Municipal Solid Waste Open Dump Site Juba, South Sudan

Preliminary Environmental Assessment

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SUMMARY

Project	Site Investigation and Preliminary Evaluation of Environmental Impacts of the Municipal Solid Waste Open Dump Site
Location	Open Solid Waste Dump Site near Jebel Kujur, southwest of Juba, South Sudan
Field study and sampling	11.10.-19.10.2012
Purpose of study	To assess the environmental impact of the practice of dumping municipal solid waste at the site near Jebel Kujur, so as to better inform decisions regarding remedial action.
Preliminary evaluation of **socio-cultural-economic** impacts of dump site operation	Despite significant operational improvement at the dump site, the health impact on the waste-pickers remains severe. There are a variety of direct threats to the waste-pickers: the heavy vehicles that move around the site while people are picking over the waste; the hospital waste dumped at the site; and toxic fumes from burning waste. There are also indirect threats posed by the preparation and consumption of food – some of which is discarded and rotten - at the site. There are only a few small scale farmers in the vicinity of the dump site. The nearest structure is 300 m away and the nearest community is 1.5 km from the site. So the general health and economic impact is low. The dump site is situated on a moderately-sloping hill, so leachate flows downhill when it rains and pools of contaminated water form as a result. This situation poses a significant risk to the waste-pickers or grazing animals that come into contact with that water. A small ephemeral water body on the north side of the hill is used as a source of drinking water by some waste-pickers: the hygienic conditions there are appalling. The dump site certainly has a negative impact on water quality. The impact of on-site dust, odour and noise on the waste-pickers is severe, but few other people are impacted by those hazards because the population around the site is so sparse.

Preliminary evaluation of **environmental impacts** of dump site operation	Impact is low as there is no groundwater body of any importance, due to the geologic and hydrogeological conditions of the site area (shallow gneiss bed rock/ generally non water bearing).
Suitability of the site	If operated as a controlled dump site, the general location of the site is regarded as suitable.
Recommendations	The on-going **conversion of open waste dumping to controlled waste dumping** activities has already shown some major improvements and should be continued and supported by all stakeholders. Health and safety measures for the **waste-pickers** are of great concern and need to be addressed immediately. A plan for the handling of **hazardous wastes** needs to be established as there is currently no alternative to the uncontrolled dumping at the site. **Future land use planning** in the vicinity of the dump site (on-going or closed) should be given high priority to minimise impacts to an acceptable level. Waste management plans should be integrated into a spatial plan for the city and its region. Plans for further **expansion of the current dump site** and scoping for new sites are seen as critical issues given the short operational timeframe of the current dump site.
Organisation	UNEP United Nations Environment Programme SIEP (Sudan Integrated Environment Project) in South Sudan

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ABBREVIATIONS

JICA	Japan International Cooperation Agency
km	Kilometre
m	Meter
SIEP	Sudan Integrated Environment Project
UNEP	United Nations Environment Programme
UNMISS	United Nations Mission in the Republic of South Sudan
JCC	Juba City Council

APPENDIX

1 INTRODUCTION

The United Nations Environment Programme (UNEP) is the United Nations focal point for addressing environmental issues at the global and regional level. Its mandate is to coordinate the development of environmental policy consensus by keeping the global environment under review and bringing emerging issues to the attention of governments and the international community for action.

UNEP's Division of Environmental Policy Implementation (DEPI) works with international and national partners, providing technical assistance and advisory services for the implementation of environmental law and policy, and strengthening the environmental management capacity of developing countries and countries with economies in transition.

The Post-Conflict and Disaster Management Branch (PCDMB) within DEPI provides cutting edge environmental science and expertise to countries affected by or vulnerable to conflicts and disasters. The objective of the branch is to minimize threats to human well-being from the environmental causes and consequences of conflicts and disasters.

The UNEP programme in South Sudan is rooted in addressing the environmental drivers of poverty and conflict, recognising that natural resources (trees, groundwater, soil etc.) provide for the most basic needs for energy, shelter, water and food. The programme has the following over-arching goal: “To assist the people of South Sudan to achieve peace, recovery and development on an environmentally sustainable basis”. The purpose of the programme is: “To improve sustainable and equitable governance, management and use of environmental resources”.

Waste management is one of the three main pillars of Sudan Integrated Environment Project (SIEP) in South Sudan. To date the programme has focused on solid waste management in Juba city.

Situated on the White Nile, Juba is the capital and largest city of the Republic of South Sudan. Since the Peace Agreement between the South and North Sudan, the city has developed very rapidly and is now considered one of the fastest-growing cities in the region. The already remarkable rate of growth increased after the country became independent on 9 July, 2011. The 2008 Census held the population of Juba to be 375,000, however, several organisations estimate the current population of Juba to be in excess of one million.

This rapid growth in population has put significant pressure on already inadequate waste management services, and there are now critical issues relating to waste management practices in Juba. There are no figures available on the amount of waste being collected in Juba at present, but, based on discussions with various stakeholders and on the observations of the authors of this report, it is estimated that around 50% of the waste is collected on a daily basis.

Waste collected from different parts of Juba is transported on a daily basis to the dump site, which is located about 13 kilometres away from the city centre near a hill called ‘Jebel Kujur’.

The dumping ground opened in 2008, although there had been dumping activities along the main road since 2006, and measures about 25,000 m^2. That space is surrounded by parcels of land that have been allocated to various ministries of central government; as well as by areas of farmland; and by scattered communities. It is the only official dumping site in Juba, and all the waste that is collected from the city's households, market places, commercial institutions and even hospitals, is dumped at this site.

Currently, public access to the dumping site is unrestricted. Scores of people including children and women are on the site every day scavenging for food products and other valuables that they later sell to others as a source of income. Given what we know from the existing literature concerning the deplorable state of waste disposal practice at the site (AWEPA 2010, UNEP SWM 2012), it would be safe to assume that Jebel Kujur poses significant risks both to the environment and to humans. This study was conducted to give an overview and assess the existing situation regarding the disposal of Juba's municipal waste at the dump site near Jebel Kujur on Yei Road.

2 METHODOLOGY AND RESULTS

2.1 Field visits / Interviews

Field visits for the study were conducted on 12.10.2012, 16.10.2012, 17.10.2012, and 18.10.2012. The sampling of soil and water was conducted in accordance with the guidelines of the Ministry of Water Resources and Irrigation (Water Specialists Mr. Samuel Valentino and Mr. Samuel W. Onesime) and the Ministry of Petroleum and Mining (Geologist Mr. Stephen Massimo). Field visits also included interviews with waste-pickers and a nearby small scale farmer.

2.2 Collection of soil samples

A total of three soil samples were collected. Sample No. 1 (N 04° 49’ 60.3”, E 031° 30’ 335”) was taken from the base of an excavation pit of 1 m depth on the south part of the dump site area. As no other heavy machinery was available, the pit was only excavated to a depth of 1 m by a wheel loader. No influence from waste is expected and the results of Sample No. 1 can be considered as background values, which can be compared to samples No. 2 and No. 3 taken from the dump site bed.

Photo 1: Excavation pit, Sample No. 1

Soil Samples No. 2 and No. 3 were collected from areas where wastes had previously been dumped from the onset of dumping activities and then removed in the course of reorganizing the dump site. The soil samples were taken from the surface up to a depth of 0.15 m (No. 2) / 0.20 m (No. 3) where weathered bedrock was encountered.

2.3 Collection of a leachate sample

Groundwater samples were neither required nor taken in the vicinity of the dump site, due to the absence of either a shallow groundwater aquifer or water-bearing boreholes in fractures or weathered zones.

To indicate the potential contaminants in the waste, a leachate sample was drawn from a logged pool within the dump site area. The sample does not show the actual impact on the underlying soil, but provides an indication of the waste characteristics, and the potential risks to the health of waste-pickers of standing water. Similarly it gives an indication of the potential risks to the surrounding environment if contaminants are leached and transported as a consequence of rainfall. The leachate samples were dispensed into appropriate plastic and glass containers.

Photo 2: Ponding, collecting a leachate sample

2.4 Collection of a water sample

Erosion from surface run-off can be observed on the northern slope of the dump site. The flow of surface run-off is increased by the terrain and very shallow bedrock. Approximately 500 m down the north hillslope there is a small pool within an ephemeral stream where the waste-pickers fetch their drinking water. Sample No. 2 was drawn from this place and dispensed into appropriate plastic and glass containers. Physico-chemical parameters were measured in-situ by the water quality specialists from the Ministry of Water Resources and Irrigation. As the tested water is used for drinking water purposes, the analysis focused on testing WHO guideline parameters.

Photo 3: Children collecting water from a pond

2.5 Analysis of environmental samples

The soil, leachate and water samples were prepared for transportation in special boxes and then taken to WESSLING Laboratories in Neuried, Germany, for analysis. Analysing Methods are listed in the laboratory reports. Generally speaking importing soil samples into the European Union is forbidden, so special permits were issued by the pertinent authorities in Austria - the point of entry,- and Germany - the country of analysis.

2.6 Results of environmental samples

Tables 1 to 6 show the results of 3 soil samples, one leachate sample and one surface water sample (drinking water).

2.6.1 Soil samples

The results of soil samples in Tables 1 and 2 are compared to the Austrian Guideline: *"Contaminated sites – Risk assessment concerning the pollution of groundwater which is to be safeguarded"*.[/10/] The Guideline assists the management of old deposits and contaminated sites.

The following criteria form the basis of the assessment of environmental effects: a) the hazardousness of the polluting substances, b) the geological and hydrological conditions at the site and c) the potential for contaminant dispersal in groundwater.[/13/]

The Guideline defines trigger values for various contaminants/ indicator parameters which suggest further investigation if values are exceeded. If (intervention) threshold values (MSW) are exceeded mitigation measures, remediation or monitoring may be necessary depending on individual site conditions such as geology, hydrology etc.

The sample results (background values and site bed) generally do not show significant environmental effects. The levels of hazardous contaminants that were found in the sample do not exceed the parameters set out in the Guideline. Sample 4 shows a slightly elevated Chromium (Cr) value (dried solids) above the trigger value. Elevated TOC-eluate values in samples 1 and 5 are possibly due to natural background values (e. g. roots in sample 1) and dumped organic matter (sample 5).

In sample 5 a trace of AOX in the eluate could be detected though the concentration does not exceed the threshold value of the compared guideline.

For reasons of comparison the values of **The National Austrian Ordinance on Landfilling** are listed in Tables 1 and 2.[/11/]

Threshold values for 4 landfill types are listed:

- Excavated soil landfill
- Construction waste landfill
- Residual material landfill
- Mass waste landfill (Municipal waste landfill)

The comparison shows that if the sample results represented soil materials to be dumped, the soils could be dumped in an excavated soil landfill or a construction waste landfill.

