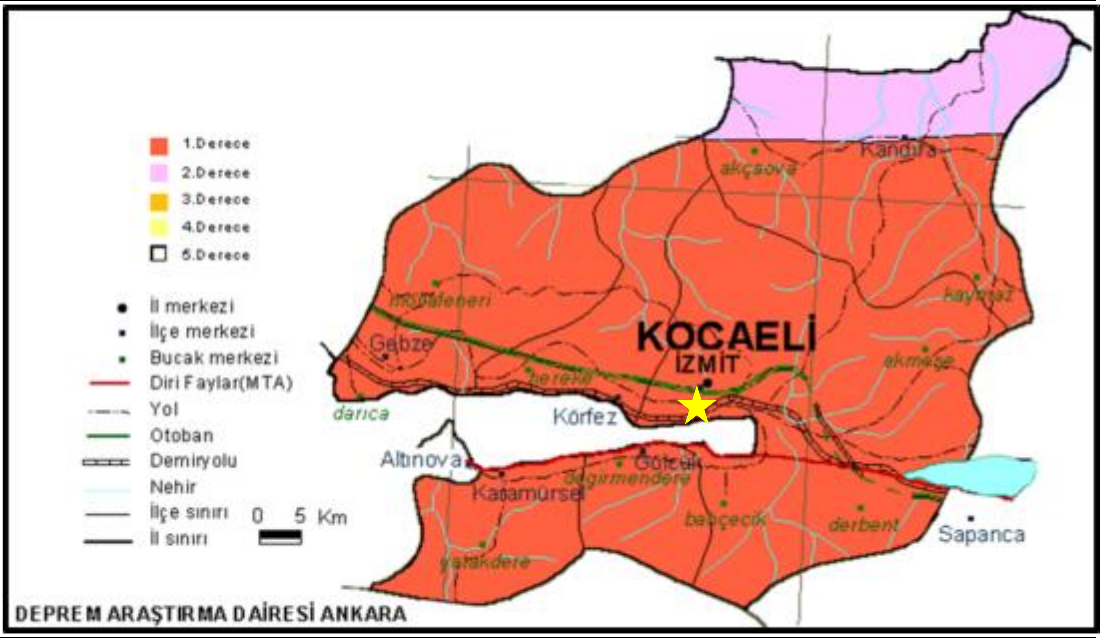

Figure 3.1 Turkey Earthquake Regions map (Disaster and Emergency Management Authority, North is to the top of the figure)

An extract of the geological map of the area is attached in appendix 11.

3.2 Geohydrology

Regional hydrology is known from extraction wells placed at a neighbouring tank storage site (OMV Petrol Ofisi). Static level of groundwater in the area is 2 – 7 m below the surface. Dynamic groundwater level is 1 – 30 meter below the surface. Most wells at the neighbouring site had groundwater levels between 1.0 and 3.8 m below the surface. The locations of these wells are (partially) downstream and downhill from the Merkim site.

The on-site well in warehouse 2 had a groundwater level of 9.5 m below the site floor, which would effectively be below sea-level. This information, together with the presence of three extraction wells for groundwater indicates that permeability of the subsurface is likely high with groundwater flow direction from North to South at high speeds.

3.3 Climate

The Merkim site is situated in the Izmit region which has a humid subtropical climate (Köppen climate classification Cfa), with considerable Mediterranean influences. Summers are hot and very humid with average maximum temperatures around 29 °C in July and August. Winters are cool and damp with the lowest average minimum temperatures around 3 °C. Precipitation is high and fairly evenly distributed year round; it is heaviest in autumn, winter and spring. Snowfall is not uncommon between the months of December and March. Table 3.1 gives the average monthly temperature in degrees Celsius and precipitation in mm.

Table 3.1 Climate statistics for Izmit (source Devlet Meteoroloji İşleri Genel Müdürlüğü)

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Average temperature (C°)	6.2	6.5	8.6	13.0	17.4	21.8	23.8	23.6	20.1	15.9	8.3	5.4	10.93
Precipitation (mm)	91.3	74.9	72.0	55.3	45.9	50.4	39.2	54.2	50.6	94.5	87.2	107.8	823.3

General wind direction for the area is from North and North-East in winter and in summer mostly from the North-East.

4 Site investigation history

Appendix 1 of the Work Plan (Tauw Reference R001-1239389BFF-beb-V04-NL) contains an overview of the executed site investigations and site inventories with their main outcomes, carried out between 2005 and 2013. This section provides the raw data and preliminary conclusions to the data. In the scope of the study the following reports have been reviewed:

1. IPEP - Pesticide Stockpile in Derince, Kocaeli, Bumerang (April 2005)
2. Link Inspection Expertise Services Co. Ltd. – report GL-1212/05 (21 November 2005)
3. Link Survey Report (09 December 2011)
4. Survey report ITS. Caleb Brett/Denis Survey S.A. (9 December 2011)
5. Marmara Research Centre – Chlorine Pesticide Analysis Studies in the samples (raw materials, soil, wall and water) of Merkim Endüstri Ürünleri A.S. (28 November 2013)

4.1 IPEP – Bumerang report (April 2005)

The IPEP Bumerang report offers a good starting point for the site investigation history. It provides a detailed physical description of the site including pictures from the period prior to the sealing of the warehouses. A thorough review of the site ownership gives insight in the ownership changes over the past 30 years and some history on the production of pesticides in the area. The report refers to further documents dating from 2004 that so far have not been uncovered in this project. The analytical data in the report is indicative at best as maps with sampling locations are missing.

4.2 Link reports (2005 – 2011)

Link Inspection Services Co Ltd made two reports with a first assessment of the quantities of the wastes. The report from 2005 included site measurements and the 2011 report is essentially an update of the 2005 report.

A marked difference exists between the 2005 and the 2011 inventories (see Table 4.1 and 4.2). The 2011 showed approximately 700 tons less POP-pesticides. The difference between the 2005 and the 2011 inventories is mostly due to disposal activities undertaken by the site owner (see table 2.2) and to a different specific weight used to estimate the amounts of the POP-pesticides. In addition during the 2011 inventory none of the POP-pesticides packed in drums have been included.

In addition, the measurements of the LINK reports for warehouse 3, 4, 5 and 6 are incorrect. The size of the warehouse is not 25 x 20 m but rather 30 x 20 m.

The Survey report ITS. Caleb Brett/Denis Survey S.A. (9 December 2011) is essentially the same as the 2011 Link report.

Table 4.1 Past POP-pesticides inventories 2005 - 2011

Warehouse	2005 Inventory				2011 Inventory			
	Drum no.	Drums (weight in tons)	Bags volume (m^3)	Bags (weight in tons)	Drum no.	Drums (weight in tons)	Bags volume (m^3)	Bags (weight in tons)
1	84	13	94.5	84	n.a.	0	69.3	57
2	688	103	106.5	102	n.a.	n.a.		n.a.
3	928	139	120	120	n.a.	n.a.		n.a.
4	0	0	400	384	n.a.	0	633.15	527
5	0	0	456	438	n.a.	0	456	380
6	0	0	1650	1,584	n.a.	0	1650	1,375
Total	**1,700**	**255**	**2,827**	**2,712**	**n.a.**	**0**	**2,808.45**	**2,339**

Table 4.2 Past POP-pesticides inventories used specific weights and volume compensation

Unit	Quantity	Weight/unit kg	Volume compensation	Specific weight kg/dm^3	Total weight tons
2005 inventory					
Drum	1,700 pieces	150	n.a.	n.a.	255
Bags	2,827 m^3	n.a.	0.8	1,200	2,712
2011 inventory					
Drums	n.a.	n.a.	n.a.	n.a.	n.a.
Bags	2,808.45 m^3	n.a.	1	0,833	2,339

4.3 Marmara Research Centre – Chlorine Pesticide Analysis Studies (2013)

In 2013 the UNDP commissioned The Marmara Research Centre (MAM Tübitak) to investigate the site. This report provides the best insights into the chemical composition of the material present at the site. The report focussed on four types of materials and these materials are sampled. The materials are:

- Soil
- Building materials of the wall s and floors
- POP-pesticides in piles
- Groundwater

The MAM Tübitak investigated the soil within the compound premises by dividing the outdoor areas in 16 separate areas where composite samples were taken as illustrated in figure 4.1.Table 4.3 gives for each soil sample the soil sample number the location (as in figure 4.1) and the analytical results parts per million (ppm).

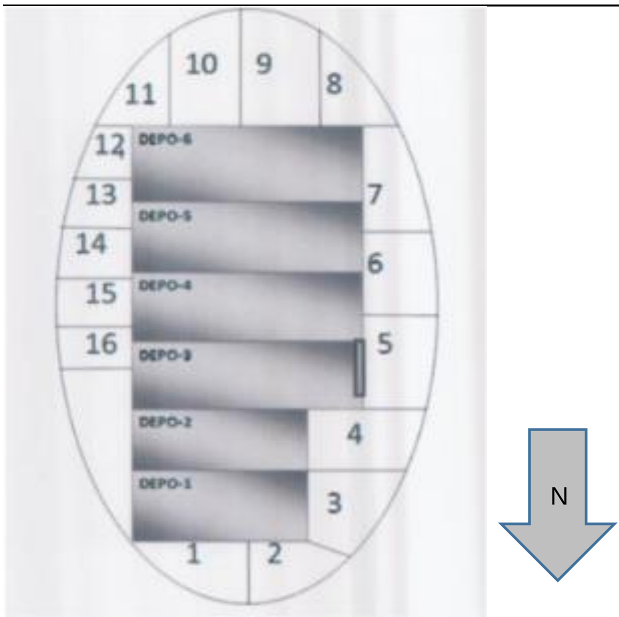

Figure 4.1 Location of soil samples – MAM Tübitak report 2013 (North is to the bottom of the picture)

Table 4.3 Soil samples taken and analysed by MAM Tübitak, the concentrations are given in ppm

Sample Number	Location	α-HCH	β-HCH	γ-HCH	δ-HCH	4,4’-DDT	4,4’-DDE	4,4’-DDD	Pentachloro-benzene	Total
988-1	1	5.4	15.3	0.5	0.2	6.5	1	18.7	<0.1	47.5
988-2	2	2.9	8.1	0.3	5.9	16.5	5.9	415.8	<0.1	455.3
988-3	3	47.2	13.4	0.9	0.4	11.1	5	223.7	<0.1	301.7
988-4	4	512.1	96.9	18.5	4.7	1	0.2	4.9	<0.1	638.3
988-5	5	988.7	225.2	26	10.2	4	1.6	109.9	<0.1	1,365.7
988-6	6	4.9	21.8	0.1	0.1	3.6	0.8	36.5	<0.1	67.8
988-7	7	307.3	111.5	5.9	3.6	0.8	0.2	5.2	<0.1	434.5
988-8	8	0.3	0.1	0.1	<0.1	1.7	0.2	5.3	<0.1	7.8
988-9	9	0.2	0.1	<0.1	<0.1	0.5	0.1	1.6	<0.1	2.4
988-10	10	0.1	<0.1	<0.1	<0.1	0.1	0	0.1	<0.1	0.3
988-11	11	0.1	0.1	<0.1	<0.1	0.5	0.1	1.2	<0.1	2.1
988-12	12	0.2	0.1	<0.1	<0.1	0.5	0.2	1.8	<0.1	2.7
988-13	13	0.1	0.7	<0.1	<0.1	3.9	0.9	16.6	<0.1	22.1
988-14	14	<0.1	0.1	<0.1	<0.1	0.6	0.2	2.9	<0.1	3.8
988-15	15	1,260.7	328.3	140.9	1.9	1.3	1.3	12.4	<0.1	1,746.9
988-16	16	0.3	0.1	<0.1	<0.1	0.7	0.1	0.4	<0.1	1.7

The MAM Tübitak results of the soil samples show that the main soil contamination to be present around the current entrance to the site, the North part of the site and on the eastern side of warehouse 4. Since no entrance is present on the Eastern part of warehouse 4, the most likely cause of the high concentrations of pesticides in the soil there is cross-contamination during the sampling. An unknown source area for POP-pesticides (for instance due to a gap in the wall that caused airborne particulate) and/or seeping rainwater from the warehouse floor can however not be excluded.

The presence of DDT is limited to the area to the North, where inside the warehouses and on the floor DDT is also found. The other soil is contaminated with HCH and the pictured presence of POP-pesticides is consistent with the contents of the various warehouses.

MAM Tübitak also sampled the floors and walls inside the warehouses as indicated in figure 4.2. Sampling was done by collecting dust from the walls and floors. The dust samples were analysed for HCH, DDT and their isomers. The analytical results of the wall and floor samples (ppm) are given in table 4.4.

