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HUMAN HEALTH RISK ASSESSMENT
EAST AREA TA'AS SITE (TEL AVIV, IL)

RAMBOLL ENVIRON

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EAST AREA TA'AS SITE (TEL AVIV, IL)

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CONTENTS

TABLES

DRAWING

ANNEXES

1. INTRODUCTION AND SCOPE OF WORK

Yahel Engineering Initiating Projects Ltd. (Yahel) on behalf of the Israel Land Administration (ILA) requested Ramboll Environ Italy S.r.l. (Ramboll Environ) to develop a Tier 2 Human Health Risk Assessment (HHRA) for the eastern part of the Nof Yam project area, or "Ta'as site", external and not previously included in the redevelopment project where a wider risk assessment process is ongoing and where a urban redevelopment is also envisaged.

In Ramboll Environ understanding, the redevelopment plan involves the construction of residential buildings, as reported in the conceptual designs of building plan provided by Yahel (Rif. **Annex 1**), surrounded by landscaped areas.

To assess whether the entire plot of land to be redeveloped might have been impacted by a potential contamination and, in the event, whether this impairments may pose a risk to the health of the future residents, Yahel accomplished the following investigations:

- Active soil gas survey;
- Shallow soils sampling and analytical screening.

Based on the information provided, no direct investigations have been performed on deeper soils and the underlying groundwater.

The job goal is to develop a HHRA aiming at assessing whether there is a potential risk for the potentially exposed future receptors associated with contaminants detected in concentrations above the target levels.

The HHRA has been developed according to the indications provided in the technical guidance "Israel Risk-Based Corrective Action (IRBCA)" edited by the IRBCA Workgroup[1].

This document has been prepared by Ramboll Environ on behalf of Yahel, based in the data provided (Section 4), their review and elaborations (Section 5) and describes the assumptions (Section 6 and 7) and outcomes (Section 8).

1.1 Disclaimer

The HHRA has been developed based on characterization data provided by Yahel in table's format. Analytical certificates have not been provided, therefore Ramboll Environ did not have access to the original data forms.

Data have been considered as valid, but have not been verified, so in view of the above Ramboll Environ does not assume any responsibility with the Client and third parties if any mistakes related to the data transcription has occurred.

The Scope of Work did not entailed an assessment of the contamination mechanisms nor of the contamination origin/s and source/s. Furthermore, the Scope of Work did not encompass the calculations of Site Specific Target Levels (SSTLs) for remediation and/or the development of any remedial hypothesis, design and/or plan, but to address areas where the recorded concentrations may pose a risk to potential receptors.

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[1] IRBCA Workgroup is participated by: the Israel Ministry of Environment (MoE), the Israeli's Water Authority (IWA), the Ministry of Health (MoH), the Israeli Institute of Energy and Environment (IIEE), the Israel Electric Corporation (IEC), the Israeli Institute, Manufacture's Association of Israel (IIMAI) and the Israel Union of Environmental Defense (IUED)

2. SITE DESCRIPTION

The area of interest (hereafter "the site") is approximately 700,000 square meters wide of irregular shape, it is located in the Sharon region, 15 kilometers north to Tel Aviv and within the area of jurisdiction of Herzlyia, between the coast, eastward, and the Highway #2, westward, and it is included in the "Nof Yam-Apolonia Building Plan". Just a small portion, approximately 2% of the site is located within the perimeter of "Ta'as site", with the remaining 98% located outside (ref. **Drawing 1**).

Ta'as Site was a military site specializing in the production of propellants, explosives and ingredients, including Trinitrotoluene (TNT), Nitrocellulose (NC) and Nitroguanidine (NQ), for mortar, tank and artillery ammunition and ball powders, as well as for pesticides production. The production started in the 1950s and stopped completely in 1996 when the facility was dismantled and relocated in a different area. The majority of the production buildings, were demolished and vacated.

In the plot of land targeted for this work, no industrial and/or production activity is known to have taken place according to the information provided by Yahel.

At the site an urban development plan is envisioned, entailing both buildings for residential and commercial purposes as well as green areas. A layout of the urban development plan has been provided by Yahel (cfr Drawing X), indicating the different land destinations and future buildings footprint.

3. REFERENCE DOCUMENTS

The following documents provided by Yahel for the scope of the present work have been considered in this document:

[1] *Plans of "APB Buini" redevelopment;*

[2] *"Building Plan description.xls";*

[3] *"Location of soil gas sampling Boreholes.dwg":*

[4] *"Nof-Yam Soil gas results excel.xls";*

[5] *"Wind Rose Nof Yam.pdf".*

The following documents previously provided by Yahel have been considered in this document as appropriate:

i. *Nof Yam Site - Remedial Investigation Report, Volume 1, 1996 - This document contains the characterization report and the risk assessment prepared by Ecology and Environment Inc (hereinafter IR report);*

ii. *Nof Yam Site - Remedial Investigation Report, Volume 2, 1996 - This document contains the maps annexed to the characterization report (annexed to Doc #1);*

iii. *Excel data Taas Nof Yam , 1996 - This document contains the Data Base with the characterization results (annexed to Doc #1);*

iv. *HM4000 PRW - Taas Nof Yam - This document contains site maps in *dwg format, partly from the characterization report (annexed to Doc #1);*

v. *SOW VI.3 - Taas Nof Yam – This document includes some site maps in *dwg format (utilities, land uses, etc.), plus the documentation referred to a Request for Proposal for remedial activities to be conducted at Nof Yam dated at 2003,*

vi. *Yellow spill English – Abstract of an article referred to the site "orange patch" (original source: A. Groweiss and H. Michelson – "Investigation into the "Yellow Spill" in the sea by North Herzliya", ISRANALYTICA 2006).*

vii. *"Soil Gas Survey Report – IMI Nof Yam Propellants and Explosives plant",* issued by LDD Advanced Technologies Ltd., November 2015;

viii. *"Report as to the finding of the Soil Survey- IMI Nof yam-November 2015"*,issued by LDD Advanced Technologies Ltd., November 2015;

ix. *"ESC Soil Survey- IMI Nof-Yam, August 2016"*, issued by LDD Advanced Technologies Ltd., August 2016.