Photo 4: Sampling the dump site surface, Sample No. 4

Photo 5: Sampling the dump site surface, Sample No. 4

SOIL SAMPLE		SAMPLE 1	SAMPLE 4	SAMPLE 5	OEN S2088-1 (2004) (Risk Assesment values)				DVO 2008 (Landfill Ordinance)			
Sample designation	Unit	Result	Result	Result	PW a	PW b	MSW a	MSW b	TYPE A	TYPE B	TYPE C	TYPE D
Water soluble part	%	<0.1	<0.1	0.15	Trigger val.		Threshold val.		Landfill type (fulfil criteria)			
Dry mater	Gew%	96	96	94								
Aluminium (Al)	mg/kg	19000	23000	7100								
Antimony (Sb)	mg/kg	<5	<5	<5								
Arsenic (As)	mg/kg	2	2	1.3	50	200			50	200	5000	500
Barium (Ba)	mg/kg	320	320	82								10000
Beryllium (Be)	mg/kg	<0.3	<0.3	0.5								
Lead (Pb)	mg/kg	6.3	8.6	16	100	500			150	500		5000
Boron (B)	mg/kg	<10	<10	<10								
Cadmium (Cd)	mg/kg	<0.3	<0.3	<0.3	2	10			2	10	5000	30
Calcium (Ca)	mg/kg	4400	3500	4700								
Chromium (Cr)	mg/kg	83	110	28	100	500			300	500		8000
Chromium (VI)	mg/kg	<0.2	<0.2	<0.2								
Cobalt (Co)	mg/kg	17	24	5.4					50	100		500
Iron (Fe)	mg/kg	26600	33000	16000								
Copper (Cu)	mg/kg	34	41	10	100	500			100	500		5000
Magnesium (Mg)	mg/kg	10000	14000	1700								
Manganese (Mn)	mg/kg	370	490	190								
Molybdenum (Mo)	mg/kg	<3	<3	<3								
Nickel (Ni)	mg/kg	38	59	8.9	100	500			100	500		2000
Mercury (Hg)	mg/kg	<0.1	<0.1	<0.1	1	5			1	3	20	20
Selenum (Se)	mg/kg	<5	<5	<5								
Silver (Ag)	mg/kg	<10	<10	<10								100
Thallium (Tl)	mg/kg	<0.5	<0.5	<0.5								
Vanadium (V)	mg/kg	65	90	35								
Zinc (Zn)	mg/kg	54	89	120	500	1500			500	1500		5000
Tin (Sn)	mg/kg	<5	<5	<5								
Total organic carbon (TOC)	Gew%	0.11	0.18	0.9								
Loss on ignition (550°C)	Gew%	1.8	2.1	2.7						5	8	
Benzene	mg/kg	<0.01	0.0521	<0.01	1	1						
Toluene	mg/kg	<0.01	<0.01	<0.01								
Ethyl benzene	mg/kg	<0.01	<0.01	<0.01								
m-, p-Xylene	mg/kg	<0.01	<0.01	<0.01								
o-Xylene	mg/kg	<0.01	<0.01	<0.01								
Sum of presented BTEX	mg/kg	-/-	0.0521	-/-	6	6			6	6	6	6
EOX	mg/kg	<0.5	<0.5	<0.5								
POX	mg/kg	<0.5	<0.5	<0.5								
Hydrocarbons C10-C40	mg/kg	<10	15.6	78.7	100	100	500	1000	50	1000	5000	20000
Naphthalene	mg/kg	<0.02	<0.02	<0.02	1	5						
1-Methylnaphthalene	mg/kg	<0.02	<0.02	<0.02								
2-Methylnaphthalene	mg/kg	<0.02	<0.02	<0.02								
Acenaphthylene	mg/kg	<0.2	<0.2	<0.2								
Acenaphthene	mg/kg	<0.02	<0.02	<0.02								
Fluorene	mg/kg	<0.02	<0.02	<0.02								
Phenanthrene	mg/kg	<0.02	<0.02	<0.02								
Anthracene	mg/kg	<0.02	<0.02	<0.02								
Fluoranthene	mg/kg	<0.02	<0.02	<0.02								
Pyrene	mg/kg	<0.02	<0.02	<0.02								
Benzo(a)anthracene	mg/kg	<0.02	<0.02	<0.02								
Chrysene	mg/kg	<0.02	<0.02	<0.02								
Benzo(b)fluoranthene	mg/kg	<0.02	<0.02	<0.02								
Benzo(k)fluoranthene	mg/kg	<0.02	<0.02	<0.02								
Benzo(a)pyrene	mg/kg	<0.02	<0.02	<0.02					0.4			
Dibenz(ah)anthracene	mg/kg	<0.02	<0.02	<0.02								
Benzo(ghi)perylene	mg/kg	<0.02	<0.02	<0.02								
Indeno(1,2,3-cd)pyrene	mg/kg	<0.02	<0.02	<0.02								
Sum of PAH 15	mg/kg	-/-	-/-	-/-	4	10	100					
Sum of PAH 16	mg/kg	-/-	-/-	-/-					4	30	300	300
Phenol, steam volatile	mg/kg	<0.1	<0.1	<0.1								
Sum of 7 PCB	mg/kg	-/-	-/-	-/-								

Table 1: Soil Sample results (dried solids)

PW a(trigger value):Specially protected aquifers or aquifers with a high relevance for future water management, PW b: Aquifers which are not likely to be used.
Background colour (green, yellow) indicates when screening value is exceeded.
Landfills: TYPE A: Excavated soil landfill, TYPE B: Construction waste landfill, TYPE C: Residual material landfill, TYPE D: Mass waste landfill (Municipal waste landfill)

SOIL SAMPLE		SAMPLE 1	SAMPLE 4	SAMPLE 5	OEN S2088-1 (2004) (Risk Assesment values)				DVO 2008 (Landfill Ordinance)			
IN ELUATE, filtrated	**Unit**	Result	Result	Result	PW a	PW b	MSW a	MSW b	BAD	BRM	RSD	MAD
Conductivity 25°C	µS/cm	51	72	187	150	250			150	300		
pH-Value		8.4	8.7	8.9	6 11	6 11	5 12	5 13	6.5 11	6 13	6 12	6 13
Aluminium (Al)	mg/kg	0.39	0.51	0.5	5	20					100	
Antimony (Sb)	mg/kg	<0.05	<0.05	<0.05							0.7	5
Arsenic (As)	mg/kg	<0.05	<0.05	<0.05	0.1	0.5	1	1	0.5	0.75	2	25
Barium (Ba)	mg/kg	0.13	0.26	0.11					10	20	100	300
Beryllium (Be)	mg/kg	<0.01	<0.01	<0.01								
Lead (Pb)	mg/kg	<0,03	<0,03	<0,03	0.1	0.5	1	1	1	2	10	50
Boron (B)	mg/kg	0.14	0.14	0.13						30		
Cadmium (Cd)	mg/kg	<0.005	<0.005	<0.005	0.05	0.05	0.5	0.5	0.05	0.5	1	5
Calcium (Ca)	mg/kg	37	53	37								
Chromium (Cr)	mg/kg	<0,03	<0,03	<0,03	0.5	1	5	10	1	2	10	70
Chromium (VI)	mg/kg	<0,08	<0,08	<0,08						0.5		20
Cobalt (Co)	mg/kg	<0,03	<0,03	<0,03					1	2	5	50
Iron (Fe)	mg/kg	0.18	0.17	0.22	10	20					20	
Copper (Cu)	mg/kg	<0,03	<0,03	0.15	1	5	10	10	2	10	50	100
Magnesium (Mg)	mg/kg	12	12	6.3								
Manganese (Mn)	mg/kg	<0.1	<0.1	<0.1	5	10						
Molybdenum (Mo)	mg/kg	<0,03	<0,03	0.04							10	30
Nickel (Ni)	mg/kg	<0,03	<0,03	<0,03	1	1	5	5	1	2	10	40
Mercury (Hg)	mg/kg	<0.0002	<0.0002	<0.0002	0.01	0.01	0.02	0.05	0.01	0.05	0.1	0.5
Selenium (Se)	mg/kg	<0.05	<0.05	<0.05							0.5	7
Silver (Ag)	mg/kg	<0.1	<0.1	<0.1					0.2	1	1	10
Thallium (Tl)	mg/kg	<0.01	<0.01	<0.01								
Vanadium (V)	mg/kg	<0.05	0.08	0.32								
Zinc (Zn)	mg/kg	<0.05	<0.05	0.06	10	30			20	20	50	200
Tin (Sn)	mg/kg	<0.05	<0.05	<0.05					2	10	20	200
Ammonium (NH4)	mg/kg	<0.5	<0.5	6	10	20			8	40	300	10000
Ammonium-nitrogen (NH4-N)	mg/kg	<0.4	<0.4	4.7								
Chloride (Cl)	mg/kg	10	40	180	2000	2000				5000		
Cyanide total (CN)	mg/kg	<0.05	<0.05	<0.05	0.5	0.5						
Cyanid (CN), easily released	mg/kg	<0.1	<0.1	<0.1					0.2	1	1	20
Fluoride (F)	mg/kg	12.2	10	5	20	50			20	50	150	500
Nitrite-N (NO2-N)	mg/kg	<0.0304	<0.0304	<0.0304	2	2			2	10	15	1000
Nitrite (NO2)	mg/kg	<0.1	<0.1	<0.1								
Nitrate (NO3)	mg/kg	<10	30	80								
Nitrate-N (NO3-N)	mg/kg	<2,26	6.78	18.1	100	100			100	500		
Phosphorus (calc.as PO4)	mg/kg	0.800	4	22								
Phosphorus (P)	mg/kg	0.26	1.3	7					5	50	50	
Sulfate (SO4)	mg/kg	20	40	110	2500	2500				6000		25000
Sulfide (S), dissolved	mg/kg	2	4	3								
TOC	mg/kg	400	50	380	50	100			200	500	500	2500
AOX	mg/kg	<0.2	<0.2	0.25	0.1	0.3			0.3	3	30	30
Hydrocarbon Index	mg/kg	<1	<1	<1					5	50	100	200
Naphthalene	mg/kg	<0.0001	<0.0001	<0.0001	0.02	0.02						
Acenaphthylene	µg/l	<0.1	<0.1	<0.1								
Acenaphthene	µg/l	<0.01	<0.01	<0.01								
Fluorene	µg/l	<0.01	<0.01	<0.01								
Phenanthrene	µg/l	0,02	0,02	0,02								
Anthracene	µg/l	<0.01	<0.01	<0.01								
Fluoranthene	µg/l	<0.01	<0.01	<0.01								
Pyrene	µg/l	<0.01	<0.01	<0.01								
Benzo(a)anthracene	µg/l	<0.01	<0.01	<0.01								
Chrysene	µg/l	<0.01	<0.01	<0.01								
Benzo(b)fluoranthene	µg/l	<0.01	<0.01	<0.01								
Benzo(k)fluoranthene	µg/l	<0.01	<0.01	<0.01								
Benzo(a)pyrene	µg/l	<0.005	<0.005	<0.005								
Dibenz(ah)anthracene	µg/l	<0.01	<0.01	<0.01								
Benzo(ghi)perylene	µg/l	<0.01	<0.01	<0.01								
Indeno(1,2,3-cd)pyrene	µg/l	<0.01	<0.01	<0.01								
Sum of 6 PAH	mg/kg	-/-	-/-	0.0075								
Sum of presented PAH	mg/kg	0.0002	0.0002	0.0127								
Sum of 4 PAH	mg/kg	-/-	-/-	0.0327								
Sum of Anionic surfactants (MBAS)	mg/kg	<0.0001	<0.0001	<0.0001					1	5	20	
Phenol, steam volatile	mg/kg	<0.0001	<0.0001	<0.0001								

Table 2: Soil Sample results (leachate)

2.6.2 Leachate sample

As there is no definite guideline for the evaluation of collected surface leachate, the results of the leachate sample in Table 3 is compared to the Austrian Guideline: "*Contaminated sites – Risk assessment concerning the pollution of groundwater which is to be safeguarded*". An appropriate approach to assessing potential environmental effects would be to compare the screening values for eluate concentrations of soil samples with the Guideline.

The leachate sample was first analysed without filtration to show the actual (total) concentrations including solid particles in the collected sample fluid. For comparison with potential seepage of the leachate and potential migration of contaminants, the sample was filtered and a selection of parameters analysed.

The unfiltered leachate shows elevated values of various parameters (e.g. Manganese, TOC) which are characteristic of the wastes involved. The comparison of the results (chemical analysis) for the filtered leachate sample gives no indication of an environmental hazard.