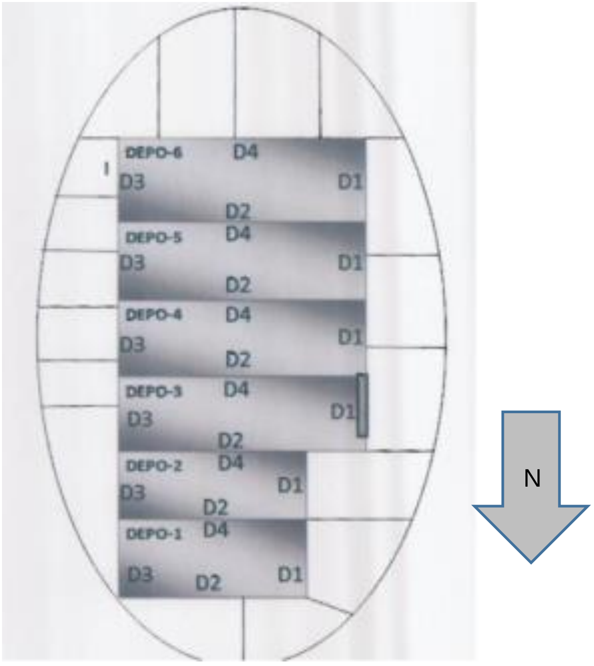

Figure 4.2 Sample location of wall and floor samples – MAM Tübitak report 2013 (North is to the bottom of the picture)

Table 4.4 Wall and floor samples taken and analysed by MAM Tübitak the concentrations are given in ppm

Sample Number	Location	α-HCH	β-HCH	γ-HCH	δ-HCH	4,4'-DDT	4,4'-DDE	4,4'-DDD	Penta chloro-benzene	Total
988-17	1D-2	466.1	132.7	20.8	33.2	0.5	0.1	2.1	<0.1	655.5
988-18	1D-3	1.156.00	240.6	61.5	39	0.4	0.1	2	<0.1	1,499.6
988-19	1D-4	24.1	12.1	14.2	10.7	0.5	<0.1	1.4	<0.1	63.1
988-20	1D-5 floor	2,123.00	26.8	<0.1	4	17.5	6.9	517.8	2.4	2,698.4
988-21	2D-1	1,340.10	420.1	350.1	158.3	21.6	3.7	131.8	<0.1	2,425.9
988-22	2D-2	1,381.70	455.1	379.3	163.6	21.2	0.8	58.3	<0.1	2,459.9
988-23	2D-3	1,295.30	295.4	517	155.1	4.5	0.6	72	<0.1	2,339.9
988-24	2D-4	1,171.10	197.3	65.8	21.9	5.4	0.7	38.7	<0.1	1,500.8
988-25	2D-5 floor	1,418.20	259.2	1,500.00	1,500.00	9.3	51.4	396.8	1.3	5,136.2
988-26	3D-1	228.9	28.2	174.8	88.3	0.4	0.1	1.8	1	523.4
988-27	3D-2	5,487.30	1,250.00	340.1	110.3	0.2	<0.1	0.4	0.6	7,188.7
988-28	3D-3	2,949.90	537	136.6	52.4	0.2	<0.1	0.8	0.2	3,676.9
988-29	3D-5 floor	8,712.50	53.6	8,440.00	127.7	1.2	1.2	28.2	5.1	17,369.4
988-30	4D-1	1,349.60	180.5	52.2	20.4	<0.1	<0.1	0.2	<0.1	1,602.8
988-31	4D-3	445.2	53.4	60.5	26.9	0.1	<0.1	0.3	0.7	587.1
988-32	4D-5 floor	4,390.50	700.2	4,774.30	2,736.50	0.8	3.2	17.7	1	12,624.1
988-33	5D-1	567	67.9	79.6	33.3	<0.1	<0.1	0.1	<0.1	747.8
988-34	5D-3	44.3	6	12.9	12.3	<0.1	<0.1	0.2	<0.1	75.6
988-35	5D-4	22.3	2.3	24.8	13.9	<0.1	<0.1	0.1	0.3	63.7
988-36	5D-5 floor	6,468.40	11.3	6,759.60	67.8	20.7	16.1	1.223.10	0.7	14,567.6
988-37	6D-1	222	39	35	8	86.7	20	664.5	0.6	1,075.8
988-38	6D-2	85.2	11.4	48.2	5.5	8.5	1.4	16.1	0.7	177
988-39	6D-3	439.5	111.8	11	6.5	1.2	0.2	0.3	<0.1	570.4
988-40	6D-4	17.1	21.8	6.1	5.1	0.4	0.2	1.8	<0.1	52.5
988-41	6D-5 floor	3,710.80	383.4	2,061.60	16.1	184.5	119.9	4.269.20	0.5	10,745.9

MAM Tübitak staff collected only surface materials that they scraped of the walls. The total sample (composite) quantity of each wall was no more than 10-20 grams. This would explain the high levels of POP-pesticides found on the walls as this material mostly includes the dust that has settled on the outer surfaces. These concentrations should not be seen as representative for the POP-pesticide concentration of the materials of the walls and floors themselves.

MAM Tübitak also took samples directly from the wastes at two points in warehouses 5 and 6. The exact sampling locations are not clear. Table 4.5 provides an overview of the analytical results of these waste samples.

Table 4.5 Pile samples taken and analysed by MAM Tübitak the concentrations are given in ppm

Sample number	α-HCH	β-HCH	γ-HCH	δ-HCH	4,4'-DDT	4,4'-DDE	4,4'-DDD	Pentachloro-benzene	Total
988-42	276,869.00	25,789.00	10,153.00	2,889.00	<0.1	<0.1	<0.1	<0.1	315.700
988-43	320,035.90	24,569.10	5,152.60	1,544.00	<0.1	<0.1	<0.1	<0.1	351,301.6
988-44	307,266.70	26,790.80	13,358.30	7,541.70	<0.1	<0.1	<0.1	<0.1	354,957.5
988-45	371,953.20	30,610.90	5,769.20	1,689.30	<0.1	<0.1	<0.1	<0.1	410,022.6
988-46	315,593.30	25,526.70	12,660.00	3,440.00	<0.1	<0.1	<0.1	<0.1	357.220
988-47	302,122.20	25,688.90	13,177.80	6,100.00	<0.1	<0.1	<0.1	<0.1	347,088.9
988-48	261,482.60	28,037.80	3,633.70	159.9	<0.1	<0.1	<0.1	<0.1	293,314
988-49	337,579.60	27,031.80	3,861.70	178.3	<0.1	<0.1	<0.1	<0.1	368,651.5
988-50	311,662.40	25,978.80	6,243.90	1,772.00	<0.1	<0.1	<0.1	<0.1	345,657.1
988-51	297,431.00	21,341.40	8,341.40	4,337.90	<0.1	<0.1	<0.1	<0.1	331,451.7

The MAM Tübitak waste sampling shows that the wastes found at the site contain 29-41 % HCH isomers, with the rest inorganic material. Out of the total weight, 26-37 % was found to be α-HCH, and 0.05-1.3 % γ-HCH. This is consistent with Lindane-productions wastes. The below diagram (figure 4.3) shows average POP waste composition based on the MAM Tübitak results.

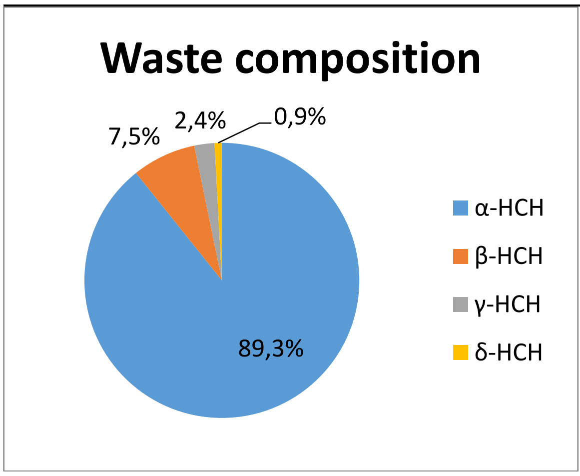

Figure 4.3 HCH composition in waste pile samples of MAM Tübitak

The MAM Tübitak report also mentions that groundwater is sampled from one of the on-site wells. The water was analysed for HCH, DDT and pentachlorobenzenes. No contamination was detected in the this groundwater sample.

5 Turkish legislation and international legislation

5.1 Turkish legislation overview on hazardous wastes

The legal framework of hazardous wastes management in Turkey is based upon the Law on Environment 2872. This law is complemented by a number of specific by-laws. Relevant legislation on hazardous waste management in this respect is:

- Law on Environment No. 2872 (O.J. 11.08.1983- 18132) amended by Law No. 5491 (2006):
  - By-law on waste management (O.J. 02.04.2015-29314)
  - By-law on landfilling of wastes (O.J. 26.03.2010-27533)
  - By-law on incineration of wastes (O.J. 06.10.2010-27721)
  - By-law on EIA (O.J. 25.11.2014 -29186)
  - Communiqué on waste interim storage facilities (O.J. 26.04.2011-27916)
  - Communiqué concerning carriage of wastes by road (O.J. 20.03.2015-29301)
  - Decision on Liability Insurance for hazardous materials (O.J. 11.03.2010-25518)
  - By law concerning the carriage of dangerous goods by road (O.J. 24.10.2013-28801)
  - By law concerning the carriage of dangerous goods by rail (O.J. 16.07.2015-29418)
  - By law concerning the carriage of dangerous goods by sea (O.J. 03.03.2015-29284)

Turkey has ratified the following international conventions related to hazardous wastes:

- The Convention on the Control of Trans boundary Movements of Hazardous Wastes and Their Disposal (Basel Convention)
- The European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) adopted as by law No. 5434 (30.11.2005)
- Convention on International Carriage by Rail (COTİF) - International Carriage of Dangerous Goods by Rail (RID) as main annex C of the (O.J. 01.06.1985-18771)
- International Convention on Safety of Life at Sea (SOLAS)
- International Convention on the Prevention of Pollution of Sea by Vessels (MARPOL 73/78) - (O.J.24.06.1990-20558)
- Rotterdam Convention on the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade has only been accepted by Turkey
- Stockholm Convention on Persistent Organic Pollutants has been ratified by Turkey

5.2 International legislation on waste sampling

Various international standards on waste sampling exist. Most of the available protocols and standards are focussed on the sampling and analysis of production wastes. For the sampling of the wastes at the Merkim site the ‘Guidance on the classification and assessment of waste (1st edition 2015)’ guidelines of the British government, are used.

These guidelines are one of the most recent and available online guidelines. These guidelines are based on the following protocols and procedures:

- Framework for the preparation and application of a sampling plan (BS EN 14899:2005):
  - Part 1: Guidance on selection and application of criteria for sampling under various conditions (PD CEN/TR 15310-1:2006)
  - Part 2: Guidance on sampling techniques (PD CEN/TR 15310-2:2006)
  - Part 3: Guidance on procedures for sub-sampling in the field (PD CEN/TR 15310-3:2006)
  - Part 4: Guidance on procedures for sample packaging, storage, preservation, transport and delivery (CEN/TR 15310-4:2006)
  - Part 5: Guidance on the process of defining the sampling plan (PD CEN/TR 15310-5:2006)

For the sampling of the wastes themselves the protocols as prescribed in the; NVN:5860:1999 Dutch regulation for sampling of wastes; are used. The Dutch regulation more clearly defines the sampling equipment and strategies.

Turkish legislative requirements state that waste classification should be done by a testing organization that is authorized by the authorities. In the case of the Merkim warehouse the authorized testing facility is MAM Tübitak.

5.3 Sampling methodology and protocol

Various international standards are available for the sampling and classification of wastes. In most cases these standards are made for production wastes with a known origin. In the case of the wastes present at the Merkim site the origin of the wastes is not completely clear. Background information on the wastes is available but there is clearly some variability in the waste materials. The objective of the sampling campaign is therefor to obtain sufficient information on the nature, composition and properties of the wastes to determine if it is a hazardous waste and to assign their waste codes in accordance with Turkish and EU legislation as well as the Basel convention.

Technical goals of the waste sampling are the following:

- Identify if the waste is a mixture
- Identify which hazardous waste substances are present in the waste
- Determine the concentration of hazardous substances present
- Identify if wastes are present that are not POP-pesticides

To achieve these goals the procedures as prescribed in appendix D of the ‘Guidance on the classification and assessment of waste (1st edition 2015)’ guidelines of the British government are followed.

As the background information on the wastes (see chapter 2 – 4 of this report) is limited and previous analytical results indicated different waste types, the waste is sampled in the following two steps:

1. Basic characterisation of the wastes to establish waste populations and variability of the wastes
2. Compliance testing to determine final characteristics of the wastes

Based on visual assessment of the on-site waste a number of waste populations have been identified. These are given in table 5.1. The material in the drums was not classified as a separate waste population as the drums contained the same bags as found in the piles in the warehouses. To increase the accuracy of the testing, waste sub-populations were limited to approximately 100 m^3.

Table 5.1 Waste (sub)populations

Sub-population	Location	Material type	Dimensions	Chemical characteristics
1	Warehouse 1	Yellow powder	In 30 litre bags – total quantity 50 – 100 m^3	Non-reactive to acids – most likely POP-pesticides
2, 4, 5	Warehouse 4	White blocks and powder	In 50 litre bags – total quantity 100 – 400 m^3	Non-reactive to acids – most likely POP-pesticides
3	Warehouse 4	Yellow powder	In 30 litre bags – total quantity 50 – 100 m^3	Non-reactive to acids – most likely POP-pesticides
6-10	Warehouse 5 – East side	White blocks and powder	In 50 litre bags – total quantity 200 -500 m^3	Non-reactive to acids – most likely POP-pesticides
11-25	Warehouse 6	White blocks and powder	In 50 litre bags – total quantity 1,000 – 2,000 m^3	Non-reactive to acids – most likely POP-pesticides
26, 27	Warehouse 4-6	Yellow powder	In 30 litre bags – total quantity 20 – 50 m^3 mixed with other wastes	Non-reactive to acids – most likely POP-pesticides

Constituents to be analysed were defined by the outcomes of the MAM Tübitak investigation (see paragraph 4.3) and consist of:

- α-HCH
- β-HCH
- γ-HCH
- δ-HCH

- 4,4’-DDT
- 4,4’-DDE
- 4,4’-DDD

The presence of high concentrations of one of these components quickly provides the necessary input to establish if the material is a hazardous waste. In case none of these components is present in high concentrations further testing is be required.