For the purposes of this document, Ramboll Environ made also reference to the following international standards:

A. *Israel Risk Based Corrective Action (IRBCA) Technical Guidance" [August 2014]*

B. *"Exposure Factors Handbook", EPA 2011;*

C. ASTM– *"Standard Practice for Phase II Environmental Site Assessment Process"* [2005];

D. ASTM - *"Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers"* D5092 04 [2004];

E. ASTM - *"Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)"* D-2487-06 [2006];

F. ASTM *"Standard Guide for Using Rock Mass Classification Systems for Engineering Purposes"* D-5878-05;

G. *ASTM "Standards on Environmental Site Characterization"* (2002);

H. *ASTM "Standards on Environmental Sampling"* (2002);

I. *ASTM "Standards on Ground Water and Vadose Zone Investigation"* (1996);

J. ASTM *"Standard Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities" D5299-99 (2012);*

K. U.S. Environmental Protection Agency [2000a]: *Quality Manual for Environmental Programs (EPA Order 5360.1 A1).* Washington, D.C.*;*

L. ASTM *"Standard Guide for Sampling Ground-Water Monitoring Wells" D4448 (2013).*

M. ASTM *"Standard Test Method for Particle-Size Analysis of Soils"* D422 - 63(2007) e2;

N. ASTM *"Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds"* D-4547-06;

O. EPA 5035*, "Closed-system purge-and-trap and extraction for volatile organics in soil and waste samples";*

P. ISO: *Soil quality - Sampling - Part 5: "Guidance on the procedure for the investigation of urban and industrial sites with regard to soil contamination"* [2005]*;*

Q. *Standard ASTM D4448-85a* (1992);

R. *EPA/540/S-95/504,* April 1996;

S. A.S.T.M *"Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* " - American Society for Testing and Materials, 2015;

T. EPA Region 9 "*Regional Screening Levels for contaminants*– update of January 2015;

U. USEPA-OSWER *"Risk Assessment Guidance for Superfund – Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal risk Assessment) Interim"*, March 2003;

V. EPA *"Supplemental guidance for developing soil screening levels for superfund sites"* , December 2002;

W. CONCAWE *"European Oil Industry Guideline for Risk-Based Assessment of Contaminated Sites"* –1997;

X. EPA *"Soil Screening Guidance: Technical Background Document"* – U.S. Environmental Protection Agency 1996;

Y. ASTM *"Risk Based Corrective Action Applied at Petroleum Release Sites"* – A.S.T.M. - American Society for Testing and Materials, 1995;

Z. CARACAS *"Concerned Action on Risk Assessment for Contaminated Sites in the European Union"* European Union Project.

4. SITE INVESTIGATION ACTIVITIES

Site investigations conducted on behalf of Yahel by an Israeli contractor, were accomplished in the period 23-26 October, 2016 and entailed the following:

- active soil gas survey on a 50 by 50 or 25 by 25 meters grid;
- collection and analysis of 6 shallow soils samples (depth of sampling 0,25m bgs) from a small area of approximately 16,000 square meters in the middle western part of the site.

Based on the information provided, no direct investigations have been performed on deeper soils (i.e. deeper than 0.25 m bgs) and the underlying groundwater.

4.1 Soil gas results

Active soil gas survey consisted of 118 borings drilled to various depth ranging between 1,5 and 10.0 m below ground surface (b.g.s.) for a total of 158 active soil gas samples collected. In Ramboll Environ interpretation of the data provided, the soil gases have been sampled at the depth of 1,5m independently from each borehole effective depth, plus 40 out of 118 also sampled at 10 meters b.g.s.. All the gas samples underwent analytical screening for VOCs and SVOCs families. However, it worth noting that different analytical sets have been adopted for the screening, i.e.:

- Different among the samples collected at 1.5 meters depth;
- Different among the samples collected at 10 meters depth;
- Different among the samples collected from the same borehole at 1.5 and 10 meters depths.

Further to the above, the soil gas sampling procedures and installation techniques were not described in the provided documents and it has been therefore not possible for Ramboll Environ to assess possible limitations in the results quality to be taken into account during the risk assessment calculations.

Recorded concentrations have been compared by Yahel with the target limits assumed equal to the minimum values between Tier 1 Risk Based Target Levels provided in IRBCA guidelines (RBTL Tier 1 for residential use) and the Vapor Intrusion indoor Air Screening Levels (IASL) [2] provided by New Jersey Department of Environmental protection.

For some of the substances no target limits was defined.

The comparison accomplished by Yahel between the concentrations detected in soil gas samples and the target reference limits, is summarized in the following table reporting the exceeding samples only.

Soil gas sampling point	IRBCA RBTL (ug/m3)	New Jersey IASL (ug/m3)	Compound exceeding Threshold values	Soil gas sampling depth (m)	Threshold value (ug/m3)	Concentration (ug/m3)
G-32	9,28	26	Naphtalene	1,5	9,28	16,14
G-36	9,28	26	Naphtalene	1,5	9,28	12,32
G-37	13,7	24	Chloroform	1,5	13,7	14,94

[2] "UPDATE TO THE NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION (NJDEP) VAPOR INTRUSION SCREENING LEVELS". March 2013, New Jersey Department of Environmental protection

Soil gas sampling point	IRBCA RBTL (ug/m3)	New Jersey IASL (ug/m3)	Compound exceeding Threshold values	Soil gas sampling depth (m)	Threshold value (ug/m3)	Concentration (ug/m3)
G-38	9,28	26	Naphtalene	1,5	9,28	13,94
G-42	9,28	26	Naphtalene	1,5	9,28	17,19
B-3	126	49	Ethylbenzene	10	49	81,98
	126	49	Ethylbenzene	10	49	78,33
B-17	76,9	27	Trichloroetylene	10	27	34,5
OR-1	9,28	26	Naphtalene	1,5	9,28	9,44
OR-7	9,28	26	Naphtalene	1,5	9,28	101,07
OR-9	13,7	24	Chloroform	10	13,7	14,7
OR-11	12,1	76	1,1 Dichloroethane	1,5	12,1	111,91
OR-18	76,9	27	Trichloroetylene	10	27	35,57
	12,1	76	1,1 Dichloroethane	10	12,1	342,86
	13,7	24	Chloroform	10	13,7	18,46
OR-20	12,1	76	1,1 Dichloroethane	1,5	12,1	27,77
OR-21	12,1	76	1,1 Dichloroethane	10	12,1	107,14
	13,7	24	Chloroform	10	13,7	25,63
OR-22	12,1	76	1,1 Dichloroethane	1,5	12,1	1673,73
	13,7	24	Chloroform	1,5	13,7	100,63
	12,1	76	1,1 Dichloroethane	10	12,1	107,14
OR-25	12,1	76	1,1 Dichloroethane	10	12,1	133,44