Photo 6: Collecting a leachate sample from a logged pool, Sample No. 3

LEACHATE (SAMPLE 3)					OEN S2088-1 (Risk Assessm. val.)			
Parameter	Unit	unfiltered	filtered	filtered (mg/kg)	Trigger		Threshold	
Evaporation residue	mg/l	5,900			PW b		MSW b	
Conductivity	µS/cm	5,652			250			
ph-value	--	7			6	11	5	13
Aluminium (Al)	µg/l	1,100	82	0.82	20			
Antimony (Sb)	µg/l	<5	<5					
Arsenic (As)	µg/l	6	11	0.11	0.5		1	
Barium (Ba)	µg/l	860	690					
Beryllium (Be)	µg/l	<1	<1					
Lead (Pb)	µg/l	31	<3		0.5		1	
Boron (B)	µg/l	920	810					
Cadmium (Cd)	µg/l	<0.5	<0.5		0.05		0.5	
Calcium (Ca)	µg/l	380,000	370,000					
Chromium (Cr)	µg/l	10	7	0.07	1		10	
Chromium (VI)	mg/l	<0.008						
Cobalt (Co)	µg/l	17	<3					
Iron (Fe)	µg/l	22,000	1,100	11	20			
Copper (Cu)	µg/l	12	<3		5		10	
Magnesium (Mg)	µg/l	190,000	170,000					
Manganese (Mn)	µg/l	6,300	5,700	57	10			
Molybdenum (Mo)	µg/l	<3	<3					
Nickel (Ni)	µg/l	21	7	0.07	1		5	
Mercury (Hg)	µg/l	<0,2			0.01		0.05	
Selenum (Se)	µg/l	<5	<5					
Silver (Ag)	µg/l	<10	<10					
Thallium (Tl)	µg/l	<1	<1					
Vanadium (V)	µg/l	<5	<5					
Zinc (Zn)	µg/l	370	28	0.28	30			
Tin (Sn)	µg/l	<5	6					
Ammonium (NH4)	mg/l	7.22			20			
Ammonium-nitrogen (NH4-N)	mg/l	5.6						
Chloride (Cl)	mg/l	750			2000			
Cyanide total (CN)	mg/l	<0.005			0.5			
Cyanid (CN), easily released	mg/l	<0.01						
Fluoride (F)	mg/l	<0,2			50			
Nitrite-N (NO2-N)	mg/l	<0,01			2			
Nitrite (NO2)	mg/l	<0,00304						
Nitrate (NO3)	mg/l	2						
Nitrate-N (NO3-N)	mg/l	0.452			100			
Phosphorus (calc.as PO4)	µg/l	23,000						
Phosphorus (P)	µg/l	7,600						
Sulfate (SO4)	mg/l	2			2500			
Sulfide (S), dissolved	mg/l	0.1						
Total organic carbon (TOC)	mg/l	2,280			100			

Table 3: Leachate results (Part 1)

LEACHATE (SAMPLE 3)		unfiltered	filtered	OEN S2088-1 (Risk Assessm. val.) Trigger PW b	Threshold MSW b
AOX	µg/l	<1.000		0.3	
Hydrocarbon Index	mg/l	0.3			
Naphthalene	µg/l	<0.1		0.02	
Acenaphthylene	µg/l	<1			
Acenaphthene	µg/l	<0.1			
Fluorene	µg/l	<0.1			
Phenanthrene	µg/l	<0.1			
Anthracene	µg/l	<0.1			
Fluoranthene	µg/l	<0.1			
Pyrene	µg/l	<0.1			
Benzo(a)anthracene	µg/l	<0.1			
Chrysene	µg/l	<0.1			
Benzo(b)fluoranthene	µg/l	<0.1			
Benzo(k)fluoranthene	µg/l	<0.1			
Benzo(a)pyrene	µg/l	<0.05			
Dibenz(ah)anthracene	µg/l	<0.1			
Benzo(ghi)perylene	µg/l	<0.1			
Indeno(1,2,3-cd)pyrene	µg/l	<0.1			
Sum of 6 PAH	µg/l	-/-			
Sum of presented PAH	µg/l	-/-			
Sum of 4 PAH	µg/l	-/-			
Phenol, steam volatile	mg/l	2.15			
Benzene	µg/l	1			
Toluene	µg/l	0.3			
Ethyl benzene	µg/l	<0.2			
m-, p-Xylene	µg/l	<0.2			
o-Xylene	µg/l	<0.2			
Styrene	µg/l	<0.2			
Cumene	µg/l	<0.2			
Sum of presented BTEX	µg/l	1.3			
Dichloromethane	µg/l	<0.05			
Trichloromethane	µg/l	<0.05			
Tetrachloromethane	µg/l	<0.05			
1,2-Dichloroethane	µg/l	<0.05			
1,1,1-Trichloroethane	µg/l	<0.05			
Vinyl chloride (VC)	µg/l	<0.05			
cis-1,2-Dichloroethene	µg/l	<0.05			
Trichlorethene	µg/l	<0.05			
Tetrachlorethene	µg/l	<0.05			
Sum of canc. CHC (VC, CCl4, 1,2-DCM)	µg/l	-/-			
Sum of presented VOX	µg/l	-/-			

Table 4: Leachate results (Part 2)

2.6.3 Drinking water sample

The chemical analysis results of the surface water pool used for drinking water purposes were compared to the WHO Guidelines for drinking water. That analysis did not reveal any toxic components and therefore there is no chemical hazard. That is not to suggest that the water in the pool is fit to drink. It certainly is not: the hygienic condition of the pool is atrocious.

Photo 7: Hill slope north of dump site

Photo 8: Sampling the water pond, Sample No. 2

DRINKING WATER		SAMPLE 2	
	Unit	Result	WHO Guidelines
Conductivity	µS/cm	380	---
pH-value	---	7,2	---
Total org. carbon (TOC)	mg/l	6	---
Total hardness	°dH	8,4	---
Aluminium	µg/l	31	---
Antimony	µg/l	<5	20
Arsenic	µg/l	<5	10
Barium	µg/l	69	700
Lead	µg/l	<3	10
Boron	µg/l	<10	2400
Cadmium	µg/l	<0,5	3
Calcium	µg/l	22.000	---
Chromium	µg/l	<3	50
Copper	µg/l	<3	2000
Magnesia	µg/l	23.000	---
Manganese	µg/l	<10	---
Molybdenum	µg/l	<3	---
Sodium	µg/l	50.000	---
Nickel	µg/l	<3	70
Mercury	µg/l	<0,2	6
Uranium	µg/l	<1	30
Nitrate	mg/l	<1	50
Nitrite (NO2)	mg/l	0,37	3
Chloride	mg/l	37	---
Fluoride	mg/l	1	1,5
Sulfate	mg/l	4	---
Cyanide	mg/l	<0,005	0,0006
Chlorine (Cl)	mg/l	<0,1	5
Chlorine (Cl), free	mg/l	<0,1	---
Benzene	µg/l	<0,2	10
Toluene	µg/l	<0,2	700
Ethylbenzene	µg/l	<0,2	300
m-, p-Xylene	µg/l	<0,2	0,3
o-Xylene	µg/l	<0,2	0,3
Styrene	µg/l	<0,2	20
Cumene	µg/l	<0,2	---
Sum of presented BTEX	µg/l	-/-	---
Dichloromethane	µg/l	<0,5	20
Tetrachloromethane	µg/l	<0,5	---
1,2-Dichloroethane	µg/l	<0,5	30
cis-1,2-Dichloroethene	µg/l	<0,5	---
Trichlorethene	µg/l	<0,5	20
Tetrachlorethene	µg/l	<0,5	40
Sum of canc. CHC (VC, CCl4, 1,2-DCM)	µg/l	-/-	---
Sum of presented VOX	µg/l	-/-	---

Table 5: Drinking Water results

3 OPEN DUMP SITE NEAR JEBEL KUJUR

3.1 Site Description

Lagoon Dump Site is located approximately 13 km from Juba Town Centre in the west of the Mountain Jebel Kujur. The elevation of the site is about 550 m. The dump site is reached first via the main road leading to Yei and then by a smaller road leading directly to the dump.

Dumpsite Name	Dump Site near Jebel Kujur		
Location	RejafPayam (Juba County), South Sudan		
Area of existing dump site area	2,56 ha		
Area and Coordinates of total dump site area (JICA)	25 ha (25,000 m²)		
	Northing	Easting	Elevation
	4°49'45.0"	31°30'21.8"	556.338
	4°49'32.6"	31°30' 31.3"	558.000
	4°49'22.2"	31°30'18.9"	548.031
	4°49'34.6"	31°30' 08.4"	546.062

Table 5: Dump Site location

Figure 1: Project Location (Source: Google maps)

3.2 Description of Dump Site

Type of Dump Site	Open dump site, the dump site is currently being converted to a controlled dump site
Dump Site operation since	Open dumping since 2008 at the site and along the main road
Dumpsite Operator	Municipality
Consulting Agency	JICA (Japan International Cooperation Agency)
Property owned by	Juba Municipality/ County (the community owned site area is seeded to the County and managed by the Municipality)
Total Area of the Dump Site	25.000 m² (500 m² x 500 m²) including projected site area.
Estimated area covered by actual open dumping operations 2012	5.000 m² (initial core dumping area: 1.3 ha)
Excavation depth and volume	Excavation up to a depth of approximately 2 m was carried out at the onset of open dumping activities in the northern site area. This excavated core area covers approx. 1.3 ha.
Soil characteristics of site bed	Soil thickness of excavated area approx. less than 1 m. Bedrock is visible occasionally. Other area up to approx. 3 m of overlying lateritic soil. Visual inspection shows reddish brown coloured gravely and stony sand with very little clay.
Access road	Previous dumping activities next to the road. Several small heaps and also larger areas still exist alongside of the access road. Notable erosion of the access road due to surface run-off.

Table 6: General information of dump site

Dumping procedure	Haphazard waste dumping began in 2006 along the main road. Actual management activities of dumping procedures started in September 2012 and are conducted by JICA (JICA's engagement started 2011). The existing dump heaps of previous activities are being piled, compacted and covered with soil. Dumping is now organized in cells and covered with soil. Dumping is carried out on daily basis. There are no specified opening times for the dump site as no entry controls exists. The Municipality and JICA are setting up a controlled entry procedure.
Estimated average depth of waste	Formerly tipping of waste into heaps approx. 2 m high without compaction. On-going cell filling and compaction with wheel loader or bulldozer approx. 3 m high.

Stability of slopes	The stability of slopes is sufficient.
Soil covering	Currently, the soil for covering activities is taken within the site. Soil cover is applied in accordance to the availability of heavy machinery.
Heavy machines on site	Wheel loader or bulldozer (depending on availability)
Leachate seepage and ponding	Due to the coarse soil characteristics of the dump site bed, seepage is considered to be moderate to high in areas with no direct underlying bedrock. In areas of underlying bedrock seepage is low and occurs mostly in fractures or weathered zones. Ponding can be seen on several areas of the dump site.
Run-off and erosion	During heavy rains the run-off is high due to the convex topography leading to erosion on the site and of the access road.
Burning of wastes	Burning is still very common. Since the management of operations by JICA, waste burning is discouraged and has lessened.
Evidence of gas migration at the surface and boundaries of the site	Gas migration could be identified in areas of stagnant water ponding.
Evidence of waste slipping	Waste slipping has not been reported.
planning activities of the site by JICA	JICA is implementing the conversion of the dump site to a controlled dumping site.

Table 7: Operational Data of dump site

Source	Juba Town
Waste characterization	Municipal wastes of Juba Town Juba Teaching Hospital (JTH), other private and public hospitals in addition to clinics
Hazardous Wastes	The site was cleared of Unexploded Ordinances (UXO) by UNMISS There is no visual indication of industrial wastes.
Hospital/Surgical Waste	Juba Teaching Hospital (JTH) uses an incinerator for the disposal of health hazardous waste, though such mode of disposal is not always in function due to limitations as lack of fuel. Clinics send their medical waste to the dump site.

Population served (wastes collected)	Population of the three payams, which make up Juba Municipality (Kator, Munuki, Juba) in addition to part of Juba County (Rejaf Payam) is approx. 0.8 to 1 Million.
Volume of daily Waste (t)	Approx. 500 t (approx. 60-70 trucks x 8 tonnes)
Estimated waste volume dumped 2006-2012 (t)	Unknown
Projected filling of dump site	According to calculations carried out by JICA the current dump site area will be filled within one and a half years.

Table 8: Waste description and volumes

Photo 9: Highest section of the dump site area, facing West, background: Jebel Kujur

Photo 10: Initial dumping area, facing SE

4 ENVIRONMENTAL SETTING

4.1 Climatic Conditions

General description	The climate of the Republic of South Sudan is tropical to savannah with temperatures in the region of 20°C – 35°C
Annual precipitation (mm)	Approx. 1,000 mm (upwards of 100 mm from April to October)
Rainy season	May to October
Dry season	December to January
Main wind direction	East to West

Table 9: Climatic conditions

4.2 Site Topography of Site and surroundings

The topography in the southwest of Juba is undulating and the terrain is generally tilted towards the northern parts. The dump site area is located on the southern side of a hill and reaches nearly to the highest point. The terrain is slightly sloped all the way down to the main road. Following the convex topography of the dump site surroundings, the terrain slopes both to the east and to the west. On the north side of the hill there is an ephemeral stream that flows from the hilltop to the North. However, generally speaking surface water should be expected to follow the topography and flow in a southerly direction.