To assess spatial variability of the wastes, a drilling campaign was started to allow for even the deepest layers of wastes in warehouse 6 to be reached. The scale of the initial sampling campaign is one sample per 100 m^3.

As a specific code is available for organochlorine pesticides, no specific separation is needed between DDT and HCH wastes in the final waste population.

Appendix D of the of the ‘Guidance on the classification and assessment of waste (1st edition 2015)’ guidelines of the British government describes an elaborated statistical approach to interpret the results and to check if the wastes are hazardous or not. In the case of the Merkim site a statistical approach is only relevant in case non-POP wastes were discovered. POP wastes have concentrations of POP-pesticides that far exceed the 50 mg/kg threshold limit and statistical checks if these wastes can be classified as non-hazardous are as such useless.

The sampling approach to the wastes is probabilistic sampling. To reach deeper levels of the wastes a stratified random sampling method has been applied to the wastes in warehouse 6.

According to appendix D of the ‘Guidance on the classification and assessment of waste (1st edition 2015)’ guidelines of the British government the number of samples required depends on the desired precision of the waste classification. In the case of the Merkim site the only requirements would be to establish if wastes are:

- POP-pesticides
- Non-POP-pesticides

Wastes that are POP-pesticides are above all threshold limits. Wastes that are non-POP-pesticides should be further tested to check their hazardousness. Essentially this means that one sample per sub-population is sufficient and if one of the sub-populations turns out to be a non-POP material additional sampling is needed.

5.3.1 Quality of wastes in bags

The POP-pesticides bags sampling was done in two stages (see figure 5.1).

The initial stage selected various sub-populations of the wastes based on physical characteristics and location of the wastes in the warehouse. The various sub-populations were sampled using a manual percussion auger system. The manual percussion auger had a diameter of 20 mm. Material collected with the auger was bagged in zip-lock bags for each individual point. A total of 129 points were sampled till a maximum depth of 4 m below the surface of the wastes. All sampling points were indicated with spray paint and their position was measured relative to the individual warehouse walls. Appendix 4 has an overview of the exact sampling locations.

On-site the collected materials were reviewed. Where no distinct differences existed between sampled materials, 5 sampling points were used to make one composite sample of points located close to one another. Samples that were distinctly different were analysed in composite samples with similar materials. The latter was done to ensure no other wastes present at the site that are not POP-pesticides were missed. In total 27 composite samples were made. An overview of the composite samples is presented in appendix 3.

The composite samples were transferred to MOST Laboratories in Istanbul to dissolve the sample materials in an acetone-water solution. The protocol for the MOST Laboratories is given in Section 4.2.5 of the in Inception Report (Tauw Reference R002-1239389GMC-los-V02-NL). Dissolved samples were shipped to AL-West laboratories in the Netherlands for GC-MS screening for non-volatile components.

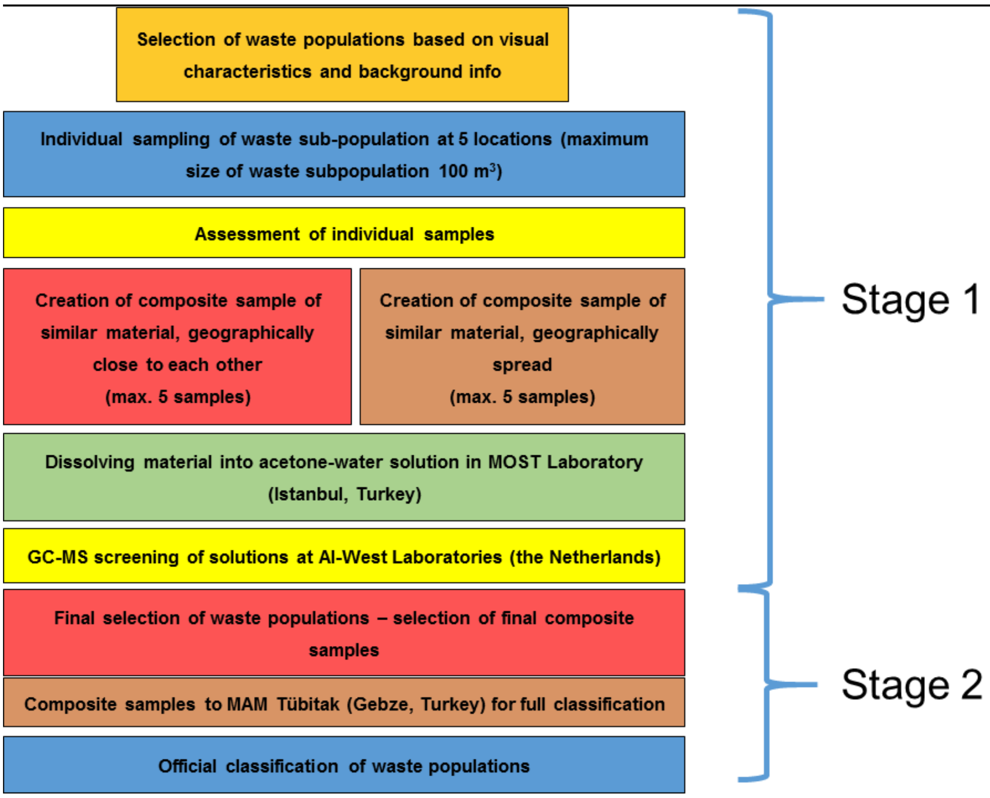

Figure 5.1 Sampling procedure POP-pesticides bags in two stages

The analysis from Al-West laboratories provided the necessary input to determine the final waste populations in the second stage.

For the second stage 9 representative waste populations were chosen for full HCH and DDT analysis by MAM Tübitak to establish the final waste quality and classification.

5.3.2 Quantity estimates for waste in bags

To assess the total quantity of bags with POP-pesticides present in the warehouses 1, 4, 5 and 6 a 3D map of the warehouse interior using a laser scanner (Faro 330 3D Lazer) with two base station (Sokkia 530RK) was made. Laser scanning was executed by EMA Harita survey company under supervision of Tauw.

The laser scanner made a 3D map of the warehouses with an accuracy of 2 cm.

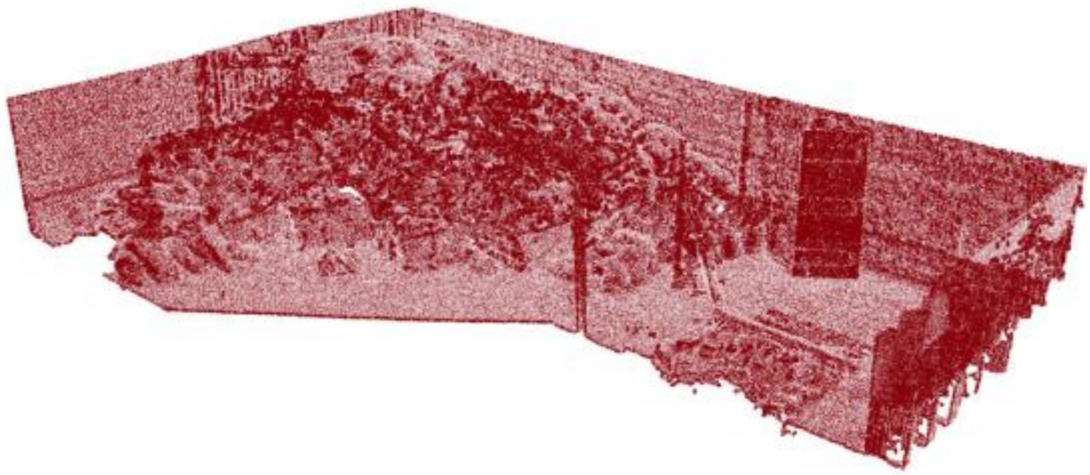

Figure 5.2 3D scan of wastes in warehouse 1

5.3.3 Drums

Final methodology for drum inventory slightly differs from the methodology as presented in the inception report because of safety issues. All full drums on site have been individually checked. Drums have been classified according to their:

- Contents, drums are:
  - Empty
  - Completely or partly filled with leaked rain water
  - Completely or partly filled POP-pesticides (in bags)Completely or partly filled with other waste severely impacted by POP-pesticides usually empty packaging, wasted wooden pallet and/or floor sweepings
- Type:
  - Metal
  - HDPE/PE
  - Other
- Size:
  - 200 litres
  - Other

The full drums have been weighed individually or per 4 drums on a pallet and all are individually numbered (see figure 5.3). Appendix 5 has an overview of all drums. All weighed and numbered drums have been moved to a new location and a map with the drum locations was drafted (appendix 6).

Drums in very poor state have been manually repacked in empty drums in better condition present at the site. These severely damaged drums have been added to scrap metal pile on site. Drums are in such a poor condition that none of them is suitable for re-use or future transport.

Where necessary, pallets have been replaced to allow for more appropriate stacking. For the movement of the drums a Komatsu electric forklift with built-in scale was used. The Komatsu forklift scale was used to assess the weight of the drums. Accuracy of the scale is estimated at ± 20 %.


Figure 5.3 Banding of drums (left). Individual weighing and transport of drums (right)

The drums have not been colour coded as this did not provide added benefits for the inventory. Some of the drums have been banded for safety during weighing and inventory.

Empty drums have been collected by type and counted (see figure 5.4). For the empty drums their specific weight has been recorded to allow for calculation of total weight.

Figure 5.4 Empte PP drums (left). Empty steel drums (right)

5.3.4 Floors

To assess the quantity of POP-pesticides present on the warehouse floors and to establish the impact of the POP-pesticides on the concrete floors, the following methodology has been used:

- At 8 locations spread out over warehouses 1 – 5 a representative m^2 square was spray painted on the floor (see figure 5.5). All loose material within the m^2 was collected and weighed to provide an impression of the total quantity of material present
- Cracks in the floor have been cleaned and their depth checked at indicative locations
- At three locations a concrete core was taken from the floor
- At two locations the concrete floor support layer beneath the floor was assessed by manually drilling till the original soil

Concrete cores were taken using a concrete coring driller with a 10 cm diameter (see figure 5.5). Concrete cores were visually checked on-site and divided in distinctive parts with a circular concrete cutter. The top parts of the concrete core (presumably the most impacted) and the underlying layer (presumably clean) were crushed outside the warehouse in a metal basin and send the MOST Laboratories for analysis on DDT and HCH and their isomers. A total of 6 samples were sent to MOST laboratories for analysis on HCH and DDT.

After concrete coring, at two locations, using an Edelman hand auger the support layer for the concrete floor was checked. Manual drills were made through the support layer till maximum 1.2 m below the floor surface. Three samples were taken and analysed for DDT and HCH, one sample was taken and analysed for Polycyclic Aromatic hydrocarbons (PAH), Total Petroleum Hydrocarbons (TPH, C10-C40) and Heavy Metals (Cu, Pb, Zn, Cd, Cr, Ni, As, Co, Hg) at MOST Laboratories in Istanbul. Holes left after concrete coring have been filled with cement.

Figure 5.5 Weight of materials on the floors (left) Concrete coring (rigth)

5.3.5 Walls

To assess the impact of the walls by POP-pesticides a total of 6 building blocks have been removed from the North-west wall of warehouse 4. Blocks were removed from the wall using a Makita percussion drill with flat head (see figure 5.6). The blocks were packed in plastic inside the warehouse and transferred outside for processing (see figure 5.6).

Outside the warehouse the blocks were crushed in a metal basin to obtain a granular structure and transferred to MOST Laboratories for analysis on DDT, HCH and their isomers. A total of 6 samples were shipped to MOST Laboratories for analysis.
Holes in the walls have been closed with new lightweight building blocks and polyurethane foam for airtightness.

Figure 5.6 Collection of building blocks (left) Outside processing of blocks prior to transfer to laboratory (rigth)

5.3.6 Other materials

During the fieldwork it became clear that large quantities of packaging wastes were present in warehouses 4 and 5. To get an indicative impression of the specific weight of this material the material was collected in 200L drums at three separate locations (see figure 5.7). For locations where the wastes were more compacted 40 % more material was collected to compensate for the loosening of the materials during the transfer to the drum for weighing. The PPE wastes next to the entrance (see figure 5.7) were assessed by weighing individual bags.

Figure 5.7 Weighing of packaging wastes (left) PPE wastes next to entrance (right)

A sample was taken of the roof sheets to establish if contains asbestos. The sample was send to AL-West laboratories (the Netherlands) for analysis.

6 Site survey

6.1 Background

The Initial Conceptual Site Model (ICSM) in the Inception Report (Tauw Reference R002-1239389GMC-los-V02-NL) provided an overview of the available site information and information gaps. The following paragraphs will address these gaps and in chapter 9 an updated Conceptual Site Model (CSM) and the residual site knowledge gaps analysis is given. Appendix 18 provides a day to day log book of the activities performed at the site.