Table 1- Exceedances in soil gas reported by Yahel

4.2 Soil sampling results

Collected shallow soil samples were screened for: Metals (Zinc, Silver, Arsenic, Boron, Barium, Cadmium, Chromium, Copper, Mercury, Manganese, Nickel, Lead, Selenium), TPHs (DRO-Diesel Range Organics, ORO-Oil Range Organic, GRO-Gasoline Range Organics) and total SVOCs.

Returned concentrations for all the soil samples and all the screened parameters were compared with IRBCA Tier 1 reference concentrations for residential soil and found lower than the thresholds with no exceedance recorded (**Table 1**).

5. INPUT DATASET EVALUATION

Preliminary to the Risk Assessment run and according to the methodology already developed, discussed and agreed upon with Yahel and the MoE, Ramboll Environ pursued an assessment of the dataset quality and significance for the job scopes.

Some uncertainties, inconsistencies and data gaps discussed in the following sections have been identified and required a number of assumptions for which the Risk Assessment is deemed valid.

5.1 Observations on soil gas investigation

Different analytical sets have been adopted for the screening the soil gas samples, the reason of which is not indicated in the documents provided. This led to a not homogeneous distribution of determinations and discrepancies in the results significance. **Table 2** below reports the number of total determination by substance.

PARAMETER	n. of determinations for each parameter
Naphthalene	15
1,1,1-trichloroethane	32
1,1,2-trichloroethane	4
1,1-dichloroethane	16
1,1-dichloroethene	26
2-butanone	37
2-hexanone	6
Acetone	29
Benzene	12
Carbon disulfide	12
Ethyl chloride	3
Chloroform	22
Chloromethane	14
Ethylbenzene	15
Heptane	6
Methylene chloride	36
O-xylene	24
Tetrachloroethylene	21
Toluene	61
Trichloroethylene	20
Freon-11	10
Xylenes (total)	43
Freon-12	8
Cyclohexane	10
Hexane	14
Isopropyl alcohol	97
P+m - xylene	39
Methyl tert-butyl ether	21
1,3,5-trimethylbenzene	20
1,2,4-trimethylbenzene	42
Freon-113	21

PARAMETER	n. of determinations for each parameter
Propene	15
Ethanol	28
1-ethyl-4-methyl-Benzene	19
Tetrahydrofuran	2

Table 2- Analytical determinations

5.2 Observations on Soil investigation

Below have been summarized the main inconsistencies identified with respect to the shallow soils investigations.

- The soil investigations have been restricted to a limited portion of the site (i.e. approximately 2% of the total extension) and no soil characterization have been performed in the areas where buildings have been planned.
- The soil investigations have been limited to the shallowest depth with no samples collected deeper than 0.25 meters depth. Analytical screening has been limited to a restricted number of substances, does not match the soil gas screening suite.
- No rationale is indicated in the provided documents to sustain the aforesaid investigations choices.
- The stratigraphic setting of the area was not investigated.
- Site specific parameters as grain size, pH, organic carbon and bulk density have not been tested.

6. PRELIMINARY CONCEPTUAL SITE MODEL (CSM)

6.1 Assumptions

Taking into account the inconsistencies discussed in Section 5, Ramboll Environ developed the below listed assumptions to fill in the data gaps to develop the risk assessment:

- as a general rule were data are lacking or insufficient, conservative assumptions have been adopted;
- results of the shallow soil samples (0-0.25 meters deep) have been considered extended to represent the entire shallow soil thickness up to 1 meter bgs;
- shallow soils (0-1m) are uncontaminated (i.e. detected concentrations below target limits), or alternatively, the areas will be paved and unpaved areas covered with at least 1 meter thick horizon of clean soils;
- underlying groundwater is not used for any purpose (e.g. drinking water, domestic water, irrigation water) and no abstraction well is located onsite;
- stratigraphic setting has been assumed consistent with the Ta'as site (see. Documents viii and ix listed in Section 3) and the geotechnical parameters have been assumed according to United States Department of Agriculture (USDA) classification for a "sand" grainsize. Site specific parameters, whether not experimentally determined have been assumed according to IRBCA guidelines;
- construction workers potential exposure has not been considered as the data are not sufficient, thus it has been considered they will be protected by direct contacts (i.e. dust inhalation, soil ingestion and dermal contact) adopting safe procedure and adequate Personal Protection Equipment (PPE), according to Israeli Health and Safety regulation.

These assumptions could be reassessed improving the CSM reconstruction, in the event that additional investigations and/or information and/or data are accomplished/provided by Yahel.

Further to the above, for the compounds detected in soil gas for which Yahel did not define the target levels, and not included in IRBCA guidelines, Ramboll Environ considered a target limit equal to the minimum values between the two following international references:

- Vapor Intrusion indoor Air Screening Levels (IASL);
- Vapor Intrusion Screening Levels (VISL)[3].

Table 3 below, reports the Threshold values assumed for establishing soil gas concentrations exceedances.