Most of the trees in the forest that once dominated this landscape were felled for use as fuel wood during the war.

Photo 11: Bush land along the access road (background: Jebel Kujur)

4.3 Geology, Hydrogeology

The dumpsite lies within the Gneiss Zone. In some areas – like the western bank of the Nile - the gneisses are covered by lateritic soil.

Photo 12: Excavation showing shallow weathered bedrock

The overlying soil thickness at the site area can reach depths of approx. 5 m. Bedrock is occasionally observed at the surface of the upper parts of the dump site area. The colour of the soil is reddish to brown.

A pit was excavated at the site up to a depth of 1 m. The lateritic soil taken from that pit consists of gravely and stony sand with little clay components. A soil sample from the pit was taken for analysis (Sample No. 1).

The hydrogeological map of South Sudan shows that the area lies in an area of low hydrogeological importance.

Existing surface water bodies (perennial)	None within 1000 m
Existing Wells and distance from dump site	No existing wells within 1000 m.
Groundwater table of aquifer (depth)	There is no existing ground water expected. Water occurs within the fractures of the Gneiss formation.
Groundwater flow direction	Unknown/ not applicable
Groundwater quality	Unknown/ not applicable
Permeability cm/s	Unknown/ not applicable
Groundwater gradient m/km	Unknown/ not applicable
Flooding situation during wet seasons	Due to the elevated location the dump site is not prone to flooding.

Table 10: Hydrogeological conditions

4.4 Socio-Cultural Environment

4.4.1 Population and Neighbouring Communities

The nearest community to the dump site is on the main road at a distance of about 3 km (Jebel Kujur checkpoint on the main road).

Very few families live in the vicinity of the dump site. Some are **small scale farmers** growing sorghum, ground nuts, maize and vegetables. The nearest homestead is about 300 m to the south east of the dump site.

Most of the **waste-pickers** live in Likwilili, a small community approximately 4 km away from where they commute daily to the dump site.

4.4.2 Land Use Pattern

The above-mentioned farmers use or occupy very little of the land close to – within 500 m – to the site.

The nearest **institutional establishment** is the Ministry of Higher Education, which is 1 km away. The World Food Programme (WFP) has a warehouse 2.5 km away.

Residential plots and sites for government institutions like the Ministry of Heritage, Ministry of Finance, Ministry of Mining and Petroleum, are to be developed along the main road at a distance of 1.8 km from the dump.

The Government plans to expand the dump site to an area of 25 ha.

The populations both of Juba and of the area surrounding the city have grown rapidly as refugees have returned from the Sudan and economic migrants have flooded in from neighbouring Uganda, Kenya, Ethiopia, and Congo (Martin et al. 2011). That population explosion has already created illegal settlements in and around Juba, and it will certainly cause more to spring up near the dump site in the near future.

Activity at the dump has only a minimal **economic impact** on the few subsistence farmers nearby. That impact is mostly caused by plastics that are blown into the farmers' fields and then – with some difficulty - have to be removed. One such farmer offered the example of goats becoming unwell or dying after ingesting plastics, as evidence of the negative economic impact of the dump.

Currently there is no economic impact on **private property prices** not only because much of the land in the vicinity is allocated to government ministries and so is uninhabited, but also because the nearest community is about 3 km away. However, Juba and its neighbouring communities are growing rapidly, so private property prices may increase in the mid-term.

4.4.3 Waste Picking

Up to a hundred waste-pickers can be seen at the dump site on any given day. In general they come in search of plastics such as PET bottles, nylon sacks, and tyres, and metal scrap like aluminium metal cans. What they find they will sell at a modest profit.

Dealers buy the collected materials, which are then stored at the dump site or on a plot on the main road for resale. Most recycled materials are then shipped to China.

Most waste-pickers are locals and come to the dump site daily. Some waste-pickers that were interviewed mentioned that they live on the outskirts of the city (e.g. in Durupi or Likwilili); others came from Terekeka County.

There is no typical waste-picker. A range of ages and both sexes are represented at the site: some of the pickers are lactating mothers with babies, many others are children.

At the time of writing the waste-pickers use absolutely no protection when they collect recyclable materials. When the waste trucks arrive, the pickers simply stand next to or behind the vehicles so as to get a good chance of finding anything useful.

It was very clear from visiting the site that there are a wide variety of severe health risks facing the picker community. Waste-pickers that were interviewed offered as an example of those risks, the recent death of a child who was killed by a reversing waste truck.

Photo 13: Water Specialists (Ministry of Water Resources and Irrigation) talking to waste-pickers (Photo: Jada Albert)

Hospital wastes dumped at the site pose an enormous health risk. In general there are obvious adverse consequences of dumping - rather than incinerating - surgical waste. In particular the used hypodermic syringes and needles that could be seen at the site pose a direct risk of infection to anyone walking over or sorting through the waste.

It was obvious from visiting the site that the burning of waste is a routine occurrence. The practice is used not only to reduce the volume of waste but also to expose sought after metals that might otherwise remain concealed (UNEP 2012). The toxic fumes generated by the practice of burning hazardous materials are a serious threat to the health of the waste-pickers. It is noteworthy that the technique of covering waste has led to a reduction in waste burning activities.

Waste-pickers prepare and eat food amid the waste at the dump site. In doing so, they risk ingesting hazardous substances. Frequently they eat foodstuff that they find at the site regardless of its condition or the threat it poses to their health.

Most of the waste-pickers are aware of the risks they face when scavenging at the dump site. Many expressed concern over access to Tetanus injections. Some pointed out in interview that waste picking poses threats to their social status as well as to their physical health. Many of those were at the dump site without the knowledge of their families and friends, and lived in fear of being stigmatised.

5 SIGNIFICANT ENVIRONMENTAL ISSUES

A comprehensive and detailed assessment of the environmental issues was impeded by a lack of information – a deficiency that is mapped by the gap analyses in sections 5.1 and 5.2. As a consequence this description of the outstanding issues should be seen as constituting a preliminary investigation only.

5.1 Identification and assessment of environmental effects from existing open wastes dumping practices in situ and on surrounding water, land and air.

The preliminary in-situ soil contamination and leachate analyses indicate no significant environmental effects from the current waste dumping. No sampling was undertaken in the area surrounding the dump, but the in-situ results provide a reasonable indication that there are minimal or *virtually safe* impacts outside the dump. Groundwater was absent in the site and no samples were required.

The hydrogeological character of the dump site poses a very low risk to groundwater resources. The site inspection and one excavation showed weathered bedrock. There is no significant groundwater resource associated with the dump site area and the area is considered to have low hydrological importance.

Nevertheless there remain significant environmental risks from potential effects due to deficiencies in the waste management practices. The remediation works currently being undertaken by JICA (Japan) should provide some mitigation in the short to medium term. This is based on the following:

1. The existing haphazard dumping (or heaps) on the site, along the main road and access road is being cleared and further dumping activities are being reorganized. For example, dumping in cells at the dump site.
2. Managerial measures and procedures to control entry into the dump site, including the current construction of an entry control and site administration building.
3. It is planned to construct a perimeter fence around the dump and implement ventilation pipes.

Gap Analysis

The desktop study and site visit found several gaps in the level of information required to monitor and manage the dumping operation. They are listed as follows:

1. Relatively few hydrological and hydrogeological records and assessments
2. Topographic map of the larger area of the dump site, to provide sufficient detail for further site planning.
3. Assessment of all small scale farmers/settlers within 2500 m.

Although the site visit provided a good indication of the soil and bedrock characteristics of the dump site, further investigations - including excavation pits and probing – should be carried out.

5.2 Identification and assessment of environmental and socio-economic effects on waste-pickers and neighbouring communities

Impact	Potential Significance of Impact	Comments
Local community health impacts	Low	Local community is located >2500 m from the dump site so impact is low.
Dust and odour	Moderate	The area is very sparsely populated with nobody living within 300 m. Odour impact has lessened significantly following soil covering of waste.
Health impact on Waste-pickers	High	Waste-pickers are at a high risk of health problems.
Surface water run-off	High	The dump site is situated on a moderate sloped hill which may lead to leachate emanating downhill.
Future land use	High	Property use of adjacent plots during and after the operation of the dump site is hindered due to emanating dust, noise, odour, traffic etc.
Reduction of local property value	Low	As the adjacent property is governmentally owned there is no impact on local property value.

Table 11: Significant Impacts/Issues

The above effects have been identified and their potential impact has been assessed, by comparing the situation at the dump site – where there are no health and safety regulations, protocols or controls - with the best practices and universally accepted norms for municipal waste management operations.

The contaminant migration from surface runoff and sub-surface flows during the wet season poses a significant health risk to waste-pickers, either from direct contact or through drinking water. A small ephemeral water body on the north side of the hill is used for drinking water purposes by some waster pickers and hygene conditions are appalling. Although the preliminary analyses of industrial contamination levels showed no cause for concern, the ubiquitous and unregulated presence of faecal and decomposing animal matter in the refuse is an unacceptable health risk. Sanitary waste should be separated immediately from any other material.

Vehicle movements within the dump have resulted in at least one undocumented death of a waste-picker (UNEP 2012).

Gap Analysis

1. Neither health and safety nor medical records were available to determine the number and circumstances of injuries and deaths caused by operations at the dump or the damage done to the health of waste-pickers by their exposure to waste at the site. There is only the anecdotal evidence provided by the waste-pickers themselves.
2. Individual people such as drivers or contractors – as opposed to agents of the state - look after the waste-pickers to an extent, but they operate under no clear management structure.

6 CONCLUSIONS AND RECOMMENDATIONS

The operating regime at the open dump site will benefit from a number of mitigation measures being implemented through the JICA project, which continues to improve the current situation considerably. That effort should receive ongoing support and enhancement when necessary.

That success notwithstanding, this report has identified several major deficiencies in the management and operation of the dump site that require the immediate implementation of remedial administrative action and monitoring. The gravity of the existing situation will be exacerbated as the population of Juba and the area around it grows and the volume of waste increases.

Furthermore there are no practical methods or mechanisms available at the site for the safe disposal or treatment of hazardous wastes like industrial waste, oil sludge, or surgical waste. There is a high probability there will be uncontrolled dumping of hazardous waste materials at the dump site near Jebel Kujur.

Lastly, a contingency plan should be devised to cope if the site does not close as scheduled when it reaches capacity in 2014. There is a very real possibility that the dump may simply be expanded as a matter of expediency.

6.1 Recommendations for Mitigation Measures and Monitoring

All the recommendations given below should be planned in accordance with the involved stakeholders.

Most of the changes that will need to be made to convert the site from an open to a controlled dump are managerial or operational. However, some minor structural modifications - like monitored detention ponds for surface run-off or ventilation measures for the compacted refuse heaps – will also be necessary.