6.2 Health and safety

Health and Safety procedures as prescribed in the Inception Report were implemented and consistently followed. At the start of the field works a Task Based Risk Analysis was made (see appendix 2). Staff working on the site signed in and off with the respective site clearances. No accidents or injuries occurred during the fieldworks.

6.3 Sampling and assessment of wastes

6.3.1 Bags

Bag sampling was executed between the 2nd and the 7th of November 2016. Each individual sample got a sample ID in the field. Appendix 3 and 4 provide all details and a map with the exact individual sampling locations. In the field composite samples of each waste subpopulation were made. The table 6.1 provides an overview of the composite waste samples. Each composite sample has an unique sample ID. The composite sample ID has a 'W' with a number standing for the Warehouse number, a number giving the sample number and a 'D' with a number for the depth the individual samples are taken. The sample with the ID: **W4-1 D1** is the first composite sample taken from Warehouse 4 at a depth of max 1 meter below the waste surface.

Table 6.1 Sampling of bags

Waste sub population	Sample ID	Sample code	Depth (m-surface)	Sampling points	Location of sample	Physical description
2	W4-1 D1	771876	Variable	1, 2, 4, 5	First waste pile on west side of Warehouse 4	White, hard powder and chunks in canvas and plastic bags
3	W4-2 D1	771880	Variable	6 – 10	Stacked wastes in NW corner of warehouse 4	Light yellow powder in canvas bags

4	W4-3 D1	771881	Variable	11 – 13, 15	West part of warehouse 4	White, hard powder and chunks in canvas and plastic bags
5	W4-4 D1	771882	Variable	16 – 20	SE part of warehouse 4	White, hard powder and chunks in canvas and plastic bags
6	W5-1 D1	771883	Variable	21 – 25	NE corner warehouse 5	White, hard powder and chunks in canvas and plastic bags
7	W5-2 D1	771884	Variable	26, 27, 29, 30	SE corner warehouse 5	White, hard powder and chunks in canvas and plastic bags
8	W5-3 D1	771885	Variable	31 – 35	NW corner warehouse 5	White, hard powder and chunks in canvas and plastic bags
9	W5-4 D1	771886	Variable	36 – 40	Mount in SW part of warehouse 5	White, hard powder and chunks in canvas and plastic bags
10	W5-5 D1	771887	Variable	41 – 45	SW corner warehouse 5	White, hard powder and chunks in canvas and plastic bags
11	W6-1 D1	771888	0 – 1 m	46 – 50	SW corner warehouse 6	White, hard powder and chunks in canvas and plastic bags
12	W6-2 D1	771889	0 – 1 m	51, 53, 55	Southern edge warehouse 6	White, hard powder and chunks in canvas and plastic bags
13	W6-3 D1	771895	0 – 1 m	56 – 60	SE corner warehouse 6	White, hard powder and chunks in canvas and plastic bags
14	W6-4 D1	771896	0 – 1 m	63 – 65	NE corner warehouse 6	Yellow powdery materials
15	W6-5 D1	771897	0 – 1 m	67 – 70	Centre warehouse 6	White, hard powder and chunks in canvas and plastic bags
16	W6-6 D1	771898	0 – 1 m	71, 73, 75	NW corner warehouse 6	White, hard powder and chunks in canvas and plastic bags

1	W1-1 D1	771899	Variable	77 – 81	NE corner warehouse 1	Yellow powdery material
17	W6-8 D2	771900	1 – 2 m	201 – 205	NW corner warehouse 6	White, hard powder and chunks in canvas and plastic bags
18	W6-9 D2	771901	1 – 2 m	206 – 210	NE corner warehouse 6	White, hard powder and chunks in canvas and plastic bags
19	W6-10 D2	771902	1 – 2 m	211 – 215	SW corner warehouse 6	White, hard powder and chunks in canvas and plastic bags
20	W6-11 D2	771903	1 – 2 m	216 – 220	Centre east part warehouse 6	White, hard powder and chunks in canvas and plastic bags
26	WT-1 D1	771904	0 – 1 m	3, 14, 55, 66, 72	Various	Yellow powdery material
27	WT-2 D1	771918	0 – 1 m	27, 52, 74	Various	Yellow powdery material
21	W6-12 D3	771922	2 – 3 m	221, 223 – 225	Centre east side warehouse 6	White, hard powder and chunks in canvas and plastic bags
22	W6-13 D3	771930	2 – 3 m	226 – 230	Centre warehouse 6	White, hard powder and chunks in canvas and plastic bags
23	W6-14 D3	771931	2 – 3 m	231 – 235	NW part warehouse 6	White, hard powder and chunks in canvas and plastic bags
24	W6-15 D3	771932	2 – 3 m	236 – 238, 240	SW part warehouse 6	White, hard powder and chunks in canvas and plastic bags
25	W6-16 D4	771933	3 – 4 m	241 – 244	Centre line warehouse 6	White, hard powder and chunks in canvas and plastic bags

Field tests were done to get an accurate impression of the specific weight of the POP-pesticides wastes at the site (see table 6.2). A subdivision was made between three POP wastes types:

1. POP pesticides that are present in hard blocks
2. Dry powdery material
3. Wet material

Table 6.2 Specific weight of POP pesticides

Material	State	Description	Estimated specific weight (kg/ m^3)
White hard blocks	Dry	White hard blocks, present in 50L canvas/plastic bags. Blocks are cracked and look like the use to be wet. Very hard material	802 kg/m^3
White powder	Dry	White powdery material present in 50L canvas/plastic bags.	852 kg/m^3
White powder	Saturated	White powdery or clayes material. Completely saturated present in 50L canvas/plastic bags	1,447 kg/m^3

The specific weight of the dry powdery material closely resembles specific weights provided by Merkim (833 kg/m^3). Specific weight of the bags with hard blocks is slightly lower, most likely due to spaces between the POP pesticide wastes blocks. Water saturated pesticides (paste form) have a significantly higher specific weight.

Labels found inside DDT containing bags (see figure 7.1) show that the specific weight of DDT containing bags is 1,006 kg/m^3. For calculation purposes the following specific weights will be used.

Table 6.3 Specific weight of POP pesticides

Material	State	Description	Estimated specific weight	Variability
White blocks	Dry	HCH production wastes	833 kg/m^3	± 5 %
White or light yellow powder	Dry	HCH end product	833 kg/m^3	± 5 %
White powder	Saturated	HCH production wastes	1,447 kg/m^3	+ 5 to - 40 %
White or light yellow powder	Saturated	HCH end product	1,447 kg/m^3	+ 5 to - 40 %*
Yellow powder	Dry	DDT (10 %)	1,006 kg/m^3	± 5 %
Yellow powder	Saturated	DDT (10 %)	1,447 kg/m^3	+ 5 to - 40 %

The specific weight of the saturated POP pesticides should be seen as a near maximum weight, depending on the level of saturation these materials can be much lighter, hence the skewed variability.

6.3.2 Drums

The drum inventory at the site was executed between the 7th and 16th of November. A total of 1,632 drums have been counted and weighed at the site. Table 6.4 provides an overview of the inventoried drums.

Table 6.4 Drum inventory

Drum	Steel 200L	Steel 125L	PE200L	HDPE175L	HDPE150L	HDPE 65L
Empty	672	13	43	11	65	2
Water*	28				1	
POP pesticides	692					73
POP mixed with water	7					
POP mixed with other materials	6					
Other materials	18				1	
Total	**1,423**	**13**	**43**	**11**	**67**	**75**

*** Water contents of drums as of November 2016, due to leaking roof this quantity is likely to increase**

Each drum type (see figure 6.1) has been weighed to establish the specific waste of the drums. The drum weight varies slightly with the type of drum. Especially for the metal drums, weights can differ as not all drums have been cleaned completely and the thickness of the drum walls varies slightly. Table 6.5 provides an overview of the specific weight of the various drums.

Table 6.5 Specific weights empty drums

Drum	Drum size	Weight (kg)	Number in figure 6.1
Empty blue PE drum (1H2/Y256/S/12/D/BAM 8632 M10 1720)	200 L	5.8	1
Empty blue PE drum (1H2/X232/S/08/D/BAM 8632 8435 Schuetz) with no cover	200 L	5.1	2
Empty light blue open head HDPE drum with no cover	175 L	7.7	3
Empty light blue closed HDPE drum	150 L	7.8	4
Empty blue open head HDPE drum (SAVA drum)	65 L	2.2	5

Drum	Drum size	Weight (kg)	Number in figure 6.1
Empty open head steel drum of 200 litres with no cover	200 L	13.2	6
Empty light blue open head steel drum of 125 litres	125 L	8.6	7
Steel drum cover for open head steel drum of 200 litres	n.a.	2.6	n.a.

Figure 6.1 Drums types present at the site

6.4 Sampling and assessment of building

The flowing paragraphs describe the sampling and assessment of the impact of the POP-pesticides on the building materials of the walls and the floors of the warehouse.

6.4.1 Walls (building blocks)

Walls were sampled on the 11th and 12th of November 2016. Table 6.6 provides the details of the wall samples to assess the environmental quality of the building blocks. Each wall sample has an unique sample ID. The wall sample ID has a 'W' with a number standing for the Warehouse number, a letter indication the direction of the wall and a 'W' for Wall with sample number. The sample with the ID: W4NW1 is the first wall sample taken from Warehouse 4 from the northern wall.

Table 6.6 Details of the warehouse wall samples

Ware-house	Sample ID	Sample location (m from East wall)	Sample height (m above floor level)	Description	Sample processing
4	W4NW1	8.6	1.9	Visually clean	None – whole block crushed and analyzed for DDT, HCH
4	W4NW2	7.6	1.9	Visually clean	Inner areas hoovered – crushed and whole block analyzed for DDT, HCH
4	W4NW3	6.5	1.9	Visually clean	Inner areas cut-off – outer part of block crushed and analyzed for DDT, HCH
4	W4NW4	0.9	1.55	Visually impacted by white substance	None – whole block crushed and analyzed for DDT, HCH
4	W4NW5	1.8	1.35	Visually impacted by white substance	Inner areas hoovered – crushed and whole block analyzed for DDT, HCH
4	W4NW6	3.3	1.35	Visually impacted by white substance	Inner areas cut-off – outer part of block crushed and analyzed for DDT, HCH

6.4.2 Floor waste

The waste (dust and cemented POP-pesticides) on the Warehouse floors was sampled on the 11th and 12th of November 2016. Table 6.7 gives an overview of the sampled floor waste. Each floor waste sample has an unique sample ID. The floor waste sample ID has a ‘W’ with a number standing for the Warehouse number, a ‘F’ for Floor waste and a sample number. The floor waste sample with the ID: W4-F1 is the first floor waste sample taken from Warehouse 4.

Table 6.7 Details of the floor waste samples

Ware-house	Sample ID	Sample location in meters*	Description	Weight / m^2
4	W4-F1	2.5 E 10.4 N	Limited material, completely stuck to surface	1.6 kg
4	W4-F2	7.6 E 7.1 N	Limited material, change between concrete and pesticides difficult to tell	1.6 kg
5	W5-F3	9.7 E 5.8 N	Floor with pesticide cake – wet. Underlying floor clearly impacted by dark brown colour	6.5 kg
3	W3-F4	3.6 S 18.8 E	Outside main tracks, only dust	0.3 kg
3	W3-F5	14.5 E 15.9 S	In track towards warehouse 2, mostly dust with limited hard material	7.2 kg
3	W3-F6	5.9 E 5.9 S	Dust with thin layer of hard material	13.0 kg
2	W2-F7	8.5 E 3.0 S	Thick hard layer of several cm white / yellow material	21.35 kg
2	W2-F8	9.1 E 11.8 S	Very dusty floor but not really hard layers	6.0 kg
1	W1-F9	4.5 W 4.0 N	Black dust only	3.1 kg

* Position relative to warehouse walls. E = East, W = West, N = North, S = South

Three concrete cores were taken from the floors inside the warehouse by Intergeo Turkey on the 11th of November 2016. Table 6.8 provides information on these concrete cores. Each concrete core has an unique ID. The concrete core ID has a ‘W’ with a number standing for the Warehouse number, a ‘F’ for Floor and a sample number. The core with the ID: W2-F7 is the concrete core at the same location as the W2-7 floor waste sample in Warehouse 2.

Table 6.8 Details of the concrete cores from the warehouse floors

Ware-house	Sample ID	Thickness of concrete floor (cm)	Description of concrete	Samples
2	W2-F7	20	0 – 2 cm thick solid top layer with fine gravel 2 – 5 cm solid layer with coarse gravel 5 – 20 cm very porous concrete, poor finishing at bottom	W2-F7 0 – 2 cm W2-F7 2 – 5 cm
3	W3-F6	17	0 – 2 cm solid top layer with small gravels. 2 – 8 cm solid second layer with medium sized gravels 8 – 17 cm large gravels mixed with concrete – poor finishing but limited porosity	W3-F6 0 – 2 cm W3-F6 3 – 8 cm
5	W5-F3	27	0 – 1 cm solid top layer with small gravels. 1 – 5 cm solid layer with small gravel 5 – 27 cm solid but slightly porous layer with medium gravels	W3-F6 0 – 1 cm W3-F6 1 – 5 cm

6.4.3 Other materials

The specific weight of empty packaging material in warehouses 4 and 5 was assessed on the 13th of November. Table 6.9 provides all information on the samples taken from the empty packaging.