Pollutant	U.M.	IRBCA RBTL	New Jersey IASL	EPA VISL	Threshold value for establishing contamination	Threshold value ref
Naphthalene	µg/m³	9,28	26	2,8	**9,28**	IRBCA
1,1,1-trichloroethane	µg/m³	676000	260000	170000	**260000**	New Jersey established by Yahel
1,1,2-trichloroethane	µg/m³	-	-	5,8	**5,8**	EPA VISL
1,1-dichloroethane	µg/m³	-	76	58	**76**	New Jersey established by MOE
1,1-dichloroethene	µg/m³	-	100000	7000	**7000**	EPA VISL
2-butanone	µg/m³	-	26000	170000	**26000**	New Jersey
2-hexanone	µg/m³	-	-	1000	**1000**	EPA VISL
Acetone	µg/m³	-	1600000	1100000	**1100000**	EPA VISL
Benzene	µg/m³	40,4	16	12	**16**	New Jersey established by Yahel

[3] EPA 2016 https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-levels-visls

Pollutant	U.M.	IRBCA RBTL	New Jersey IASL	EPA VISL	Threshold value for establishing contamination	Threshold value ref
Carbon disulfide	µg/m³	-	36000	24000	**24000**	EPA VISL
Ethyl chloride	µg/m³	-	-	350000	**350000**	EPA VISL
Chloroform	µg/m³	13,7	24	4,1	**13,7**	IRBCA
Chloromethane	µg/m³	-	4700	3100	**3100**	EPA VISL
Ethylbenzene	µg/m³	126	49	37	**37**	New Jersey
Heptane	µg/m³	-	-	-	**0**	-
Methylene chloride	µg/m³	-	4800	3400	**3400**	EPA VISL
O-xylene	µg/m³	13500	-	3500	**13500**	IRBCA
Tetrachloroethylene	µg/m³	1210	-	360	**1210**	IRBCA
Toluene	µg/m³	676000	260000	17000	**676000**	IRBCA
Trichloroethylene	µg/m³	76,96	27	16	**16**	New Jersey
Freon-11	µg/m³	-	36000	-	**36000**	New Jersey
Xylenes (total)	µg/m³	13500	5200	3500	**5200**	New Jersey established by Yahel
Freon-12	µg/m³	-	5200	3500	**3500**	EPA VISL
Cyclohexane	µg/m³	811000	310000	35000	**310000**	New Jersey established by Yahel
Hexane	µg/m³	-	36000	24000	**24000**	EPA VISL
Isopropyl alcohol	µg/m³	-	-	7000	**7000**	EPA VISL
P+m - xylene	µg/m³	13500	-	3500	**13500**	IRBCA
Methyl tert-butyl ether	µg/m³	1210	470	360	**470**	New Jersey established by Yahel
1,3,5-trimethylbenzene	µg/m³	-	-	-	**0**	-
1,2,4-trimethylbenzene	µg/m³	946	-	240	**946**	IRBCA
Freon-113	µg/m³	-	1600000	1000000	**1000000**	EPA VISL
Propene	µg/m³	-	-	100000	**100000**	EPA VISL
Ethanol	µg/m³	-	-	-	**0**	ND
1-ethyl-4-methyl-Benzene	µg/m³	-	-	-	**0**	ND
Tetrahydrofuran	µg/m³	-	-	70000	**70000**	EPA VISL

Table 3- Soil gas threshold Values

6.2 Geo-Hydrogeological framework

The stratigraphic setting of the area, has anticipated, has been considered analogue to the Ta'as Site area as derived by the soil investigations accomplished by Yahel in the period 2015 ÷ 2016 (see Documents vii ÷ix, Section 3).

Site scale stratigraphy considered for the purposes of this job, can be therefore described as:

- 0-6 m bgs - sand;
- 6-7 m bgs - brown clay;
- 6-10 m bgs - yellow sand.

Groundwater is known to be deeper than 40 meters bgs, thus not considered according to the assumptions listed at Section 6.1.

6.3 Primary contamination sources

Based on the information provided by Yahel, no industrial activity has ever been conducted at the site. The first historical aerial photograph publicly available from Google Earth is dated on 2004 and shows that the site was already a landscape at that time (as it is nowadays).

The neighboring Ta'as Site, as already described in Section 2, was a military site involved in industrial activities for the production of propellants, explosives and ingredients, including Trinitrotoluene (TNT), Nitrocellulose (NC) and Nitroguanidine (NQ), for mortar, tank and artillery ammunition and ball powders.

Operations at the Site started in the 1950s producing propellants, explosives and ingredients, including Trinitrotoluene (TNT), Nitrocellulose (NC) and Nitroguanidine (NQ), for mortar, tank and artillery ammunition and ball powders.

The production area initially was established in the southern part, spreading toward the northern part of the Site in the 1980s and 1990s.

Throughout the following years the production diversity was gradually increased concentrating on the manufacture of single, double and triple based propellants mainly using solvent technology.

In the 1960s some additional plants were erected, among them a Nitric Acid Concentration plant and a casting unit for double base rockets propellants.

In the early of the 1970s the TNT production ceased and the plant was discontinued and converted for the manufacture of various nitro organic intermediates for herbicides and pharmaceutical industries.

In the Site northern portion, a large explosion occurred in 1992 and as a result major damages occurred to the immediate area and a very large area outside. The activities in this part of the Site stopped since the explosion.

All the productions eventually stopped completely in 1996 and the facility was definitively dismantled and relocated in a different area.

The majority of the production buildings, were demolished and evacuated from the area.

Primary sources of contamination in Ta'as site were the releases or spills from ASTs or materials storage areas (raw, wastes) on the ground surface, and/or leakages or releases from USTs, production pipelines and/or sewage networks and plants in the shallow soils.

6.4 Secondary Contamination Sources

Based on the investigations campaign results (ref. Section 4) performed by Yahel in October 2016 and according to the assumptions adopted by Ramboll Environ to develop the CSM (ref. Section 6.1), known secondary source were identified by means of the soil gas campaign.

Shallow soils analysis returned samples compliance with the adopted threshold values for metals and Total SVOCs.

According to the assumptions reported in Section 6.1, soils deeper than 0.25 meters bgs and groundwater, were not considered in the present evaluation.

The HHRA has been implemented considering only the soil gas survey results as per the following substances exceeding the target levels:

- Naphthalene (Polycyclic Aromatic Hydrocarbon) 1,1,2-trichloroethane and 1,1-dichloroethane (Chlorinated compounds) are the most detected compound (exceed the threshold values in about 50% of the analyzed samples);

- Ethylbenzene and Chloroform were detected above the threshold values in about 20% of the analyzed samples;
- Trichloroethylene exceeds threshold value in 15% of the analyzed samples;
- Isopropyl Alcohol exceeds threshold value in 1 of the 97 analyzed samples.

Soil gas exceedances have been reported in **Drawing 1**, and summarized in the following table.