6.1.1 Short and mid-term mitigation measures

Operational Measures

- Fencing of the Dump Site Area
- Removal of existing wastes outside the designated dumping area
- Application of cover material on daily (periodical) basis
- Collection of surface runoff around the site
- Inspection of incoming waste (only municipal solid waste)
- Waste compaction and spreading
- Gas management (ventilation)

Managerial Mitigation Measures

- Discourage illegal dumping activities.
- Plan for handling waste picking activities. Waste-pickers provide an important economic and environmental service in recycling material. There are examples in other countries where innovative recycling enterprises can provide both economic and social benefits, rather than exploitation due to negligence and indifference.
- Plan for alternative or separated dumping of prohibited waste (e.g. hazardous industrial wastes, hospital refuse, munitions).
- Set up a monitoring plan, especially for water resources and flows.
- Establish an onsite Health and Safety Plan

Further recommendations

- Annual auditing of the monitoring and that the general trajectory of improvement are being achieved, as identified in this report
- A detailed EIA be conducted if the existing dumping spread over to the remaining open area of the designated dump site (25,000 m2)
- Conduct a scoping study to identify alternative dump sites
- Conduct an EIA for further proposed dump sites in conjunction with a preliminary spatial planning assessment for Juba City
- Final Closure Procedures (Closure Plan)
- Post Closure Management Programme
- Plan for handling of hazardous wastes
- Conduct a Health and Livelihood Survey of the Waste-pickers
- Conduct a screening to identify alternative dump sites

7 REFERENCES

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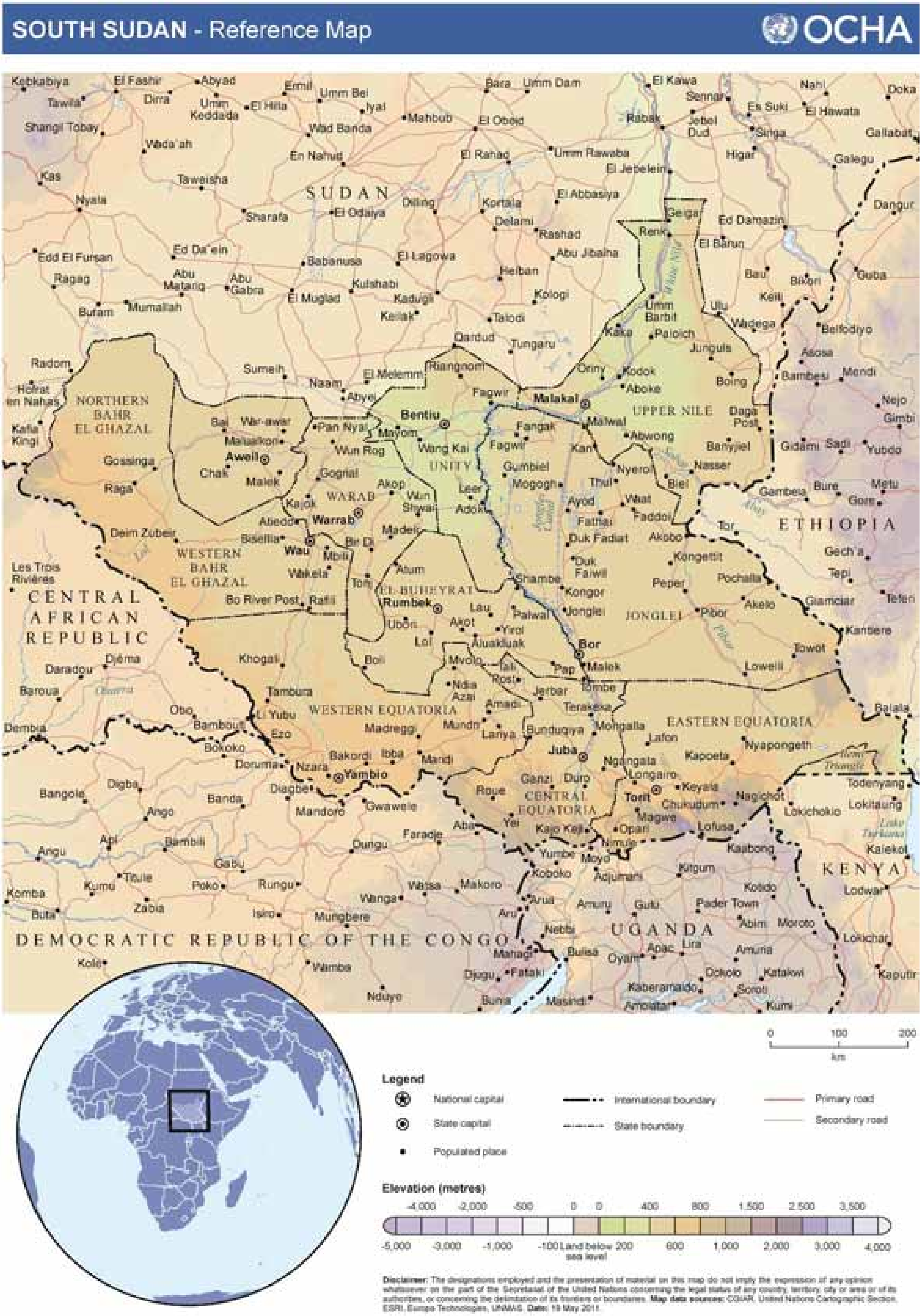
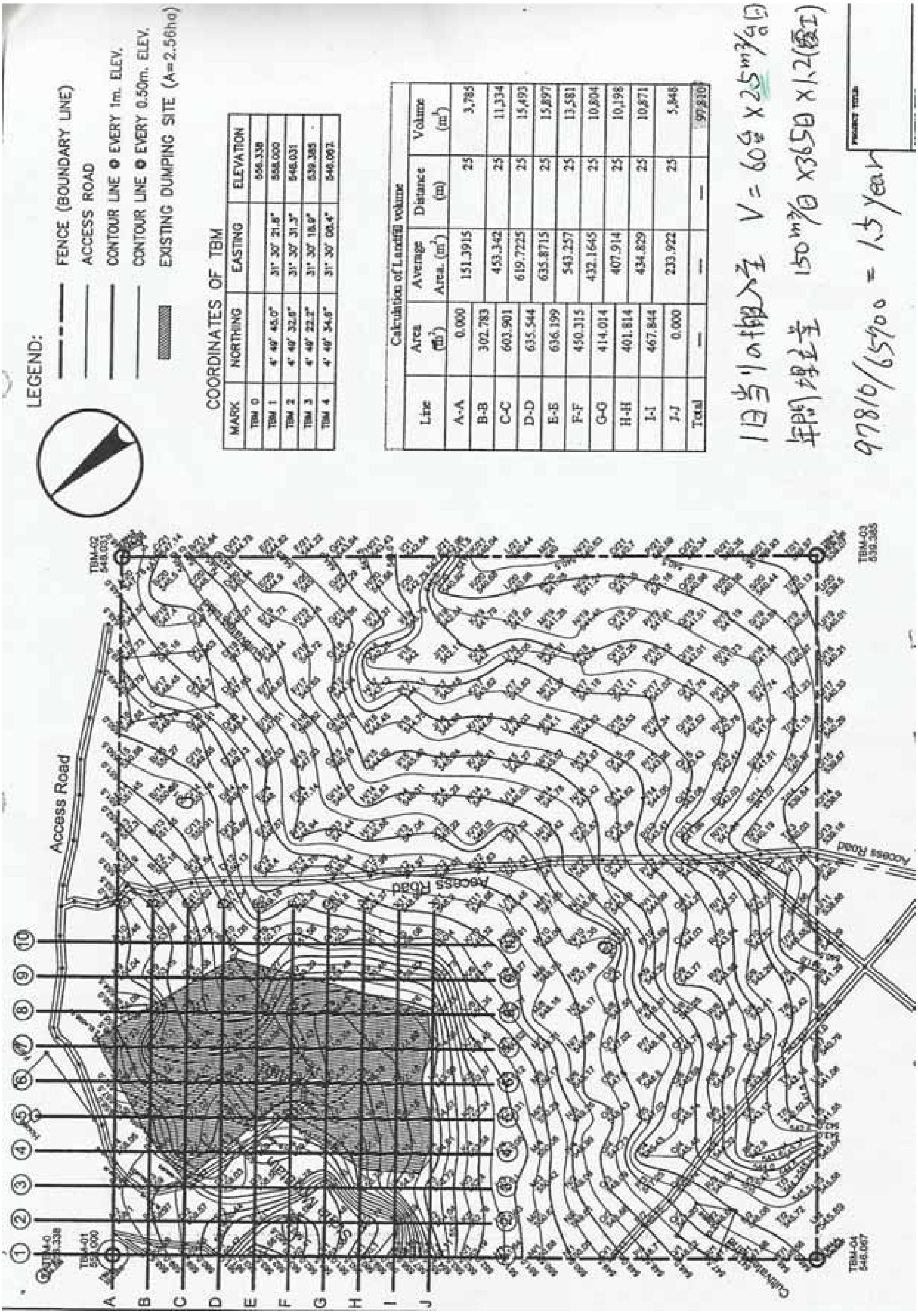
8 APPENDICES