Each waste sample has an unique ID. The waste sample ID starts with Loc (location) and a number.

Table 6.9 Details of the empty packaging wastes samples in warehouse 4 and 5

Ware-house	Sample ID	Sample location*	Description	Total sample weight	Estimated specific weight
4	Loc. 1	9.2 W 10.1 N	Paper and plastic wastes strongly compacted. Below the wastes (after 50 cm) pesticides were present. Wastes completely covered in pesticide dust.	152 kg	125 – 175 kg/m^3
4	Loc. 2	2.6 W 11.6 N	Paper and plastic wastes on concrete floor no compaction. Wastes completely covered in pesticide dust.	85 kg	50 – 100 kg/m^3
5	Loc. 3	4.5 W 9.2 N	Paper and plastic wastes inside big bag. Outside of big bag fully contaminated with POP pesticides. Contents of bag not impacted by POP dust	46 kg	25 – 75 kg/m^3

* Position relative to warehouse walls. E = East, W = West, N = North, S = South

7 Site analysis

7.1 POP-pesticides wastes

7.1.1 Indicative waste analysis Al-West

Table 7.1 provides an overview of the analytical results of the waste materials, appendix 12 contains the analytical certificates. This assessment was an indicative analysis to establish various waste populations on the site. Concentrations are given in µg/l as the wastes have been dissolved. They do not represent the total concentration of the HCH-isomers but rather provide an insight in the type of material.

Table 7.1 Indicative waste samples Al-West Laboratories (µg/l)

Sample location	Sample code	α-HCH	β-HCH	γ-HCH	δ-HCH	2,4'-DDT	4,4'-DDT	4,4'-DDD	Indicative waste type
W4-1 D1	771876	2,300	35	380	125	-	-	-	HCH production wastes
W4-2 D1	771880	130	55	200	800	-	-	-	Technical HCH
W4-3 D1	771881	2,600	400	75	25	-	-	-	HCH production wastes
W4-4 D1	771882	2,750	370	125	135	-	-	-	HCH production wastes
W5-1 D1	771883	2,300	400	160	60	-	-	-	HCH production wastes
W5-2 D1	771884	2,400	350	110	35	-	-	-	HCH production wastes
W5-3 D1	771885	2,250	350	85	70	-	-	-	HCH production wastes
W5-4 D1	771886	3,000	420	130	60	-	-	-	HCH production wastes
W5-5 D1	771887	2,400	400	110	40	-	-	-	HCH production wastes
W6-1 D1	771888	2,100	350	85	55	-	-	-	HCH production wastes
W6-2 D1	771889	2,750	470	370	120	-	-	-	HCH production wastes
W6-3 D1	771895	2,700	450	200	100	-	-	-	HCH production wastes
W6-4 D1	771896	-	-	-	-	65	215	35	DDT end product (likely Korcide 10)
W6-5 D1	771897	2,100	260	70	15	-	-	-	HCH production wastes
W6-6 D1	771898	2,000	420	65	40	-	-	-	HCH production wastes
W1-1 D1	771899	-	-	-	-	45	120	35	DDT end product (likely Korcide 10)
W6-8 D2	771900	1,400	270	250	130	-	-	-	HCH production wastes
W6-9 D2	771901	1,200	175	50	35	-	-	-	HCH production wastes

W6-10 D2	771902	1,300	320	110	20	-	-	-	HCH production wastes
W6-11 D2	771903	1,100	150	70	50	-	-	-	HCH production wastes
WT-1 D1	771904	680	110	440	440	-	-	-	Technical HCH with HCH production wastes
WT-2 D1	771918	1,500	240	350	500	-	-	-	Technical HCH mixed with HCH production wastes
W6-12 D3	771922	1,300	175	70	18	-	-	-	HCH production wastes
W6-13 D3	771930	1,150	170	45	16	-	-	-	HCH production wastes
W6-14 D3	771931	1,050	160	80	60	-	-	-	HCH production wastes
W6-15 D3	771932	1,400	230	90	50	-	-	-	HCH production wastes
W6-16 D4	771933	1,500	260	75	35	-	-	-	HCH production wastes

The indicative analytical results prove that all wastes are POP-pesticides. In most cases wastes are HCH waste products with a purity of approximately 40 % (i.e. 40 % of the material is POP-pesticides, 60 % is inorganic mixture). Limited quantities of Technical HCH (samples W4-2 D1, WT1 D1 and WT2 D1) and DDT end products (samples W1-1 D1 and W6-4 D1) have been found. The DDT end product is likely called 'Korcide 10' as labels of this material have been found inside some of the bags (see figure 7.1).

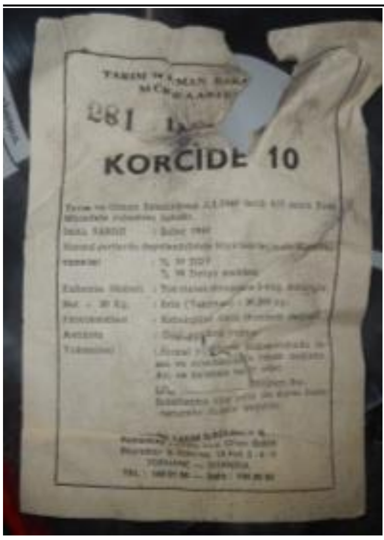

Figure 7.1 Labels found on DDT bags

7.1.2 Final waste quality sampling MAM Tübitak

Initial, indicative waste sampling characterized all wastes as POP-pesticides (paragraph 7.1.1). For formal classification of the wastes 9 samples were sent to the MAM Tübitak laboratory in Gebze Turkey. Table 7.2 contains and overview of the analytical results, appendix 17 contains the analytical certificates.

Table 7.2 POP pesticide concentration in waste samples in mg/kg – MAM Tübitak december 2016

Warehouse	1	4		5	6				Mixed
Depth (m – surface)	0 – 1	0 – 1	0 – 1	0 – 1	0 - 1	0 - 1	1 - 2	2 - 3	0 - 1
Code	W1-D1	W4-2 D1	W4-4 D1	W5-4 D1	W6-2 D1	W6-4 D1	W6-10 D2	W6-14 D3	WT-1 D1
α-HCH	633	29,904	123,544	10,157	188,218	1,575	56,210	123,924	16,155
β-HCH	109	9,858	9,119	836	26,035	131	2,855	7,454	2,157
γ-HCH	467	35,465	4,967	592	55,311	99	6,614	18,756	22,150
δ-HCH	768	40,863	2,086	110	35,231	98	8,518	18,888	33,306
4,4’-DDE	21	<5	<5	<5	<5	143	<5	<5	<5
4,4’-DDD	58	<5	<5	<5	<5	340	<5	<5	11
4,4’-DDT	7,774	48	<5	<5	17	62,725	6	16	596
Total	0.98%	11.6%	13.9%	1.2%	30.5%	6.5%	7.4%	16.9%	7.4%

As the waste samples showed a great variability and were not consistent with results found in 2013 (table 4.5) it was decided to send two samples to MOST laboratories for cross-referencing, results are presented in table 7.3.

Table 7.3 POP pesticide concentration in waste samples in mg/kg – MOST Laboratories december 2016

Warehouse	**1**	**5**
Depth (m – surface)	**0 – 1**	**0 – 1**
Code	**W1-D1**	**W5-4 D1**
α-HCH	64.85	>200,000
β-HCH	6.38	98,908
γ-HCH	18.16	16,943
δ-HCH	9.53	4,063
4,4'-DDE	846.77	0.391
4,4'-DDD	4,058.17	5.588
4,4'-DDT	61,191.56	20.941
Total	6.62%	>31.9%

To verify the marked difference in POP pesticides concentrations between the MOST Laboratories and MAM Tübitak results the initial samples were re-analysed by MAM Tübitak (table 7.4).

Table 7.4 POP pesticide concentration in waste samples in mg/kg – MAM Tübitak January 2017

Warehouse	**1**	**4**		**5**	**6**				**Mixed**
Depth (m – surface)	**0 – 1**	**0 – 1**	**0 – 1**	**0 – 1**	**0 - 1**	**0 - 1**	**1 - 2**	**2 - 3**	**0 - 1**
Code	**W1-D1**	**W4-2 D1**	**W4-4 D1**	**W5-4 D1**	**W6-2 D1**	**W6-4 D1**	**W6-10 D2**	**W6-14 D3**	**WT-1 D1**
α-HCH	<50	12,926	353,913	47,897	330,693	84	60,696	119,139	52,300
β-HCH	<50	4,217	8,487	4,490	8,735	<50	1,306	2,457	1,033
γ-HCH	<50	20,068	11,516	4,270	231	<50	5,000	13,851	14,886
δ-HCH	<50	79,148	5,126	1,906	3,308	<50	4,970	16,525	19,663
4,4'-DDE	<50	<50	<50	<50	<50	179	<50	<50	<50
4,4'-DDD	2553	<50	<50	<50	<50	433	<50	<50	1,091
4,4'-DDT	11,272	<50	<50	<50	<50	65,137	81	803	4,668
Total	1.4%	11.6%	37.9%	5.8%	34.3%	6.6%	7.2%	15.3%	9.4%

The variability between POP pesticides concentrations remained after the re-analysis of the samples. However, as all wastes remain above the hazardous wastes limit values the variability does not affect the classification of the wastes. For future incineration purposes new sampling and analysis of the wastes should provide more accurate estimates of Chlorine contents.

7.2 Quality of Building materials (MOST Laboratories)

The following paragraphs contain the results of the wall, floor and subsurface sampling at the site. As a cautionary remark it is emphasized that, due to the high concentrations of pesticide dust inside the warehouse (see figure 7.2) and despite our precautionary measures and caution during the sampling, all samples have been impacted by pesticide dust to a certain degree. In addition cross-contamination due to contaminated laboratory equipment cannot be excluded either.

Figure 7.2 Pesticide dust reflecting on the camera flash

7.2.1 Concrete cores of the floors

Table 7.5 provides the analytical results of the concrete core samples and the quality of the material below the concrete floor, appendix 14 contains the analytical certificates.

Table 7.5 Concrete cores DDT and HCH concentration in mg/kg

Component	Warehouse 2 W2-F7		Warehouse 3 W3-F6		Warehouse 5 – W5-F3	
	0 – 2 cm	2 – 5 cm	0 – 2 cm	3 – 8 cm	0 – 1 cm	2 – 5 cm
α-HCH	9,358.10	49.05	113.12	93.34	75.99	160.44
β-HCH	1,555.28	7.57	32.49	18.87	13.33	20.24
γ-HCH	4,264.26	2.93	104.46	1.55	6.35	3.97
δ-HCH	3,155.01	4.29	80.53	1.06	3.01	0.95
4,4'-DDE	0.44	<0.1	1.78	<0.1	0.35	<0.1
4,4'-DDD	0.58	<0.1	3.38	<0.1	7.27	<0.1
4,4'-DDT	28.84	<0.1	64.31	0.16	6.47	0.11
Total	18,362.51	63.84	400.07	114.98	112.77	185.71

The top of the concrete floor at warehouse 2 (sample location W2-F7) is heavily impacted by POP-pesticides. Mostly likely some thin layers of pure pesticides have been embedded in the concrete and despite vacuum cleaning and chiselling the floor at this location, not all POP pesticides could be removed. The second layer of this concrete (2 – 5 cm below surface) shows only limited impact by POP-pesticides, most of which can likely be attributed to contamination with pesticide dust during sampling or cross-contamination at the laboratory.

Concentrations of POP-pesticides of the concrete cores from Warehouse 3 (sample location W3-F6) are markedly lower than in Warehouse 2. The top 2 cm still contains a significant amount of pesticides but further down concentrations drop quickly.

Concentrations in the top cm at Warehouse 5 (sampling point W5-F3) are only about twice the background values despite the location being exposed to wet pesticides for prolonged periods. The second layer (2-5 cm) at this site contains higher concentrations of pesticides. The source of the POP-pesticides in this layer is not completely clear. It can be either transfer of POP-pesticides downwards during coring of the concrete or present inside the material itself due to prolonged infiltration of water into the concrete floor.

7.2.2 Subsurface beneath warehouse floors

Table 7.6 contains the results of the material underneath the concrete warehouse floors, appendix 14 contains the analytical certificates.

Table 7.6 Subsurface DDT and HCH concentration in mg/kg

Component	Warehouse 2 W2-F7 0.6 – 0.9 m	Warehouse 5 – W5-F3 0.6 – 0.9 m	Warehouse 5 – W5-F3 1.0 – 1.2 m
α-HCH	69.25	471.74	143.16
β-HCH	13.26	82.21	18.97
γ-HCH	7.59	31.46	1.71
δ-HCH	3.11	26.26	2.92
4,4'-DDE	5.78	4.89	10.51
4,4'-DDD	25.57	73.30	138.15
4,4'-DDT	634.05	265.10	1,989.07
TPH		6,926.61	
Chrome (Cr)		134.46	
Cobalt (Co)		10.32	
Nickel (Ni)		66.37	
Copper (Cu)		47.39	
Zinc (Zn)		252.71	
Arsenic (As)		10.35	
Cadmium (Cd)		0.31	
Lead (Pb)		144.98	
Polycyclic Aromatic Hydrocarbons (total PAH-16 EPA)		17.46	
Total pesticides	758.61	954.96	2,304.49

In Warehouse 2 (sampling point W2-F7), the subsurface sample analyses results show high DDT concentrations. Since DDT was hardly present in the concrete itself it is most likely present in-situ rather than vertical transfer of DDT during the drilling of the concrete core.