Soil gas sampling point	Threshold value (ug/m3)	Compound exceeding Threshold values	Concentration (ug/m3)
G-6_1,5	9,28	Naphthalene	12,32
OR-1_1,5	9,28	Naphthalene	9,44
OR-7_1,5	9,28	Naphthalene	101,07
B-3_10	49	Ethylbenzene	78,33
B-3-R_10	49	Ethylbenzene	82,98
B-17_10	27	Trichloroethylene	34,5
OR-9_10	13,7	Chloroform	14,7
OR-14_10	5,8	1,1,2-trichloroethane	145,14
G-24_1,5	9,28	Naphthalene	9,28
OR-11_10	76	1,1-dichloroethane	111,91
G-37_1,5	13,7	Chloroform	14,94
G-38_1,5	9,28	Naphthalene	13,94
OR-18_10	76	1,1-dichloroethane	342,86
OR-21_10	76	1,1-dichloroethane	107,14
OR-18_10	13,7	Chloroform	18,46
OR-21_10	13,7	Chloroform	25,63
OR-18_10	27	Trichloroethylene	35,57
OR-22_1,5	5,8	1,1,2-trichloroethane	23,68
OR-22_1,5	76	1,1-dichloroethane	1673,73
OR-22_1,5	13,7	Chloroform	100,63
OR-22_1,5	27	Trichloroethylene	103,28
OR-22_10	76	1,1-dichloroethane	149,59
OR-25_10	76	1,1-dichloroethane	133,44
OR-33_10	7000	Isopropyl alcohol	7604,32
G-42_1,5	9,28	Naphthalene	17,19
G-32_1,5	9,28	Naphthalene	161,14
G-32_1,5	49	Ethylbenzene	1858

Table 4- Soil gas exceedances

6.5 Potential Migration Pathways

The potential migration pathways considered active for the identified secondary sources for VOCs and SVOCs is the migration of vapors from subsoil to outdoor and indoor air.

Any other potential pathway (i.e. direct contacts with shallow soil; groundwater utilization; direct contacts with deeper soil; leaching of contamination from soil to groundwater), has been considered not active.

6.6 Identification of Possible Receptors

Given the residential redevelopment of the site, potential receptors considered are the residents (adults and children) which could potentially be exposed to contamination.

As per IRBCA guidelines, in this type of instances it is also required the assessment of the construction workers potential exposure. As introduced in Section 6, construction workers have not been considered as the data provided are not sufficient for this assessment.

Residents living in the site vicinity (i.e. offsite potential receptors), have also not been included in HHRA considering the assessment run on the on-site residents is sufficiently protective.

7. HUMAN HEALTH RISK ASSESSMENT

The HHRA is an assessment tool carried out based on professional judgment, in accordance with current scientific knowledge and applicable standards, in order to ensure the conservativeness and scientific consistency of the results.

HHRA results are always applicable and valid as long as the condition described in the CSM remain unchanged.

The HHRA described in the following has been developed in accordance with the guidelines issue by the Israeli MoE for use of the Israeli Risk Based Corrective Actions Tool (IRBCA) and also consistently with international methodological standards (ASTM end EPA HHRA technical guidelines).

As such, the methodological approach used, entailed the following steps:

- Problem formulation and definition of the Conceptual Site Model - defining the risk assessment purposes and elaborating the Conceptual Site Model, involving sources, possible pathways and potential receptors;
- Chemicals of Concern (COCs) selection process - involves a comparison of chemical concentrations in environmental media to conservative risk-based screening concentrations;
- Parametrization of the Conceptual Site Model - defining site-specific or default parameters for the Conceptual Site Model based on the IRBCA guidelines;
- Risk Characterization - assessing the exposure and effects combining, to define Risk (R) and Hazard Quotient (HI) levels related to potential contamination;
- Results evaluation - comparing IELCR and HI target levels and IELCR and HI related to potential contamination in the site conditions.

7.1 Limitations

The following limitations are relevant for the purposes of this work in addition to the assumptions discussed in Section 6:

- Ecological Risk Assessment (ERA) was not part of the scope requested by, discussed and agreed with Yahel;
- Acute risk assessment, construction workers and off-site residential receptors exposure have not been included in the assessment (see previous Sections for details);
- Chronic exposure evaluation has been performed;
- Primary contamination sources (e.g. buried wastes, underground storage tanks, piping, free phase product) are not present.

7.2 Cautions in the utilization of the Risk Assessment results

It is important to emphasize that the Risk Assessment methodology is a procedure based on mathematical models that necessarily assume specific safety factors and default options. For example, toxicological reference values are often derived using linear extrapolation (e.g., from the high doses used for laboratory tests to the low doses, which are more typical of environmental exposures or from animals to humans). These assumptions are used in a precautionary framework, even in the absence of sufficient scientific evidence.

Therefore, the Tier 2 HHRA is a precautionary tool, useful to define the cleaning up objectives in accordance with the international standards. Nevertheless, this tool is not able to ascertain the existence of a causal link between the exposure to some chemical compounds and the development of a specific disease, nor it is able to predict realistically the concentrations at which receptors will be actually exposed.

Given these above considerations, Risk Assessment results should be utilized as conservative guidelines to support decisions about the need for further action. Findings that are outside these guidelines should not automatically trigger remedial action, but may suggest the need for further evaluation of data quality, further data collection, or a more site-specific consideration of risk assessment parameters.

7.3 Acceptable risk levels

According to IRBCA guidelines, the following acceptable target risk levels have been considered applicable in the framework of a Tier 2 HHRA:

- The sum of Individual Excess Lifetime Cancer Risks (IECLRs) for each COC and for all exposure pathways must be equal to or less than 1×10^{-5};
- The sum of IELCRs for each exposure pathway and all COCs must be equal to or less than 1×10^{-5};
- The cumulative site-wide IELCR, i.e. the sum of risk for all COCs and all exposure pathways, must not exceed 1×10^{-5} because only one exposure pathway has been evaluated;
- The hazard index (HI) for each chemical, which is the sum of hazard quotient (HQs) for all complete exposure pathways for each chemical (the total risk), must not exceed 1.0;
- The hazard index (HI) for each exposure pathway, which is the sum of HQs for all COCs for each exposure pathway (the total risk) and the cumulative site-wide HI must not exceed 1.0.