APPENDIX A1: SOUTH SUDAN - REFERENCE MAP

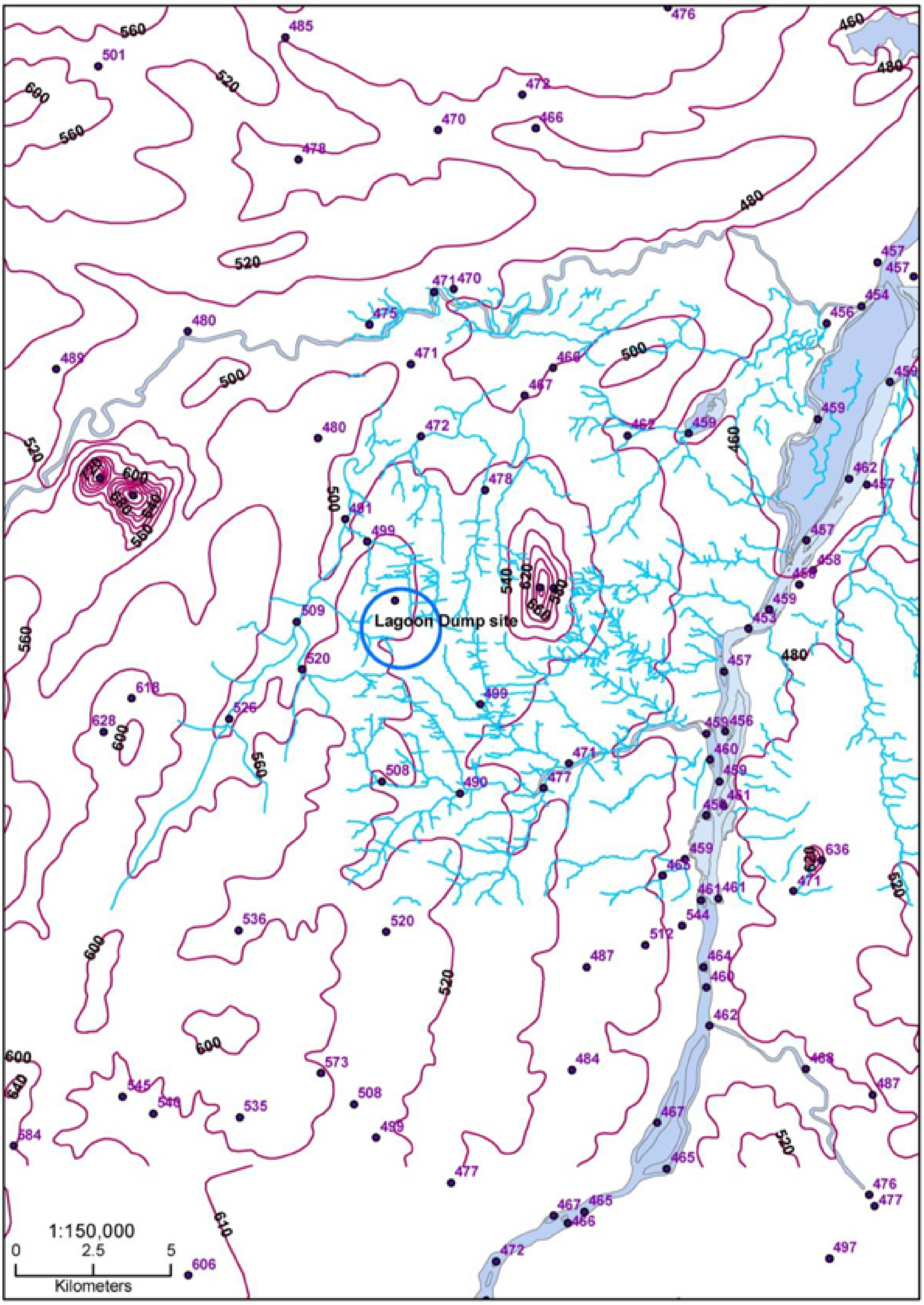


APPENDIX A2: REGIONAL AREA MAP

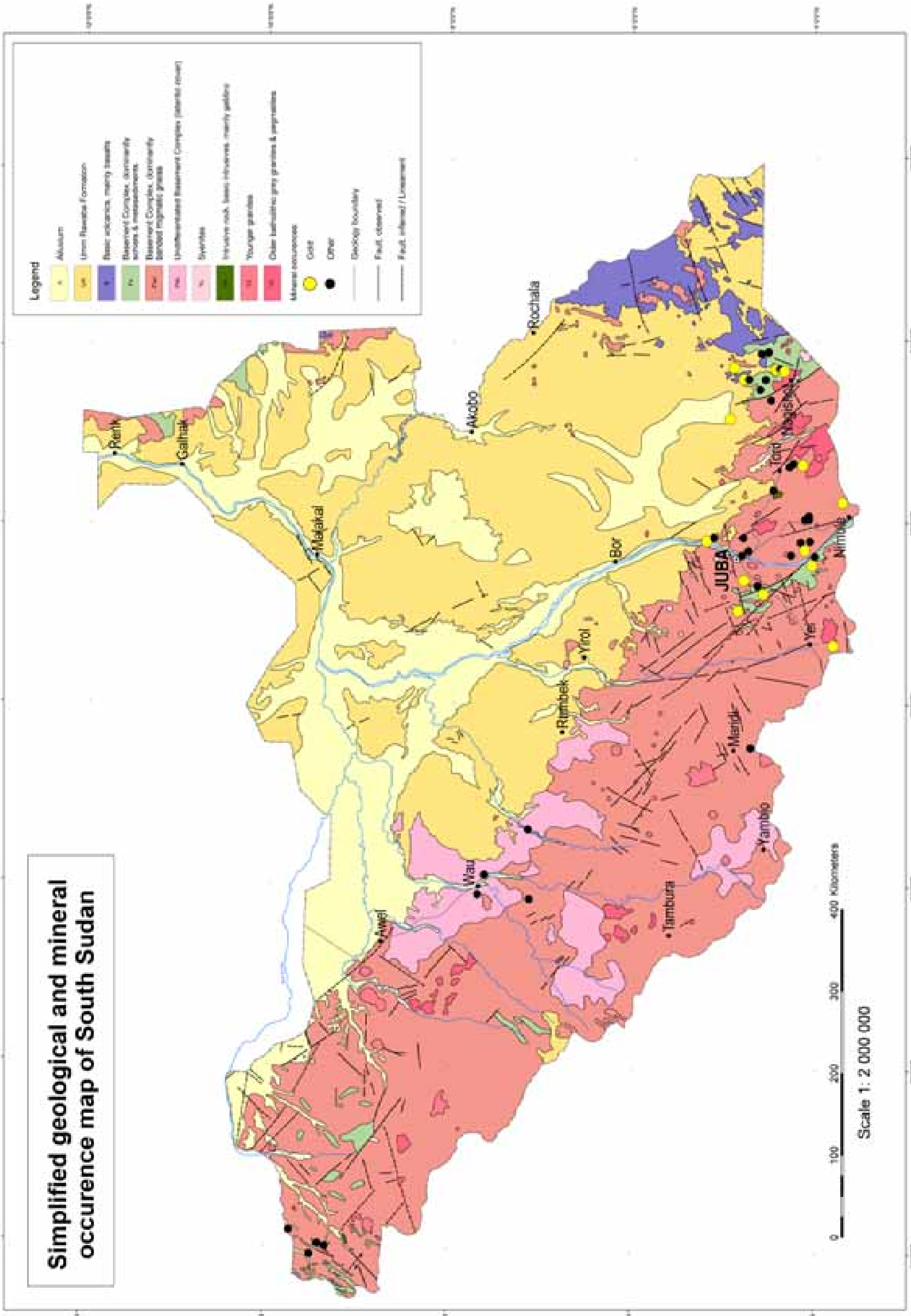
APPENDIX A3: SITE MAP



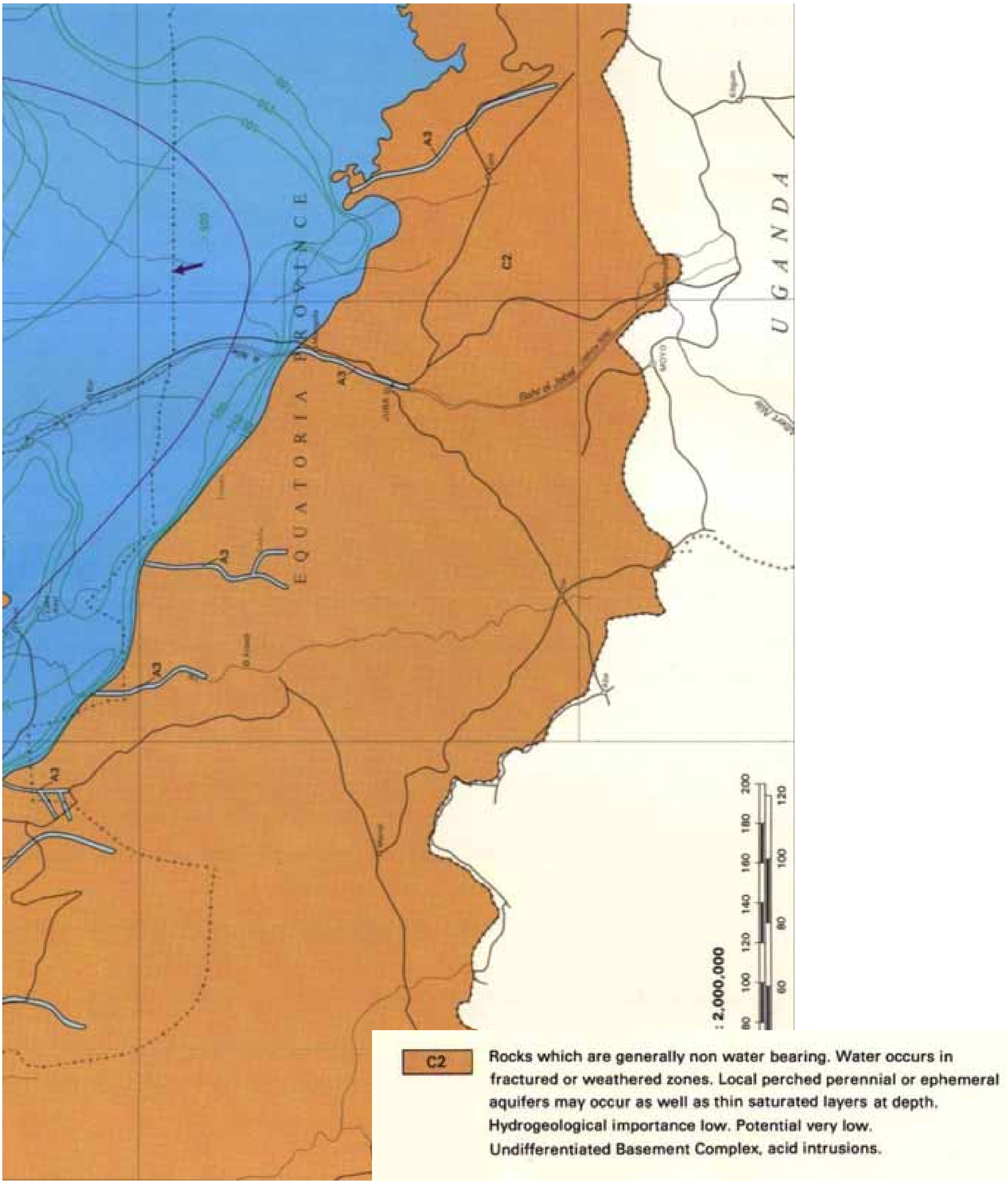
APPENDIX A4:TOPOGRAPHY AREA MAPSHOWING EPHEMERAL STREAMS



APPENDIX A5: GEOLOGICAL MAP



APPENDIX A6:HYDROGEOLOGICAL MAP



APPENDIX A7:AERIAL PHOTOGRAPHS OF DUMP SITE

Main road leading to Yei, Access road and dump site area*(Source: google maps)*

Dump site area, A-B-C-D indicate Coordinates of total projected site area *(Source: google maps)*

APPENDIX A8:SITE PHOTOGRAPHS

Photo 14: Dump Site during heavy rainfall, 12.10.2012

Photo 15: Signboard indicating the Dump Site

Photo 16: Access road, 16.10.2012

Photo 17: Dumping along the access road

Photo 18: Access road, bags with plastic bottles for recycling

Photo 19: Small maize field along the access road

Photo 20: Construction of a control building at the dump site entry

Photo 21: Initial dumping area, facing SW

Photo 22: Dumping activities

Photo 23: Water ponding

Photo 24: The wastes have not been covered with soil and occasional burning can be seen

Photo 25: Waste-pickers

Photo 26: Safety risk of waste-pickers (see woman with child) from nearby heavy machinery (Photo: Jada Albert)

Photo 27: Hospital waste (Syringe with needle) posing a health risk

Photo 28: Dumped expired food

Photo 29:Gathered metal cans

Photo 30:Plastic bottles being collected for sale

APPENDIX A9: CHEMICAL ANALYSIS REPORT

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Business Unit: Umwelt

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report

Project: Sudan

COA no. **CMU12-013746-1** Order no. **CMU-03347-12** Date **02.11.2012**

Sample no.	12-137838-01	12-137838-02	12-137838-03
Date of receipt	25.10.2012	25.10.2012	25.10.2012
Designation	Soil Sample S1	Soil Sample S4	Soil Sample S5
Sample type	Soil	Soil	Soil
Sampling by	Client	Client	Client
Sample amount	ca. 5 kg	ca. 5 kg	ca. 2 kg
Sample container	bucket	bucket	container
Number of containers	1	1	10
Start of analysis	25.10.2012	25.10.2012	25.10.2012
End of analysis	02.11.2012	02.11.2012	02.11.2012

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
Water soluble part	%	OS	<0.1	<0.1	0.15
POX	mg/kg	DM	<0.5	<0.5	<0.5
Sulfide (S) dissolved	mg/l	W/E	0.2	0.4	0.3
Anionic surfactants (MBAS)	mg/l	W/E	<0.01	<0.01	<0.01

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COA no. **CMU12-013746-1** Order no. **CMU-03347-12** Date **02.11.2012**

Sample preparation

Sample No.		12-137838-01	12-137838-02	12-137838-03
Sample designation		Soil Sample S1	Soil Sample S4	Soil Sample S5
Aqua regia dissolution	DM	29.10.12	29.10.12	29.10.12

Physical tests

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
Dry matter	Gew%	OS	96	96	94
Loss on ignition (550°C)	Gew%	DM	1.80	2.10	2.70

Volatile aromatic hydrocarbons (BTEX)

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
Benzene	mg/kg	DM	<0.01	0.05	<0.01
Toluene	mg/kg	DM	<0.01	<0.01	<0.01
Ethyl benzene	mg/kg	DM	<0.01	<0.01	<0.01
m-, p-Xylene	mg/kg	DM	<0.01	<0.01	<0.01
o-Xylene	mg/kg	DM	<0.01	<0.01	<0.01
Sum of presented BTEX	mg/kg	DM	-/-	0.05	-/-

Elements

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
Chromium (VI)	mg/kg	DM	<0.2	<0.2	<0.2

Sum Parameters

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
EOX	mg/kg	DM	<0.5	<0.5	<0.5
Hydrocarbons C10-C40	mg/kg	DM	<10	16	79
Phenol, steam volatile	mg/kg	DM	<0.1	<0.1	<0.1
TOC	Gew%	DM	0.11	0.18	0.9

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Polycyclic aromatic hydrocarbons (PAH)

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
Naphthalene	mg/kg	DM	<0,02	<0,02	<0,02
1-Methylnaphthalene	mg/kg	DM	<0,02	<0,02	<0,02
2-Methylnaphthalene	mg/kg	DM	<0,02	<0,02	<0,02
Acenaphthylene	mg/kg	DM	<0,2	<0,2	<0,2
Acenaphthene	mg/kg	DM	<0,02	<0,02	<0,02
Fluorene	mg/kg	DM	<0,02	<0,02	<0,02
Phenanthrene	mg/kg	DM	<0,02	<0,02	<0,02
Anthracene	mg/kg	DM	<0,02	<0,02	<0,02
Fluoranthene	mg/kg	DM	<0,02	<0,02	<0,02
Pyrene	mg/kg	DM	<0,02	<0,02	<0,02
Benzo(a)anthracene	mg/kg	DM	<0,02	<0,02	<0,02
Chrysene	mg/kg	DM	<0,02	<0,02	<0,02
Benzo(b)fluoranthene	mg/kg	DM	<0,02	<0,02	<0,02
Benzo(k)fluoranthene	mg/kg	DM	<0,02	<0,02	<0,02
Benzo(a)pyrene	mg/kg	DM	<0,02	<0,02	<0,02
Dibenz(ah)anthracene	mg/kg	DM	<0,02	<0,02	<0,02
Benzo(ghi)perylene	mg/kg	DM	<0,02	<0,02	<0,02
Indeno(123-cd)pyrene	mg/kg	DM	<0,02	<0,02	<0,02
Sum of presented PAH	mg/kg	DM	-/-	-/-	-/-