In Warehouse 5 (sampling point W5-F3), the first layer beneath the concrete contains high concentrations of pesticides (both HCH and DDT) but also very high concentrations of TPH. Visually this layer was contaminated (black colour). All contaminants in this layer should be seen as originally contaminated fills. These fills were present before the concrete floor was constructed. The following layer, which is most likely the original soil (1.0 – 1.2 m –ground level), contains even higher concentrations of DDT which is likely to be also present before the concrete floor was constructed.

7.2.3 Walls

Table 7.7 provides the analytical results of the concrete building blocks, appendix 15 contains the analytical certificates.

Table 7.7 Building block DDT and HCH concentration in mg/kg

Component	W4-NW1 Clean – whole block	W4-NW2 Clean - Hoovered	W4-NW3 Clean- outside	W4-NW4 Dirty – whole block	W4-NW5 Dirty – hoovered	W4-NW6 Dirty – ouside
α-HCH	54.73	52.07	47.22	394.02	198.69	43.79
β-HCH	12.51	33.94	33.08	68.1	41.79	76.26
γ-HCH	6.04	52.28	7.77	54.63	43.96	19.07
δ-HCH	3.67	27.30	1.78	22.67	19.01	2.16
4,4'-DDE	<0.1	0.26	0.13	<0.1	<0.1	0.62
4,4'-DDD	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
4,4'-DDT	0.66	0.46	0.36	<0.1	0.16	0.40
Total	77.61	166.31	90.34	539.42	303.61	142.40

Building blocks samples W4-NW1, W4-NW2, W4-NW3 and W4-NW6 show POP-pesticide concentrations close to the background levels at the site. Building blocks W4-NW4 and W4-NW5 have significantly higher POP-pesticide concentrations.

Concentrations of POP-pesticides in the building blocks are considerably lower than what was previously reported by MAM Tübitak (see paragraph 4.3). However, despite efforts to reduce the POP pesticide impact on the blocks, concentrations remain above the 50 mg/kg thresholds levels for hazardous wastes.

7.3 Analytical results of other non-POP impacted materials

The roof consists of Asbestos Cement Corrugated sheets with 10-15 % of the material consisting of Chrysotile asbestos. Appendix 13 contains the analytical certificates.

8 Stock Inventory

8.1 POP wastes

This section provides an overview of all POP-pesticides wastes and wastes that contain a significant admixture of POP-pesticides (> 1 %).

8.1.1 POP wastes present in bags

Table 8.1 presents the total volume of wastes present inside bags in the various warehouses, appendix 7 has the calculations for waste quantities.

Table 8.1 Total weight of materials inside bags

Location	Waste sub population	State of wastes	Waste type	Volume (m^3)	Volume compensation*	Specific weight (kg/m^3)	Total weight (tons)
Warehouse 1	1	Dry - powder	DDT end product	91.03	0.90	1,006	82.42
Warehouse 4	2, 4, 5	Dry – powder or blocks	HCH production wastes	241.26	0.90	833	180.87
Warehouse 4	2, 4, 5	Wet – powder of blocks	HCH production wastes	26.81**	0.90	1,447	34.91
Warehouse 4	3	Dry - powder	Technical HCH	42.35	0.90	833	31.75
Warehouse 5	6 – 11	Dry – powder or blocks	HCH production wastes	483.13	0.90	833	362.20
Warehouse 5	6 – 11	Wet – powder of blocks	HCH production wastes	53.68**	0.90	1,447	69.91
Warehouse 6	11 – 25	Dry – powder or blocks	HCH production wastes	1,475.97	0.90	833	1,106.54
Warehouse 6	11 – 25	Wet – powder of blocks	HCH production wastes	163.99**	0.90	1,447	213.57
			Total	**2,578.22**			**2,082.17**

* Factor used to compensate for empty spaces between wastes. Lower than the 0.8 used in previous reports as measurement of the wastes has been done more accurately with 3D scanning.

** Assumption is made that 10 % of all wastes in warehouse 4, 5 and 6 are wet – exact quantity depends on season and weather

Waste sub-populations 26 and 27 have been included in the other waste population volumes as these materials are similar waste types and cannot be separated for volume estimation.

8.1.2 POP-pesticides wastes in drums

Warehouse 2 and (partially) warehouse 3 contain a large number of drums where POP-pesticides wastes are temporarily stored. The drums are in poor shape and unsuitable for storage or transport of the wastes. Table 8.2 contains an overview of the total quantity of wastes present inside the drums. The weight of the drums itself is given in paragraph 8.2.2.

Table 8.2 Total weight of materials inside drums

Waste inside drums	Number of drums	Total weight including drum	Weight of drums	Total weight excluding drums
POP-pesticides	778	107,360 kg	705 x 13.2 kg 73 x 2.2 kg	97,893 kg
Other wastes	18	770 kg	18 x 13.2 kg	532 kg
Total	**796**	**108.12 tons**		**98.43 tons**

8.1.3 POP wastes present on the warehouse floors

The warehouse floors are covered with cemented and wet POP-pesticides and dust to a bigger or lesser extent. These quantities are not included in the 3D measurements as they cannot be separated digitally from the original floors. Table 8.3 provides an overview of POP-pesticide quantities on the warehouse floors. In most cases the POP-pesticides will be mixed with cement dust and other materials.

Table 8.3 Total quantity of materials on warehouse floors

Warehouse	Surface area (m^2)	Quantity of material per m^2 (kg)	Total quantity of material
1	165	3.1	511.55 kg
1b	32.8	3.1	101.68 kg
1c	32.8	3.1	101.68 kg
2	400	13.75	5,500 kg
3	600	6.83	4,098 kg
4	600	1.6	960 kg
5	600	6.5	3,900 kg
6	600	6.5	3,900 kg
		Total	**19.01 tons**

8.1.4 Other POP-pesticides wastes present on site

Two pits are present at the site, The origin of the pit in Warehouse 1b is unknown. The pit in Warehouse 2 is the former pump basin of the adjacent groundwater well. Both pits have been filled with POP-pesticides mixed with concrete rubble. In addition the floor of the corridor between Warehouse 3 and 4 has heightened with POP-pesticides mixed with soil and asbestos. Table 8.4 contains an overview of the other POP-pesticides wastes and their contents.

Table 8.4 Total quantity of materials in the pits and between Warehouse 3 and 4

Warehouse	Surface area (m^2)	Depth (m)	Volume (m^3)	Contents of pit	Estimated specific weight (kg/m^3)	Total quantity of material
1b	9.36 m^2	1.0	9.36	POP-pesticides wastes mixed with building material	1,440*	13,478 kg
2	1.5	1.0	1.5	POP-pesticides wastes mixed with building material	1,000	1,500 kg
Corridor between 3-4	13.2	0.2	2.64	POP-pesticides wastes mixed with soil and asbestos containing materials	1,400	3,696 kg
Total			**13.5**		**Total**	**18.67 tons**

* Includes a 0.8 compensation for empty space between wastes

8.2 POP-pesticides impacted materials

This section provides an overview of the quantity and quality of all materials seriously impacted by POP-pesticides at the site (POP concentration > 50 ppm).

8.2.1 Quality and quantity of POP-pesticides impacted packaging materials

Large quantities of packaging materials are present in warehouse 4 and 5. The outer surfaces of these materials are completely covered by POP-pesticides dusts. An exact concentration of POP-pesticides, as part of the total weight of the materials, is difficult to establish.

Table 8.5 Total quantity of materials in the pits and between Warehouse 3 and 4

Warehouse	Volume (m^3)	Estimated specific weight (kg/m^3)*	Total quantity of material
4	156.36	112.5**	17,590.5 kg
5	67.18	50	3,359 kg
Total	**223.54**		**20.95 tons**

* Specific weight is already compensated for empty spaces between wastes

** Average specific weight from two sampling locations

8.2.2 Quality and quantity of POP-pesticides impacted drums

Drums used to store POP-pesticides are contaminated with POP dusts and POP residue. From historic information we can conclude that nearly all drums have been used for storage of POP pesticides at one time or another. This includes the drums that are currently empty. It should be noted that not all drums have been cleaned properly prior to use for POP pesticides storage. The general state of the drums is very poor and not suitable for storage or transport. The total weight of the drums (excluding their contents) is given in tables 8.5 and 8.6.

Table 8.6 Total weight PE drums

Drums	Number of drums	Specific weight (kg/pc)	Total weight
Empty blue PE drum (1H2/Y256/S/12/D/BAM 8632 M10 1720) – 200L	43	5.8	249.4 kg
Empty light blue closed HDPE drum – 175L	11	7.7	84.7 kg
Empty light blue closed HDPE drum weight – 150L	67	7.8	522.6 kg
Empty blue open head HDPE drum (SAVA drum) – 65L	75	2.2	165 kg
Total	**196**		**1.02 tons**

Table 8.7 Total weight metal drums

Drums	Number of drums	Specific weight (kg/pc)	Total weight
Empty open head steel drum of 200 litres with no cover	1,423	13.2	18,783.6 kg
Empty light blue open head steel drum of 125 litres	13	8.6	111.8 kg
Steel drum cover for open head steel drum of 200 litres*	1,423	2.6	3,699.8 kg
Total	**1,436**		**22.60 tons**

* Not all drums have a lid but various drums contain multiple lids and they have been found all along the warehouse. We assume that all drums originally contained lids and that they are still present in the warehouses

8.2.3 Quality and quantity of materials inside drums not being POP-pesticides

In addition to POP-pesticides and other wastes (usually POP-pesticides mixed with packaging materials or wooden pallet wastes) the drums also contain wastes that are not POP-pesticides. In most cases this is rainwater that has collected inside the drums that are positioned below holes in the roof. The rainwater inside the drums has mixed with POP-pesticides residue left behind as well as with residue of the original contents of the drums. The quantity of rainwater is variable, especially now drums have been moved to different locations during the inventory of the site. The total quantity of rainwater collected in the drums is likely to increase over time. In this report the contents of ‘empty’ drums are reported for administrative purposes only.

Table 8.8 Total weight of non-POP-pesticides materials inside drums

	Number of drums	Total weight including drum (kg)	Weight of drums (kg)	Total weight excluding drums
Water	29	4,790 kg	28 x 13.2 kg 1 x 7.8 kg	4,413 kg
Empty	48	986 kg	48 x 13.2 kg	352 kg
Total		**5.78 tons**		**4.77 tons**

8.2.4 Quality and quantity of POP-pesticides impacted floors

Based on the outcomes of the analysis of the concrete core samples (see paragraph 7.2.1) an estimate is made of the depth of the floors impacted by POP-pesticides. Table 8.8 presents an overview of the warehouse concrete floor quality and quantity.

Table 8.9 Contaminated concrete floor

Warehouse	Depth (m – surface)	Average POP-pesticides concentration (mg/kg)	Area m^2	Specific weight (kg/m^3)	Total weight (kg)
1	0.005	50 – 150	230.6	2,400	2,767.20
2	0.02	500 – 20,000	400	2,400	19,200
3	0.04	50 – 500	600	2,400	57,600
4	0.05	50 – 200	600	2,400	72,000
5	0.05	50 – 200	600	2,400	72,000
6	0.05	50 – 200	600	2,400	72,000
				Total	**295.57 tons**

For warehouse 1 a limited thickness of the concrete floor impacted by POP pesticides is assumed. The reason for this is that:

- Floor in warehouse 1 is the ‘cleanest’ floor from appearance
- The floor is the higher that the floor of Warehouse 2 rainwater leaked into the Warehouse 1 will therefore drain into Warehouse 2
- Limited quantity of dust is present on the floors
- Limited impact of floors by flooding

In Warehouse 2 a thin layer of the concrete floor (0 – 2 cm) is impacted, below 2 cm, according to analytical results, the floor is not or to a very limited extent impacted by POP-pesticides. Concentrations of POP-pesticides in the core floor samples from Warehouse 3 were high in the first 2 cm and dropped significantly in the following 5 cm. However since the concentrations were still above background levels in the 3 – 8 cm a final thickness of contaminated concrete of 0 – 4 cm is taken. For Warehouse 4, 5, and 6 the vertical penetration of the floors with POP-pesticides cannot be excluded. A conservative 5 cm of contaminated concrete thickness is assumed. Reasons for this are:

- No clear decrease in POP-pesticides concentrations in concrete core from Warehouse 5
- Prolonged exposure to large quantities of dust
- Prolonged exposure to water
- Large cracks present in the concrete floors (see figure 8.1)

Figure 8.1 Large cracks in site floors (warehouse 4)

For all warehouses the exact penetration depth can only be established by layered removal of the warehouse floors during the execution of the building demolition. Quantities given in table 8.8 are for budgeting and design purposes only.

8.2.5 Quality and quantity of POP-pesticides impacted wall

All warehouse walls are made out of concrete building blocks that weigh 15.9 kg (excluding cement, including cement estimated at 20 kg per block) have a length of 0.39 m, are 0.215 m wide and have a height of 0.19 m. Based on the analytical results and visual observations in the warehouses a distinction is made between two types of warehouse wall building blocks that have been impacted by POP pesticides to such a level that they classify as hazardous wastes?