For carcinogens, IECLRs are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen (i.e., excess individual lifetime cancer risk).

Based on the evidence that a compound is a known or probable human carcinogen, a toxicity value that defines a quantitative relationship between dose and response (i.e., SF) is calculated.

A SF converts estimated daily intakes averaged over a lifetime of exposure directly to incremental risk of an individual developing cancer.

A critical assumption of this approach is that the dose-response relationship is a linear relationship in the low-dose portion of the dose-response curve. Under this assumption, the SF is a constant and risk will be directly related to intake.

Thus, the linear form of the carcinogenic risk equation is usually applicable for estimating site risks. This linear low-dose equation is defined as:

IECLR= CDI * SF

where:

IECLR= a unitless probability of an individual developing cancer over a lifetime;

CDI = chronic daily intake averaged over 70 years (mg/kg/day)

SF = slope factor, expressed in $(mg/kg/day)^{-1}$

The non carcinogenic hazard quotient assumes that there is a level of exposure (e.g., RfD or RfC) below which it is unlikely for even sensitive subpopulations to experience adverse health effects.

$$HQ = \frac{CDI}{RfD}$$

where:

HQ = hazard quotient

CDI = chronic daily intake (mg/kg/day)

RfD = Reference dose

A chronic RfD or RfC is an estimate of the daily exposure to a human population, including sensitive subpopulations, that is unlikely to cause an increased incidence of deleterious health effects during a lifetime of exposure.

Chronic RfD or RfC values are specifically developed to be protective for long-term exposure to a compound.

If this ratio of the daily intake to the RfD or RfC exceeds 1.0 (unity) for the defined exposure scenario, this provides an indication that the exposed receptor may be subject to an adverse health impact and that further investigation should be undertaken. If the ratio is below unity, then it is generally assumed that no adverse impact to human health has or will occur.

7.4 Software

The present HHRA has been developed by using the following software:

- RISC Rel 5, developed by BP Oil International Sunbury, UK and Spence Engineering Pleasanton, California. RISC has been used for Indoor exposure evaluation of risk related to soil gas concentrations;
- Risk-net 2.1 (2016), developed by RECONnet ("*Rete Nazionale sulla gestione e la Bonifica dei Siti Contaminati" an Italian network*), upon the initiative of the Department of Civil Engineering of the University "Tor Vergata" (Rome). RISK-NET has been used for Outdoor exposure evaluation in landscape area (Source S1), because the RISC software do not allow to evaluate the outdoor risk related to soil gas concentrations.

The software RBCA Toolkit ver 2.5, originally proposed in the scope of work, was not used because the analytical model implemented by this software does not allow the evaluation of a soil gas secondary source.

7.5 Parametrization of the CSM

Input data have been derived from the results of the investigations. When this has not been possible, default data reported in the IRBCA guidelines have been primarily used and when missing, international guidelines values have been considered. General assumptions and input data, described below, have been synthetized in **Table 1** through **9**.

7.5.1 Secondary source geometry, chemicals of concern and representative concentrations

The secondary source are the soil gas contaminants detected in the subsoil (**Table 4** and **Drawing 1**), the geometry of which has been assumed depending on the soil gas areal distribution exceedances based toward the building redevelopment plan, which allowed to identify the following seven sources:

- S1 - it has been assumed as a parallelepipedon located in correspondence of the soil gas monitoring points G-6, OR-1 and B-3, exceeding threshold values for Naphthalene and Ethylbenzene at the depth of 1,5m b.g.s. S1 precautionary includes also the close soil gas monitoring points without exceedances of threshold values. S1 reference area is listed as landscaped are-to-be and with the closer buildings placed at a distance greater than 30m, as such, according to ASTM Vapor Intrusion Standard, the indoor pathway is considered not active;

- S2÷S7 - they have been defined including the soil gas monitoring points with exceedances of threshold values and those without exceedances as above falling in the same neighboring buildings lot footprint.

As discussed in Section 6, the human health screening criteria have been taken equal to those reported in Yahel documentation, i.e. according to IRBCA guidelines, while for compounds for which Yahel did not set a reference values, they have been assumed equal to the minimum values between IASL and VISL target values.

On a precautionary basis also substances detected (i.e. in the same source) although not exceeding any threshold values have been included in the evaluation.

Representative sources concentrations (**Tables 5a ÷ 5g**) have been assumed equal to the maximum concentrations detected in soil gas samples. Furthermore for samples collected at different depths, the greater concentration detected in any of the samples has been considered.

No statistical evaluation have been performed due to the not homogeneous distribution and consistency of the analytical data set.

According to IRBCA guideline, values below the method detection limits have not been considered, as the detection limits are lower than the Threshold Values (Tier 1 RBTL).

7.5.2 Vadose zone

Based on the stratigraphic setting described in Section 0, the soil classification in the vadose is assumed mainly composed by "Sand", which is the USDA (United States Department of Agriculture) soil type corresponding to the most representative texture.

Table 6 summarizes the parameters considered for unsaturated soil.

7.5.3 Meteorological data

Wind speed and direction data have been based on the information provided by Yahel (**Annex 3**). No other meteo data was provided, and specifically the meteorological station location and wind velocity time series were not available and have been therefore derived from the information delivered.

Accordingly, for the assessment of the volatilization pathway, the data considered are:

- most frequent winds directions - West-East and South East – North West;
- wind speed assumed equal to the minimum velocity corresponding to the most frequent wind direction.

7.5.4 Exposure and building data

The on-site exposure considers a residential scenario with adults and children living in the area as most conservative assumption. According to IRBCA guidelines, it is assumed daily exposure of 18 hours indoor and 16 hours outdoor, with an annual frequency of 360 days. The following parameters (**Table 7** and **Table 8**) have been assumed for indoor and outdoor scenarios for the inhalation rate, according to EPA HHRA guidelines (Ref. Document B, Section 3):

- Adult: 0,9m^3/h;
- Child: 0,7 m^3/h;
- Small residential units of 63 m^2 (Ref. Document [2], Section 3) with the following characteristics:

- Length: 10m;
- Width: 6,3m.