In eluate, filtrated

Kations, anions and nonmetals

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
Cyanide total (CN)	µg/l	W/E	<5	<5	<5
Ammonium (NH4)	mg/l	W/E	<0,05	<0,05	0,6
Ammonium-nitrogen (NH4-N)	mg/l	W/E	<0,04	<0,04	0,47
Chloride (Cl)	mg/l	W/E	1	4	18
Cyanideseasily released (CN)	mg/l	W/E	<0,01	<0,01	<0,01
Fluoride (F)	mg/l	W/E	1,22	1	0,5
Nitrate (NO3)	mg/l	W/E	<1	3	8
Nitrate nitrogen	mg/l	W/E	<0,23	0,68	1,8
Nitrite (NO2)	mg/l	W/E	<0,01	<0,01	<0,01
Nitrite-N (NO2-N)	mg/l	W/E	<0,003	<0,003	<0,003
Sulfate (SO4)	mg/l	W/E	2	4	11

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Aqua regia extract

Elements

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
Mercury (Hg)	mg/kg	DM	<0,1	<0,1	<0,1
Aluminium (Al)	mg/kg	DM	19.000	23.000	7.100
Antimony (Sb)	mg/kg	DM	<5	<5	<5
Arsenic (As)	mg/kg	DM	2	3	1,3
Barium (Ba)	mg/kg	DM	320	520	82
Beryllium (Be)	mg/kg	DM	<0,3	<0,3	0,5
Lead (Pb)	mg/kg	DM	8,3	8,8	10
Boron (B)	mg/kg	DM	<10	<10	<10
Cadmium (Cd)	mg/kg	DM	<0,3	<0,3	<0,3
Calcium (Ca)	mg/kg	DM	4.400	3.500	4.700
Chromium (Cr)	mg/kg	DM	83	110	28
Cobalt (Co)	mg/kg	DM	17	24	5,4
Iron (Fe)	mg/kg	DM	28.000	33.000	16.000
Copper (Cu)	mg/kg	DM	34	41	10
Magnesium (Mg)	mg/kg	DM	10.000	14.000	1.700
Manganese (Mn)	mg/kg	DM	370	490	190
Molybdenum (Mo)	mg/kg	DM	<3	<3	<3
Nickel (Ni)	mg/kg	DM	38	59	8,9
Selenium (Se)	mg/kg	DM	<5	<5	<5
Silver (Ag)	mg/kg	DM	<10	<10	<10
Thallium (Tl)	mg/kg	DM	<0,5	<0,5	<0,5
Vanadium (V)	mg/kg	DM	65	90	35
Zinc (Zn)	mg/kg	DM	64	89	120
Tin (Sn)	mg/kg	DM	<5	<5	<5

PCB

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
PCB no. 28	mg/kg	DM	<0,01	<0,01	<0,01
PCB no. 52	mg/kg	DM	<0,01	<0,01	<0,01
PCB no. 101	mg/kg	DM	<0,01	<0,01	<0,01
PCB no. 138	mg/kg	DM	<0,01	<0,01	<0,01
PCB no. 153	mg/kg	DM	<0,01	<0,01	<0,01
PCB no. 180	mg/kg	DM	<0,01	<0,01	<0,01
PCB no. 118	mg/kg	DM	<0,01	<0,01	<0,01
Sum of 7 PCB	mg/kg	DM	-/-	-/-	-/-

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Sum Parameters

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
AOX	µg/l	W/E	<20	<20	25
TOC	mg/l	W/E	40	5	38
Phenol, steam volatile	µg/l	W/E	<10	<10	<10

Hydrocarbons

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
Hydrocarbon index	mg/l	W/E	<0,1	<0,1	<0,1

Polycyclic aromatic hydrocarbons (PAH)

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
Naphthalene	µg/l	W/E	<0,01	<0,01	<0,01
Acenaphthylene	µg/l	W/E	<0,1	<0,1	<0,1
Acenaphthene	µg/l	W/E	<0,01	<0,01	<0,01
Fluorene	µg/l	W/E	<0,01	<0,01	<0,01
Phenanthrene	µg/l	W/E	0,02	0,02	0,06
Anthracene	µg/l	W/E	<0,01	<0,01	<0,01
Fluoranthene	µg/l	W/E	<0,01	<0,01	0,28
Pyrene	µg/l	W/E	<0,01	<0,01	0,24
Benzo(a)anthracene	µg/l	W/E	<0,01	<0,01	0,1
Chrysene	µg/l	W/E	<0,01	<0,01	0,1
Benzo(b)fluoranthene	µg/l	W/E	<0,01	<0,01	0,1
Benzo(k)fluoranthene	µg/l	W/E	<0,01	<0,01	0,06
Benzo(a)pyrene	µg/l	W/E	<0,005	<0,005	0,1
Dibenz(ah)anthracene	µg/l	W/E	<0,01	<0,01	0,02
Benzo(ghi)perylene	µg/l	W/E	<0,01	<0,01	0,11
Indeno(123-cd)pyrene	µg/l	W/E	<0,01	<0,01	0,1
Sum of 4 PAH	µg/l	W/E	-/-	-/-	0,37
Sum of 6 PAH	µg/l	W/E	-/-	-/-	0,75
Sum of presented PAH	µg/l	W/E	0,02	0,02	1,27

Eluate preparation

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COA no. **CMU12-013746-1** Order no. **CMU-03347-12** Date **02.11.2012**

Physical tests

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
pH-value		W/E	8,4	8,7	8,9
Conductivity [25°C]	µS/cm	W/E	51	72	187

Elements

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
Chromium (VI)	mg/l	W/E	<0,008	<0,008	<0,008
Mercury (Hg)	µg/l	W/E	<0,2	<0,2	<0,2
Aluminium (Al)	µg/l	W/E	39	51	50
Antimony (Sb)	µg/l	W/E	<5	<5	<5
Arsenic (As)	µg/l	W/E	<5	<5	<5
Barium (Ba)	µg/l	W/E	13	26	11
Beryllium (Be)	µg/l	W/E	<1	<1	<1
Lead (Pb)	µg/l	W/E	<3	<3	<3
Boron (B)	µg/l	W/E	14	14	13
Cadmium (Cd)	µg/l	W/E	<0,5	<0,5	<0,5
Calcium (Ca)	µg/l	W/E	3.700	5.300	3.700
Chromium (Cr)	µg/l	W/E	<3	<3	<3
Cobalt (Co)	µg/l	W/E	<3	<3	<3
Iron (Fe)	µg/l	W/E	18	17	22
Copper (Cu)	µg/l	W/E	<3	3	55
Magnesium (Mg)	µg/l	W/E	1.200	1.200	830
Manganese (Mn)	µg/l	W/E	<10	<10	<10
Molybdenum (Mo)	µg/l	W/E	<3	<3	4
Nickel (Ni)	µg/l	W/E	<3	<3	<3
Phosphorus (P)	µg/l	W/E	26	130	700
Phosphorus (calc.as PO4)	µg/l	W/E	80	400	2.100
Selenium (Se)	µg/l	W/E	<5	<5	<5
Silver (Ag)	µg/l	W/E	<10	<10	<10
Thallium (Tl)	µg/l	W/E	<1	<1	<1
Vanadium (V)	µg/l	W/E	<5	8	32
Zinc (Zn)	µg/l	W/E	<5	<5	6
Tin (Sn)	µg/l	W/E	<5	<5	<5

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COA no.	CMU12-013746-1	Order no.	CMU-03347-12	Date	02.11.2012

Sample preparation

Sample No.			12-137838-01	12-137838-02	12-137838-03
Sample designation			Soil Sample S1	Soil Sample S4	Soil Sample S5
Moisture	%	OS	4	4	6
Volume of leachant	ml	OS	4250	4250	4250
Fresh mass of measurement sample	g	OS	467,3	467,5	467,5

Method	Norm	
Aqua regia decomposition	EN 13657	Umweltanalytik München
Dry matter	EN 14346	Umweltanalytik München
Determination of the loss on ignition	EN 15169	Umweltanalytik München
High volatile organic carbons (BTEX)	ISO 22155	Umweltanalytik München
Chromium (VI)	DIN 19734	Umweltanalytik München
Extractable organic halogen compounds (EOX)	DIN 38414 S17	Umweltanalytik München
Hydrocarbons in waste (GC)	EN 14039	Umweltanalytik München
Phenol index after distillation in solid	EN ISO 14402 mod.	Umweltanalytik München
TOC (total organic carbon) in solids	ISO 10694	Umweltanalytik Neuried
Mercury	ISO 16772	Umweltanalytik München
Determination of selected elements (ICP-OES / ICP-MS)	ISO 11885	Umweltanalytik München
Polychlorinated biphenyls (PCB) in sludge/sediment	DIN 38414 S20	Umweltanalytik München
Polycyclische aromatische Kohlenwasserstoffe (PAK)	LUA Merkblatt Nr. 1	Umweltanalytik München
Cyanide total	EN ISO 14403	Umweltanalytik München
Ammonium in water/ eluate	DIN 38406 E5-1/ EN ISO 11732	Umweltanalytik München
Dissolved anions chloride in water/eluate	EN ISO 10304-1	Umweltanalytik München
Cyanide easily released (water)	DIN 38405 D13/D14	Umweltanalytik München
Fluoride (F)	DIN 38405-4	Umweltanalytik München
Anion eluate in water/ eluate	EN ISO 10304 D19/D20	Umweltanalytik München
Sulfate in water/eluate	EN ISO 10304 D19/D20	Umweltanalytik München
pH-value in eluate	DIN 38404 C5	Umweltanalytik München
Electric conductivity in eluate	EN 27888	Umweltanalytik München
Chromium(VI) in water/ eluate	DIN 38405 D24	Umweltanalytik München
Mercury in water/eluate (AAS)	EN 1483	Umweltanalytik München
Determination of selected elements (ICP-OES / ICP-MS)	ISO 11885	Umweltanalytik München
Adsorbable organic halogen compounds (AOX)	ISO 9562	Umweltanalytik Hannover
Total organic carbon (TOC) in water / eluate	EN 1484 (H3)	Umweltanalytik München
Phenol index in water/eluate	EN ISO 14402	Umweltanalytik München
Hydrocarbon index in water/eluate (GC)	EN ISO 9377-2	Umweltanalytik München
Polycyclische aromatische Kohlenwasserstoffe (PAK)	EN ISO 17993 F18	Umweltanalytik München
Leachate, agitate method, W/F=10 l/kg	EN 12457-4	Umweltanalytik München
Water-soluble component in DepV 2009	EN 14346	Umweltanalytik München
Sulfide dissolved in water / eluate	DIN 38405 D26	Umweltanalytik Oppin
Anionic surfactants (MBAS)	DIN EN 903	Umweltanalytik Oppin
Bound organic bounded halogens (POX)	DIN 38414 S17 mod.	Umweltanalytik München

DM	Dry matter
OS	Original substance
W/E	water/eluate

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COA no.	CMU12-013746-1	Order no.	CMU-03347-12	Date	02.11.2012

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Dr. Nils Kunze
Dipl.-Geologist
Consultant Environment

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COA no.	CMU12-013899-2	Order no.	CMU-03347-12	Date	06.11.2012

Sample no.		12-137835-01
Designation		Oberflächenwasser
Ammonium (NH4)	mg/l	7,22
Ammonium-nitrogen (NH4-N)	mg/l	5,60
Cyanide total (CN)	µg/l	<5
Cyanideseasily released (CN)	mg/l	<0,01
Fluoride (F)	mg/l	<0,2
Nitrate (NO3)	mg/l	2
Nitrate nitrogen	mg/l	0,45
Nitrite (NO2)	mg/l	<0,01
Nitrite-N (NO2-N)	mg/l	<0,003
Phosphorus (P)	mg/l	7,6
Phosphorus (calc. as PO4)	mg/l	23
Sulfide (S) dissolved	mg/l	0,1
Chloride (Cl)	mg/l	750
Sulfate (SO4)	mg/l	2