- The first block (bottom – first layer) – not included in figure 8.2
- Contaminated blocks till the first reinforced concrete cross-beams (second layer – red in figure 8.2)

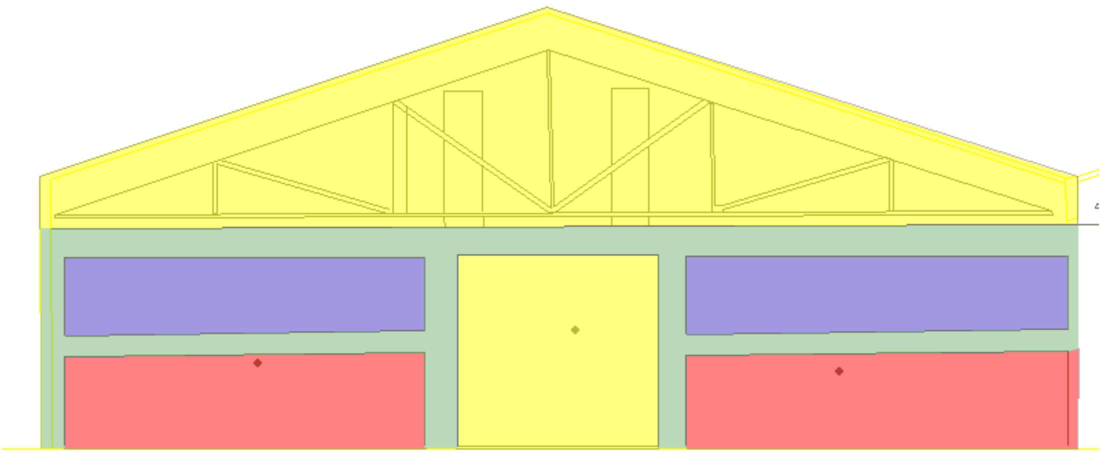

Figure 8.2 Schematic cross-section of building

The bottom or first layers of building blocks have been in contact with POP-pesticides during prolonged periods. Evidence of partial flooding of the warehouse is visible on these blocks epically in Warehouse 4 and 5. We therefor assume that these blocks have the highest POP-pesticides concentrations. Table 8.10 provides an overview of the quantities of these blocks present. Warehouse 1 is omitted from this list as no indication of serious flooding of this warehouse was present.

Table 8.10 Contaminated building blocks first layer, estimated POP concentration > 500 mg/kg

Warehouse	Heigth (m above floor level))	Approximate number of blocks	Specific weight (kg/pc*)	Total weight (kg)
2	0 – 0.20	146	20	2,920
3	0 – 0.20	195	20	3,900
4	0 – 0.20	159	20	3,180
5	0 – 0.20	92	20	1,840
6	0 – 0.20	169	20	3,380
			Total	**15.220 tons**

* Estimated average weight as total weight depends on quantity of cement used

The second layer of concrete blocks are those present below the first reinforced concrete beams of the skeletal building structure of the warehouse. This part of the wall is most severely impacted by the POP-pesticide dusts and stains can be seen on many of the wall surfaces. For calculation purposes we assume there is a strict division between the more severely impacted lower walls and the cleaner upper walls, in reality the border between the walls varies strongly and impacted and clean wall parts are present both above and below the first reinforced concrete beams.

Table 8.11 Contaminated building blocks second layer, estimated POP concentration > 50 mg/kg

Warehouse	Surface area (m^2)**	Volume m^3	Specific weight (kg/m^3*)	Total weight (kg) including bottom layer	Total weight (kg) excluding bottom layer
Short face of warehouses 4 – 6	132	28.38	1255	35,617	
West-East walls	452	97.18	1255	121,961	
North-South sides of other buildings	172.3	37.04	1255	46,485	
Residual (inner) walls	16.5	3.55	1255	4,455	
	772.8	**166.15**		208.518 tons	**193.298 tons**

* Estimated average weight as total weight depends on quantity of cement used

** Surface area based on calculation of 3D scanning, included the building blocks first layer

Non POP impacted building blocks and construction materials are briefly quantified in paragraph 8.3.

8.2.6 Quality and quantity of other POP impacted miscellaneous materials

Smaller quantities of POP-pesticides impacted materials are present at various locations inside the warehouse. Table 8.12 provides an overview.

Table 8.12 Contaminated building blocks second layer

Warehouse	Material description	Estimated average POP concentration (mg/kg)	Volume	Specific weight (kg/m³)	Total weight (kg)
3	Wooden pallet wastes	> 100	25 m^3	20	500 kg
3	Scrap metal from old drums	> 50	5 m^3	50	250 kg
3	PPE wastes	> 50	50 m^3	15	750 kg
All	Scrap metal from well and fixed machinery	> 50	3 m^3	300	900
All	Miscaleanous wastes	> 50	5 m^3	50	250 kg
				Total	**2.65 tons**

Mobile equipment (filling plant in warehouse 3, conveyor belt in Warehouse 4) have not been included in the mentioned quantities as they can be cleaned before transfer off-site.

8.3 Non POP impacted building materials

In this section a brief description of the quantities of Non POP impacted building materials is given (building materials that have POP concentrations below 50ppm). It considers the following five building materials:

- Clean building blocks above the first reinforced cross-beams (third layer, purple in figure 8.2)
- Reinforced concrete frame, green in figure 8.2
- Metal corrugated sheet finishing and doors, yellow in figure 8.2
- Miscellaneous materials including the roofs and metal support beams

Total quantity of clean concrete floor materials are omitted from this overview as the floor will not be removed as part of this project.

Table 8.13 Clean building blocks third layer, average POP concentration < 50 mg/kg

Warehouse	Surface area (m^2)**	Volume m^3	Specific weight (kg/m^3*)	Total weight (kg)
Short face of warehouses 4 – 6	104	22.36	1255	28,061
West-East walls	532	114.38	1255	143,547
North-South sides of other buildings	173	37.195	1255	46,679
Residual (inner) walls	15.9	3.418	1255	4,290
	824.9	**177.353**		**222.577 tons**

* Estimated average weight as total weight depends on quantity of cement used

** Surface area based on calculation of 3D scanning

Table 8.14 Concrete frame, average POP concentration < 50 mg/kg

Warehouse	Surface area (m^2)**	Volume m^{3*}	Specific weight (kg/m^3*)	Total weight (kg)
Short face of warehouses 4 – 6	119	35.7	2400	85,680
West-East walls	272	81.6	2400	195,840
North-South sides of other buildings	126.5	37.95	2400	91,080
Residual (inner) walls	8.6	2.58	2400	6,192
Inner columns warehouses 4 - 6	12 pc	12(0.2 * 0.8 * 4.66) = 8.94	2400	21,473
	824.9	**166.77**		**400,265 tons**

* Thickness as 0.3 m

** Surface area based on calculation of 3D scanning

Table 8.15 Metal closure at roof tops, average POP concentration < 50 mg/kg

Warehouse	Surface area (m^2)**	Specific weight (kg/m^2*)	Total weight (kg)
Short face of warehouses 4 – 6	330	7.5	2,475
West-East walls	0	7.5	0
North-South sides of other buildings	266	7.5	1,995
Residual (inner) walls	0	7.5	0
	596		**4.47 tons**

* Thickness assumed as 1.0 mm

** Surface area based on calculation of 3D scanning

In addition to the materials shown in the schematic cross-section of figure 8.2 building materials are also present on the site roof and the site roof support structure. The quantities of these are given in table 8.16.

Table 8.16 Miscallaneous materials, average POP concentration < 50 mg/kg

Other materials	Unit	Specific weight (kg/m^2*)	Total weight (kg)
Asbestos roof	3077 m^2**	16.5 kg/m^2	50,770
Roof support structure	19 metal beams	2,000 kg/pc	38,000
Miscallaneous materials	1	5,000 kg	5,000
	596		**93,770 tons**

* Specific weight based on 15 kg/m2 + 10% overlap

** Surface area based on calculation of 3D scanning

8.4 Materials Matrix

The following table contains a waste matrix describing all types of wastes found at the site that have been impacted by POP-pesticides.

Table 8.17 Total weight of materials inside drums

No.	Waste type	Volume (m^3/pc)*	Total weight (tons)	Material can be cleaned?	Volume / weight can be reduced?
	POP-pesticides wastes				
1	DDT end product***	91.03	82.42	No	No
2	Technical HCH***	42.35	31.75	No	No
3	HCH production wastes**	2444.84 + 796 drums	2,085.44	No	Yes Drying
4	POP wastes mixed with building material	13.5	18.67	No	Possibly Hand picking
	Subtotal	**2,591.72 + 796 drums**	**2,218.28**		
	Materials impacted by POP-pesticides				
5	Empty packaging	223.54	20.95	No	Possibly hand picking
6	PE drums	196	1.02	Yes	Yes Drum washing
7	Metal drums	1,436 pc	22.60	Yes	Yes Drum washing
8	Water in drums	29 pc	4.77	No	No
9	Floors		295.57	No	Yes Sampling and analyses
10	First layer concrete blocks	761 pc	15.22	No	No
11	Second layer concrete blocks	166.15	193.298	Possibly	Yes Handpicking
12	Wooden pellet wastes	25 m^3	0.5	No	No
13	Scrap metal	5 m^3	0.25	Yes	No
14	PPE wastes	50 m^3	0.75	No	No
15	Scrap metal from well and fixed machinery	3 m^3	0.9	Yes	No
16	Miscellaneous wastes	5 m^3	0.25	No	No
	Subtotal		556.078 tons		
	Clean building materials				
17	Third layer concrete blocks	177.353	222.577	Not applicable	Not applicable
18	Concrete frame	166.77	400.265	Not applicable	Not applicable

No.	Waste type	Volume (m^3/pc)*	Total weight (tons)	Material can be cleaned?	Volume / weight can be reduced?
19	Metal closure		4.47	Not applicable	Not applicable
20	Miscellaneous materials (roof and other building materials)		93.77	Not applicable	Not applicable
	Subtotal		721.082		
	Total		**3,495 tons**		

* Volume excluding compensation for empty spaces

** Includes materials repacked in drums and present on site floors

*** These are wastes that can be readily collected separately

Total quantity of POP-pesticides at the site is estimated at 2.218 tons.
The total quantity of POP-pesticide impacted building material is estimated at 556 tons.
Total quantity of clean building materials (excluding floor) is estimated at 721 tons.

8.5 Potential measures for reduction of waste

Table 8.17 provides an overview of the wastes and an indication of the possibility for the reduction of hazardous wastes via:

- Volume reduction
- Cleaning of wastes

The following section briefly describes for all wastes what options are available and if these are (economically viable).

For the wet POP pesticide wastes (part of waste sub population 2, 4, 5 and 6 – 25) a reduction of the total weight can be achieved by limiting the percolation of rainwater into the wastes. At present rainwater falling onto the roof flows directly on top of the wastes, eliminating this will, over time, dry the wastes and reduce the total weight.

For waste population 4 (POP wastes mixed with asbestos and soil) a limited reduction can be achieved by removing the large concrete blocks and asbestos sheets from the material via handpicking. Considering the limited quantity of this waste it is questionable if this is economically viable.

For waste population 5 (Empty packaging), waste quantities impacted by POP-pesticides can be reduced by manually opening large big bags present in Warehouse 5. The contents of these big bags have not been in contact with POP-pesticides dust and are as such not POP-pesticides wastes. Estimated waste reduction is about 10 %. Economic viability of this exercise depends on disposal costs for various waste types.

Drums and scrap metal at the site (waste populations 6, 7, 13 and 15) can be washed before scrapping. The need for this exercise depends on the acceptance criteria of (hazardous) waste landfills or iron smelters.

Total weight of the floors that need to be removed as hazardous wastes can most likely be reduced significantly by using a step-wise approach where floors are cleaned per 0.5 cm. Between removal of the floors the building should be cleaned of dusts to prevent re-contamination of exposed floors. Cracks in the floors should be followed separately to prevent POP-pesticides dust mixing with non-impacted floor surfaces.

The quantity of second layer of concrete blocks can be reduced by accurate selection of contaminated and non-contaminated building blocks. The use of an industrial hoover is as an option only for those blocks where no visual POP pesticides are present. In case the blocks are visually contaminated the hoover cannot remove all POP-pesticides leaving the block with a residual contamination that remains above the 50 ppm threshold. The splitting of the blocks to separate between an outer and inner part (where the inner part is contaminated) is not seen as an option as the blocks are of poor quality and will disintegrate during the splitting.

9 Waste classification and final CSM

9.1 Waste Classification

The following table provides an overview of the waste classification of all POP-pesticides and POP-pesticide impacted materials on site. Eural codes for the pure pesticides have been officially established by MAM Tübitak, see appendix 17.