- 2 m floors height (ASTM default value, missing any specific information);
- no basement or underground living space for residential uses.

7.5.5 Physical and toxicological data

Toxicity is described in terms of dose-response where the observed or potential toxic effects in humans and/or laboratory animals are associated with a given chemical exposure and include both carcinogenic and no carcinogenic response endpoints. For most CoCs, the dose-response data were retrieved from IRBCA database and, if missing, from other sources published by U.S. Environmental Protection Agency (EPA) (Region 9 Data base), as listed in **Table 9**.

No carcinogen toxicity is provided in terms of reference dose for the oral pathway (RfD) or reference concentration for the inhalation pathway (RfC). Carcinogen dose response data is provided in terms of the cancer slope factors (SF) or in terms of unit risk (IUR).

All the parameters and the bibliographical references have been reported in **Table 9**.

8. RISK ASSESSMENT OUTCOMES

According to the assumptions of the preliminary site conceptual model and considering the limitations described in the previous sections, the HHRA has been performed with a forward analysis to evaluate risk resulting in vapor migration from soil gas to outdoor and indoor air.

Software spreadsheets have been reported in **Annex 2** (editable files). Risk assessment outcomes are summarized in **Table 10a÷g**, which show that the carcinogenic risk and Hazard Index related to the concentrations of each compound analyzed in soil gas is acceptable, because less than the acceptable target risks defined at the Section 7.3, in all the sources identified.

8.1 Uncertainty analysis

U.S. EPA recognizes that quantitative evaluation of risks to humans from environmental contamination is frequently limited by uncertainty (lack of knowledge) regarding analytical data, exposure, toxicity, and risk factors.

Although risk assessment follows a formal scientific approach, making assumptions or estimates based on limited data that are available or incorporating professional judgment is an inherent part of the process and the evaluation of uncertainty is a standard component of risk evaluation (EPA, 1989). Uncertainties built into the estimation of exposure and risks may either increase or decrease the magnitude of identified risks, depending on the source of uncertainty. The methods used and assumptions made in assessing potential human health risks are subject to a certain degree of uncertainty.

Uncertainties account for potential limitations in the risk assessment methodology. Overall, uncertainties built into the estimation of exposure and risks may act to either over-or underestimate the identified risks, depending on the source of the uncertainty.

Assumptions are made using best professional judgment and scientific literature. In general, selection of complete exposure pathways and their accompanying exposure assumptions are conservatively selected.

The specific uncertainties associated with the present risk assessment include:

- Characterization of soil gas
    - Only one soil gas survey campaign was performed, so seasonal variation has not been evaluated.
    - Different analytical sets were adopted for each soil gas sample and also in samples taken at different depths in the same sampling point.
    - Soil gas sampling procedures and methods used for sampling point installation are not known.
    - Analytical methods applied by chemical lab have not been disclosed.

  Soil gas data have been assumed as representative of vapor potential contamination and therefore conservative assumptions have been applied in the representative concentration evaluation and in generally in the site conceptual model parametrization.

  Uncertainty would be greatly reduced by performing a soil gas survey in the summer, season in which, due to the high temperature, organic compound volatilization is more heightened and adopting a uniform analytical set for chemical compounds.

- Vadose zone parameters assumptions

- Missing data on particle size analysis and geotechnical data, the most conservative soil texture (i.e. consistent with the Ta’as site) was assumed.

9. CONCLUSIONS

Ramboll Environ was retained by Yahel Engineering Initiating Projects Ltd. to carry out a Human Health Risk Assessment to evaluate potential risks deriving from the concentrations exceeding the regulatory threshold limits in an area neighboring to the east the Nof Yam project area, or "Ta'as site", not previously included in the redevelopment project and where a urban redevelopment is also envisaged.

Human Health Risk Assessment (HHRA) has been performed according to the indications provided in the technical guidance "Israel Risk-Based Corrective Action (IRBCA)" edited by the IRBCA Workgroup.

In Ramboll Environ understanding, the redevelopment plan involves the construction of residential buildings, as reported in the conceptual designs of building plan provided by Yahel (Rif. **Annex 1**), surrounded by landscaped areas.

The HHRA has been developed based on data obtained by the characterization accomplished by Yahel in October 2016 and provided to Ramboll in table's format. Characterization included the following investigation activities for soils:

- Active soil gas survey;
- Shallow soils sampling and analytical screening.

Based on the information provided, no direct investigations have been performed on deeper soils and the underlying groundwater.

Preliminary to the Risk Assessment run and according to the methodology already developed, discussed and agreed upon with Yahel and the MoE, Ramboll Environ pursued an assessment of the dataset quality and significance for the job scopes.

Some uncertainties, inconsistencies and data gaps have been identified and have required the below listed assumptions:

- results of the shallow soil samples (0-0.25 meters deep) have been considered extended to represent the entire shallow soil thickness up to 1 meter bgs;
- shallow soils (0-1m) are uncontaminated (i.e. detected concentrations below target limits), or alternatively, the areas were buildings have been planned will be paved and unpaved areas covered with at least 1 meter thick horizon of clean soils;
- underlying groundwater is not used for any purpose (e.g. drinking water, domestic water, irrigation water) and no abstraction well is located onsite;
- stratigraphic setting has been assumed consistent with the Ta'as site (see. Documents viii and ix listed in Section 3) and the geotechnical parameters have been assumed according to United States Department of Agriculture (USDA) classification for a "sand" grainsize. Site specific parameters, whether not experimentally determined have been assumed according to IRBCA guidelines;
- construction workers potential exposure has not been considered as the data are not sufficient, thus it has been considered they will be protected by direct contacts (i.e. dust inhalation, soil ingestion and dermal contact) adopting safe procedure and adequate Personal Protection Equipment (PPE), according to Israeli Health and Safety regulation.

The HHRA uncertainties could be reduced by performing a soil gas survey in the summer, season in which, due to the high temperature, organic compound volatilization is more heightened and adopting a uniform analytical set for chemical compounds.

Based on the investigations campaign results performed by Yahel in October 2016 and according to the assumptions adopted by Ramboll Environ to develop the Preliminary Site conceptual model, the potential migration pathways considered active for the identified secondary sources for VOCs and SVOCs is the migrations of vapors from subsoil to outdoor and indoor air.