Volatile aromatic hydrocarbons (BTEX)

Sample no.		12-137835-01
Designation		Oberflächenwasser
Benzene	µg/l	1
Toluene	µg/l	0,3
Ethyl benzene	µg/l	<0,2
m-, p-Xylene	µg/l	<0,2
o-Xylene	µg/l	<0,2
Styrene	µg/l	<0,2
Cumene	µg/l	<0,2
Sum of presented BTEX	µg/l	1,3

Elements

Sample no.		12-137835-01	12-137835-01-1
Designation		Oberflächenwasser	Oberflächenwasser
Chromium (VI)	mg/l	<0,008	
Mercury (Hg)	µg/l	<0,2	
Aluminium (Al)	µg/l	1.100	82
Antimony (Sb)	µg/l	<5	<5
Arsenic (As)	µg/l	6	11
Barium (Ba)	µg/l	860	690
Beryllium (Be)	µg/l	<1	<1
Lead (Pb)	µg/l	31	<3
Boron (B)	mg/l	0,92	0,81
Cadmium (Cd)	µg/l	<0,5	<0,5
Calcium (Ca)	mg/l	380	370
Chromium (Cr)	µg/l	18	7
Cobalt (Co)	µg/l	17	<3

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Herr Dipl.-Ing. Michael Schauderna
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AUSTRIA

Business Unit: Umwelt
Your contact: Dr. Nils Kunze

report

Project: South Sudan

COA no.	CMU12-013899-2	Order no.	CMU-03347-12	Date	06.11.2012

	12-137835-01	12-137835-01-1
Date of receipt	24.10.2012	24.10.2012
Designation	Oberflächenwasser	Oberflächenwasser
Sample type	Surface water	Surface water
Sampling by	Client	Client
Number of containers	15	15
Start of analysis	25.10.2012	29.10.2012
End of analysis	05.11.2012	05.11.2012

Sample no.		12-137835-01
Designation		Oberflächenwasser
pH-value		7,0
Conductivity [25°C]	µS/cm	8662

Sum Parameters

Sample no.		12-137835-01
Designation		Oberflächenwasser
AOX	µg/l	<1.000
Phenol, steam volatile	µg/l	2.150
TOC	mg/l	2.280
Hydrocarbon index	mg/l	0,3

Kations, anions and nonmetals

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COA no. **CMU12-013899-2** Order no. **CMU-03347-12** Date **06.11.2012**

Sample no.		12-137835-01	12-137835-01-1
Designation		Oberflächenwasser	Oberflächenwasser
Iron (Fe)	mg/l	22	1,1
Copper (Cu)	µg/l	12	<3
Magnesium (Mg)	mg/l	190	170
Manganese (Mn)	mg/l	6,3	5,7
Molybdenum (Mo)	µg/l	<3	<3
Nickel (Ni)	µg/l	21	7
Selenium (Se)	µg/l	<5	<5
Silver (Ag)	µg/l	<10	<10
Thallium (Tl)	µg/l	<1	<1
Vanadium (V)	µg/l	<3	<3
Zinc (Zn)	µg/l	370	28
Tin (Sn)	µg/l	<5	6

Physical tests

Sample no.		12-137835-01
Designation		Oberflächenwasser
Evaporation residue	mg/l	5.900

Chlorinated volatile organic compounds (VOX)

Sample no.		12-137835-01
Designation		Oberflächenwasser
Vinyl chloride	µg/l	<0,5
Dichloromethane	µg/l	<0,5
cis-1,2 Dichloroethene	µg/l	<0,5
Trichlormethane	µg/l	<0,5
1,1,1-Trichloroethane	µg/l	<0,5
Tetrachloromethane	µg/l	<0,5
Trichloroethene	µg/l	<0,5
Tetrachloroethene	µg/l	<0,5
1,2-Dichloroethane	µg/l	<0,5
Sum of presented VOX	µg/l	-/-
Sum of canc. CHC (VC, CCl4, 1,2-DCM)	µg/l	-/-

Polycyclic aromatic hydrocarbons (PAH)

Sample no.		12-137835-01
Designation		Oberflächenwasser
Naphthalene	µg/l	<0,1
Acenaphthylene	µg/l	<1
Acenaphthene	µg/l	<0,1
Fluorene	µg/l	<0,1
Phenanthrene	µg/l	<0,1
Anthracene	µg/l	<0,1
Fluoranthene	µg/l	<0,1

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COA no. **CMU12-013899-2** Order no. **CMU-03347-12** Date **06.11.2012**

Sample no.		12-137835-01
Designation		Oberflächenwasser
Pyrene	µg/l	<0,1
Benzo(a)anthracene	µg/l	<0,1
Chrysene	µg/l	<0,1
Benzo(b)fluoranthene	µg/l	<0,1
Benzo(k)fluoranthene	µg/l	<0,1
Benzo(a)pyrene	µg/l	<0,05
Dibenz(ah)anthracene	µg/l	<0,1
Benzo(ghi)perylene	µg/l	<0,1
Indeno(123-cd)pyrene	µg/l	<0,1
Sum of 4 PAH	µg/l	-/-
Sum of 6 PAH	µg/l	-/-
Sum of presented PAH	µg/l	-/-

12-137835-01
Kommentare der Ergebnisse:
AOX W/E, AOX: Anhebung der Bestimmungsgrenze aufgrund von Matrixeffekten.
PAK W/E (EN ISO 17993), Naphthalin: Konnte nur in einer 1:10 verd. gemessen werden. Zuviele Störungen! Deshalb BG höher.

12-137835-01-1
Metalle wurden aus der nicht angesäuerten Flasche gemessen d.h. die Trübstoffe der Probe wurden mit dieser Analyse nicht miterfasst.

Shortcuts and Methods

Adsorbable organic halogen compounds (AOX)	ISO 9562	Umweltanalytik Hannover
Phenol index in water/eluate	EN ISO 14402	Umweltanalytik München
Total organic carbon (TOC) in water / eluate	EN 1484 (H3)	Umweltanalytik München
Hydrocarbon index in water/eluate (GC)	EN ISO 9377-2	Umweltanalytik München
Ammonium in water/eluate	DIN 38406-E5-1/EN ISO 11732	Umweltanalytik München
Cyanide total	EN ISO 14403	Umweltanalytik München
Cyanide easily released (water)	DIN 38405 D13/D14	Umweltanalytik München
Fluoride (F)	DIN 38405-4	Umweltanalytik München
Anions in water/eluate	EN ISO 10304 D19/D20	Umweltanalytik München
Determination of selected elements (ICP-OES / ICP-MS)	ISO 11885	Umweltanalytik München
Sulfide dissolved in water/eluate	DIN 38405 D27	Umweltanalytik Oppin
Dissolved anions chloride in water/eluate	EN ISO 10304-1	Umweltanalytik München
Sulfate in water/eluate	EN ISO 10304 D19/D20	Umweltanalytik München
High volatile organic carbons (BTEX)	DIN 38407 F9	Umweltanalytik München
Chromium(VI) in water eluate	DIN 38405 D24	Umweltanalytik München
Mercury in water/eluate (AAS)	EN 1483	Umweltanalytik München
Total dry residue in water/eluate (evaporation residue)	DIN 38409-1	Umweltanalytik München
Lightly volatile halogenated hydrocarbons (CHC)	EN ISO 10301	Umweltanalytik München
Polycyclische aromatische Kohlenwasserstoffe (PAK)	EN ISO 17993 F18	Umweltanalytik München
pH-value in eluate	DIN 38404 C5	Umweltanalytik München
Electric conductivity in eluate	EN 27888	Umweltanalytik München

W/E water/eluate

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COA no.	CMU12-013899-2	Order no.	CMU-03347-12	Date	06.11.2012

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report

Project: South Sudan

COA no. **CMU12-013906-2** Order no. **CMU-03347-12** Date **06.11.2012**

Date of receipt		12-137824-01
		24.10.2012
Designation		Trinkwasser
Sample type		Drinking water
Sampling by		Client
Number of containers		15
Start of analysis		25.10.2012
End of analysis		05.11.2012

Sample no.		12-137824-01
Designation		Trinkwasser
Chlorine (Cl)	mg/l	<0,1
Chlorine (Cl), free	mg/l	<0,1

Annexe 2 - Chemical parameters part 1

Sample no.		12-137824-01
Designation		Trinkwasser
Benzene	mg/l	<0,0002
Toluene	µg/l	<0,2
Ethyl benzene	µg/l	<0,2
m-, p-Xylene	µg/l	<0,2
o-Xylene	µg/l	<0,2
Styrene	µg/l	<0,2
Cumene	µg/l	<0,2
Sum of presented BTEX	µg/l	-/-
Cyanide total (CN)	mg/l	<0,005
1,2-Dichloroethane	mg/l	<0,0005

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COA no. **CMU12-013906-2** Order no. **CMU-03347-12** Date **06.11.2012**

Sample no.		12-137824-01
Designation		Trinkwasser
Fluoride (F)	mg/l	1
Nitrate (NO3)	mg/l	<1
Trichloroethene	mg/l	<0,0005
Tetrachloroethene	mg/l	<0,0005
Boron (B)	mg/l	<0,01
Chromium (Cr)	mg/l	<0,003
Mercury (Hg)	mg/l	<0,0002
Uranium (U)	mg/l	<0,001

Annexe 2 - Chemical parameters part 2

Sample no.		12-137824-01
Designation		Trinkwasser
Antimony (Sb)	mg/l	<0,005
Arsenic (As)	mg/l	<0,005
Lead (Pb)	mg/l	<0,003
Cadmium (Cd)	mg/l	<0,0005
Nickel (Ni)	mg/l	<0,003
Copper (Cu)	mg/l	<0,003
Barium (Ba)	µg/l	65
Molybdenum (Mo)	µg/l	<3
Nitrite (NO2)	mg/l	0,37
Dichloromethane	µg/l	<0,5
cis-1,2 Dichloroethene	µg/l	<0,5
Tetrachloromethane	µg/l	<0,5
Sum of presented VOX	µg/l	-/-
Sum of canc. CHC (VC, CCl4, 1,2-DCM)	µg/l	-/-

Annexe 3 - Indicator parameters

Sample no.		12-137824-01
Designation		Trinkwasser
Chloride (Cl)	mg/l	37
Conductivity [25°C]	µS/cm	380
Aluminium (Al)	mg/l	0,031
Manganese (Mn)	mg/l	<0,01
Sodium (Na)	mg/l	50
TOC	mg/l	6
Sulfate (SO4)	mg/l	4
pH-value		7,2

Extension of TrinkwV 2001

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COA no.	CMU12-013600-2	Order no.	CMU-63347-12	Date	06.11.2012

Sample no.		12-137824-01
Designation		Trinkwasser
Calcium (Ca)	mg/l	22
Magnesium (Mg)	mg/l	23
Total hardness	°dH	8,4

Shortcuts and Methods

High volatile organic carbons (BTEX)	[illegible]	Umweltanalytik [illegible]
Cyanide in water/eluate	[illegible]	Umweltanalytik [illegible]
Lightly volatile halogenated hydrocarbons (LHC)	[illegible]	Umweltanalytik [illegible]
Fluoride (F)	[illegible]	Umweltanalytik [illegible]
Nitrate (NO3)	[illegible]	Umweltanalytik [illegible]
Determination of selected elements (ICP-OES / ICP-MS)	[illegible]	Umweltanalytik [illegible]
Nitrite in water / eluate	[illegible]	Umweltanalytik [illegible]
Dissolved anions chloride in water/eluate	[illegible]	Umweltanalytik [illegible]
Conductivity in water	[illegible]	Umweltanalytik [illegible]
Total organic carbon (TOC) in water / eluate	[illegible]	Umweltanalytik [illegible]
Sulfate in water/eluate	[illegible]	Umweltanalytik [illegible]
pH-value in water	[illegible]	Umweltanalytik [illegible]
Gesamthärte in Wasser/Eluat	[illegible]	Umweltanalytik [illegible]
Chrome (D) in water/eluate	[illegible]	Umweltanalytik [illegible]

W/E water/eluate

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