Table 9.1 Waste classification for transport

No.	Waste type	UN Code	Transport Name	ADR Class	ADR Classification code	ADR Packaging group	Eural codes
1	DDT end product	2811 / 2761	TOXIC SOLID, ORGANIC, N.O.S. (1,1,1-Trichloro-2,2-bis (4-chlorophenyl)ethane) ORGANOCHLORINE PESTICIDE, SOLID, TOXIC (1,1,1-Trichloro-2,2-bis(4-chlorophenyl)ethane)	6.1	T2/T7	III	02 01 08* 07 04 07* 07 04 13* 16 03 05* 20 01 19*
2	Technical HCH	2811 / 2761	TOXIC SOLID, ORGANIC, N.O.S. (γ-1,2,3,4,5,6-Hexachlorocyclohexane) ORGANOCHLORINE PESTICIDE, SOLID, TOXIC (γ-1,2,3,4,5,6-Hexachlorocyclohexane)	6.1	T2/T7	III	02 01 08* 07 04 07* 07 04 13* 16 03 05* 20 01 19*
3	HCH production wastes	2811 / 2761	TOXIC SOLID, ORGANIC, N.O.S. ((1α,2α,3β,4α,5β,6β)-1,2,3,4,5,6-Hexachlorocyclohexane) ORGANOCHLORINE PESTICIDE, SOLID, TOXIC ((1α,2α,3β,4α,5β,6β)-1,2,3,4,5,6-Hexachlorocyclohexane)	6.1	T2/T7	III	02 01 08* 07 04 07* 07 04 13* 16 03 05* 20 01 19*
4	POP wastes mixed with asbestos and soil	3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (soil containing organochlorine pesticides and chrysotile asbestos)	9	M7	III	17 05 03*
5	Empty packaging	3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (empty packaging exposed to organchlorine pesticides dusts)	9	M7	III*	07 04 13*

No.	Waste type	UN Code	Transport Name	ADR Class	ADR Classification code	ADR Packaging group	Eural codes
6	PE drums	3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (empty PE drums exposed to organchlorine pesticides dusts)	9	M7	III*	07 04 13*
7	Metal drums	3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (empty metal drums exposed to organchlorine pesticides dusts)	9	M7	III*	07 04 13*
8	Water in drums	3082	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (water exposed to organochlorine pesticides)	9	M6	III*	07 04 01*
9	Floors	3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (concrete exposed to organchlorine pesticides dusts)	9	M7	III*	17 01 06*
10	First layer concrete blocks	3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (concrete exposed to organchlorine pesticides dusts)	9	M7	III*	17 01 06*
11	Second layer concrete blocks	3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (concrete exposed to organchlorine pesticides dusts)	9	M7	III*	17 01 06*
12	Wooden pallet wastes	3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (wood exposed to organchlorine pesticides dusts)	9	M7	III*	17 02 04*
13	Scrap metal	3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (metal exposed to organchlorine pesticides dusts)	9	M7	III*	17 04 09*
14	PPE wastes	3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (packaging and personal protection equipment exposed to organchlorine pesticides dusts)	9	M7	III*	16 01 21*

No.	Waste type	UN Code	Transport Name	ADR Class	ADR Classification code	ADR Packaging group	Eural codes
15	Scrap metal from well and fixed machinery	3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (metal exposed to organchlorine pesticides dusts)	9	M7	III*	17 04 09*
16	Miscellaneous wastes	3077	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (miscellaneous wastes exposed to organchlorine pesticides dusts)	9	M7	III*	16 01 21*
17	Third layer concrete blocks	N.a**.	N.a**.	N.a**.	N.a**.	N.a**.	17 01 07
18	Concrete frame	N.a.**	N.a.**	N.a.**	N.a.**	N.a.**	17 01 01
19	Metal closure	N.a.**	N.a.**	N.a.**	N.a.**	N.a.**	17 04 05
20	Miscellaneous materials (roof and other building materials)***	N.a.**	N.a.**	N.a.**	N.a.**	N.a.**	17 06 05

* According to provision 335 of the ADR these mixtures are not subject to ADR provisions provided that packaging does not contain more than 10gr of environmentally hazardous solids

** Not applicable – not hazardous wastes

*** Not applicable – provision 168 of ADR confirms that asbestos which is present within a binder, or packaged in such a way that no fibres can escape is not subject to the ADR

9.1.1 Waste Classification with regards to IMDG code

According to the IMDG classification system substances with UN code 2761 and 2811 and packing group III are not considered as marine pollutants (no secondary risk). Stowage and handling of UN 2761 is Category A and SW2. Its special provisions are 61, 223, 274. For UN2811 stowage and handling is Category A. Its special provisions are 223, 274. It should be noted that DDT and Lindane individually are considered as marine pollutants.

Substances with UN 3077 and UN3082 are considered as a marine pollutant. Special provisions of UN 3077 are 274, 335, 966, 967 and 969. Stowage and handling of it is Category A and SW23. Special provisions of UN 3082 are 274, 335 and 969. Stowage and handling of it is Category A.

Because of the fact that UN 3077 and UN 3082 are considered as marine pollutants, they are subject to IMDG Code. Marine pollutants are subject to the regulations in Annex-III of MARPOL 73-78 and they should be transported under the provisions of Annex III of MARPOL 73/78.

Previous shipments of POP-pesticides from this site used waste code UN2811, ADR 6.1.

9.2 Updated Conceptual Site Model

Figures 9.1 and 9.2 show the updated Conceptual Site Model of the warehouses and direct surroundings. The Conceptual Site Model is based on the site investigation of November 2016. This Conceptual Site Model does not include an assessment of the soil and groundwater status. The latter will be done in sub-task 7.1.

The Conceptual Site Model shows a top view of the warehouse with schematically the presence of bags of pesticides and drums. A cross-section through one of the warehouses is used to provide insight into the overall questions of the area. Appendix 10 shows the conceptual site model in greater detail.

Figure 9.1 The site location sketch illustrating the Conceptual Site Model of the warehouse

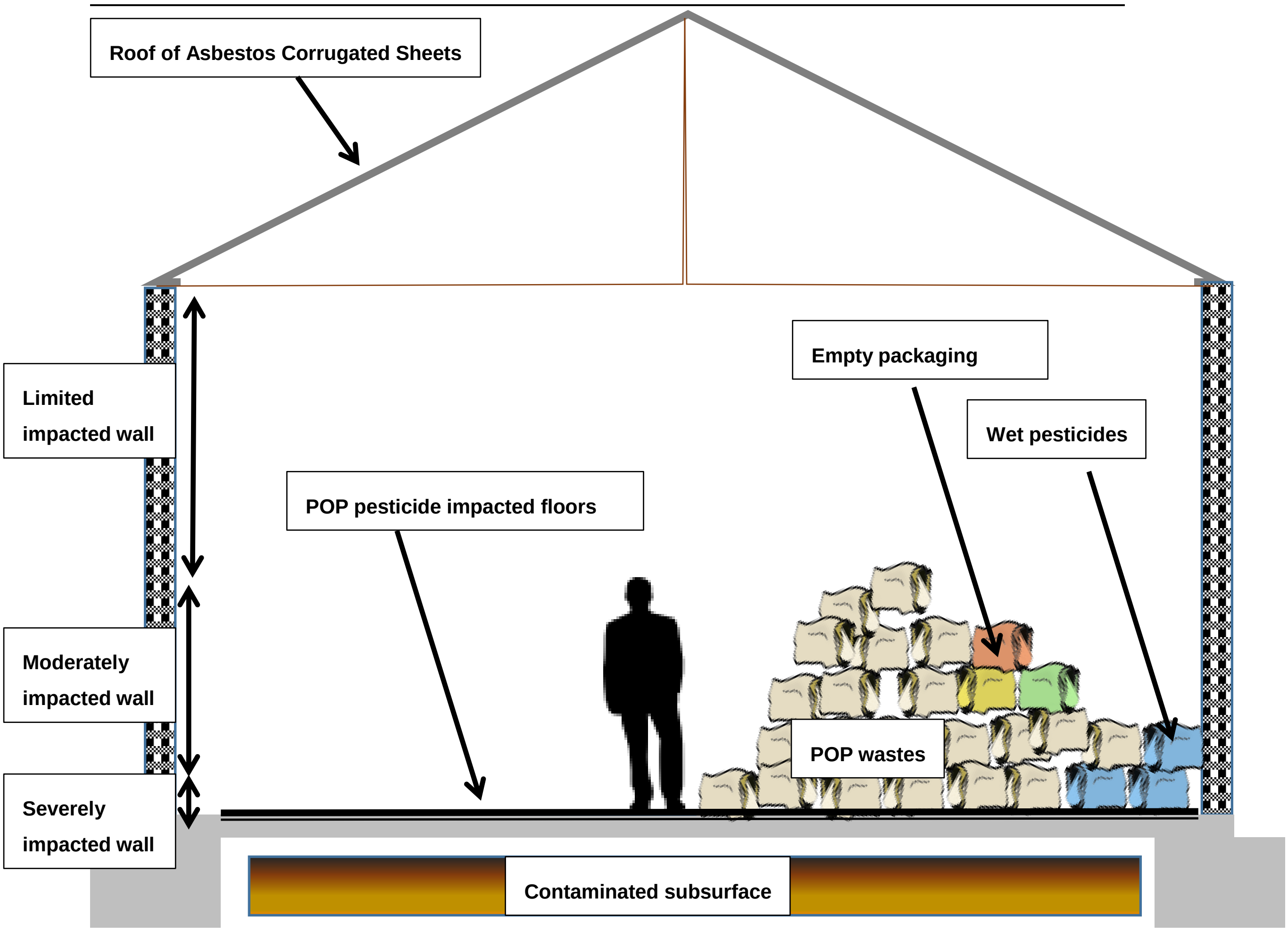

Figure 9.2 Schematic cross-section of warehouses

9.3 Remaining information Gaps

No major information gaps remain for the site. Only potential issue is the presence of POP-pesticides underneath the concrete floor of the warehouse. Sampling of the subsurface in Warehouse 5 showed that the material directly beneath the warehouse floor contains high concentrations of Total Petroleum Hydrocarbons (TPH) and DDT. This indicates that the subsurface of the warehouse is contaminated with products closely related to pesticide production. A possibility is that the warehouse area, before the construction of the warehouse, was used for the disposal and/or burning of pesticide wastes. Prior to the removal of the warehouse floors the status of the soil underneath should be verified.

10 Conclusions and recommendations

10.1 General

- The site status is sufficiently clear to proceed with the next task of this assignment drafting technical specifications for the removal of the POP pesticides stockpiles the POP-pesticides impacted wastes, the other waste and to demolish the above ground parts of the warehouse
- A large quantities POP-pesticides and other wastes are stored in substandard conditions
- Building materials and other non-POP-pesticides wastes have been affected by the stored POP-pesticides wastes
- Steel drums used to pack POP-pesticides have become waste and a large number is rusted because of leaking rainwater
- The lower parts of the walls and parts of the floors are classified as hazardous waste due to their POP-pesticides contents being above 50 ppm
- The warehouse provides an unsafe storage conditions for all waste because:
  - Due to extensive leakage of rainwater, POP-pesticides migrate into the groundwater through the open unprotected groundwater well inside the warehouse
  - Due to extensive leaking of rainwater POP-pesticides migrate into the soil under the warehouse floor through cracks in the floor
  - Due to extensive leaking of rainwater POP-pesticides migrate into the soil surrounding the warehouse through seepage
  - Fire hazard, as the roof has openings, vegetation is growing close to the building and the flammable waste (pallet wood and empty packaging) is stored inside the warehouse

10.2 Waste specific

- In the Merkim warehouse are the following **POP-pesticides waste types** present
  - 2,082.17 ton POP-pesticides in bags and on the site floors
  - 98.43 ton POP-pesticides in drums
  - 19.01 ton of POP-pesticides mixed with construction materials

The majority of the POP-pesticides are HCH production wastes, limited quantities of DDT and Technical HCH are also present at the site.

- In the Merkim warehouse are the following **waste types contaminated with POP-pesticides** in concentration above 50 ppm present
  - 295.57.ton of concrete form the warehouse floor
  - 191.80 ton of concrete building blocks
  - 28.1 ton of empty packaging, PPE wastes and other miscellaneous wastes
  - 23.62 ton of empty contaminated drums
  - 4.77 ton of contaminated water
- Unknown quantity of contaminated soil under the warehouse floor

10.3 Waste disposal

- For packaging and transport purposes the POP-pesticides waste do not need to be separated and can be packed as one hazardous POP pesticides waste
- For the other POP impacted waste types pre-treatment on-site is most likely economically beneficial in order to reduce transport volume and/or reduce hazardous properties:

10.4 Soil and groundwater

- The topsoil / fill under the warehouse floor is contaminated. The origins of the contamination are not completely clear.
- The groundwater under warehouse is most likely impacted and should be surveyed

10.5 Final recommendations

The warehouse has been surveyed in sufficient detail to continue with the drafting of the technical specifications. Based on the site investigation we have the following direct recommendations:

- Draft a strategy to limit the current fire hazard of the site and implement directly
- Fix the warehouse roof and clean gutters to limit percolation of the wastes by rainwater. This has the following immediate benefits:
  - Reduce smell for surrounding
  - Reduce impact of wastes on site subsurface
  - Reduce total weight of POP-pesticides by reducing percolation of wastes by rainwater

Appendix

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Photo report

Appendix

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Task Based Risk Assessment and attendance sheets

Appendix

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Overview composite samples wastes

Appendix

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Map sampling locations wastes

Appendix

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Drum inventory

Appendix

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Map of drum inventory

Appendix

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Calculations waste quantities

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Measurements warehouses

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Autocad drawings buildings

Appendix

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Conceptional Site Model

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Extract of maps of the area

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Analytical certificates AL-West wastes

Appendix

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Analytical certificates AL-West asbestos

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Analytical certificates MOST laboratories floors

Appendix

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Analytical certificates MOST laboratories building blocks

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Analytical certificates MOST laboratories subsurface

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Analytical certificates MAM Tübitak wastes

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Logbook Merkim site inventory