The HHRA results show that in all of the identified sources, the risk related to the soil gas concentrations detected in each source is acceptable (i.e. lower than the acceptable risk levels defined at the Section 7.3), therefore no risks exist for any residential future receptors who may be exposed to vapor inhalation.

In order to manage any potential future groundwater use at the Site, an institutional control would be required in the form of a deed restriction. The deed restriction would be placed on the entire Site to prohibit future groundwater use by restricting the installation of onsite wells for any use, including domestic or household use.

In order to manage any potential exposure of residential receptors with shallow soils (0-1m), the areas were buildings have been planned will be paved and unpaved areas covered with at least 1 meter thick horizon of clean soils.

In case of soil excavation, in order to manage any potential exposure of construction worker, not included in the present evaluation, a soil management plan could be implemented. The soil management plan should include a safe procedure and adequate Personal Protection Equipment (PPE), according to Israeli Health and Safety regulation, for soil excavations occurring in presence of contaminated shallow and deeper soil.

TABLES

Table 1: Soil investigation results

Pollutant	Threshold value for establishing contamination (Residence)	Location					
		K-1	K-2	K-3	K-4	K-5	K-6
Dry Material (%)	-	99,6	99,4	98,1	97,6	99,2	99,4
TPH DRO	100-5000	<12	<12	<12	<12	<12	<12
TPH ORO		<10	<10	<10	<10	<10	<10
TPH GRO		<35	<35	<35	<35	<35	<35
TPH DRO+ORO		<22	<22	<22	<22	<22	<22
Ag	20,00	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
As	17,00	<0.5	<0.5	2,39	1,11	<0.5	<0.5
B	-	2,90	3,70	7,90	6,80	2,70	2,80
Ba	500,00	14,00	21,20	52,80	46,50	12,60	14,40
Cd	10,00	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Cr	150,00	5,88	8,52	23,80	20,60	5,25	5,91
Cu	150,00	2,70	4,00	12,30	10,30	1,60	2,10
Hg	5,00	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Mn	2.000,00	86,40	151,00	396,00	348,00	82,20	98,10
Ni	130,00	2,80	4,50	13,20	11,50	2,30	2,60
Pb	250,00	3,30	3,30	18,40	16,30	2,60	2,70
Se	5,00	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Zn	300,00	47,30	16,00	44,60	38,60	12,40	12,10
SVOC	-	In All samples the result was: Not Detected					

Table 2: Active soil gas survey results

Pollutant		IRBCA RBTL	New Jersey IASL	EPA VISL	Threshold value for establishing contamination		Threshold value ref
Naphthalene	µg/m³	9,28	26	2,8	**9,28**	**9,28**	IRBCA
1,1,1-trichloroethane	µg/m³	676000	260000	170000	**260000**	**260000**	New Jersey established by Yhael
1,1,2-trichloroethane	µg/m³	-	-	5,8	**5,8**	**5,8**	EPA VISL
1,1-dichloroethane	µg/m³	-	76	58	**76**	**76**	New Jersey established by MOE
1,1-dichloroethene	µg/m³	-	100000	7000	**7000**	**7000**	EPA VISL
2-butanone	µg/m³	-	26000	170000	**26000**	**26000**	New Jersey
2-hexanone	µg/m³	-	-	1000	**1000**	**1000**	EPA VISL
Acetone	µg/m³	-	1600000	1100000	**1100000**	**1100000**	EPA VISL
Benzene	µg/m³	40,4	16	12	**16**	**16**	New Jersey established by Yhael
Carbon disulfide	µg/m³	-	36000	24000	**24000**	**24000**	EPA VISL
Ethyl chloride	µg/m³	-	-	350000	**350000**	**350000**	EPA VISL
Chloroform	µg/m³	13,7	24	4,1	**13,7**	**13,7**	IRBCA
Chloromethane	µg/m³	-	4700	3100	**3100**	**3100**	EPA VISL
Ethylbenzene	µg/m³	126	49	37	**49**	**37**	New Jersey
Heptane	µg/m³	-	-	-	**-**	**0**	-
Methylene chloride	µg/m³	-	4800	3400	**3400**	**3400**	EPA VISL
O-xylene	µg/m³	13500	-	3500	**13500**	**13500**	IRBCA
Tetrachloroethylene	µg/m³	1210	-	360	**1210**	**1210**	IRBCA
Toluene	µg/m³	676000	260000	17000	**676000**	**676000**	IRBCA
Trichloroethylene	µg/m³	76,96	27	16	**27**	**16**	New Jersey
Freon-11	µg/m³	-	36000	-	**-**	**36000**	New Jersey
Xylenes (total)	µg/m³	13500	5200	3500	**5200**	**5200**	New Jersey established by Yhael
Freon-12	µg/m³	-	5200	3500	**3500**	**3500**	EPA VISL
Cyclohexane	µg/m³	811000	310000	35000	**310000**	**310000**	New Jersey established by Yhael
Hexane	µg/m³	-	36000	24000	**24000**	**24000**	EPA VISL
Isopropyl alcohol	µg/m³	-	-	7000	**7000**	**7000**	EPA VISL
P+m - xylene	µg/m³	13500	-	3500	**13500**	**13500**	IRBCA
Methyl tert-butyl ether	µg/m³	1210	470	360	**470**	**470**	New Jersey established by Yhael
1,3,5-trimethylbenzene	µg/m³	-	-	-	**-**	**0**	-
1,2,4-trimethylbenzene	µg/m³	946	-	240	**946**	**946**	IRBCA
Freon-113	µg/m³	-	1600000	1000000	**1000000**	**1000000**	EPA VISL
Propene	µg/m³	-	-	100000	**100000**	**100000**	EPA VISL
Ethanol	µg/m³	-	-	-	**-**	**0**	ND
1-ethyl-4-methyl-Benzene	µg/m³	-	-	-	**-**	**0**	ND
Tetrahydrofuran	µg/m³	-	-	70000	**70000**	**70000**	EPA VISL

Pollutant	B-10_1,5	B-11_1,5	B-13_1,5	B-15_1,5	B-16_1,5	B-17_1,5	**B-17_10**	B-18_1,5	B-19_1,5	B-12_1,5	B-12_10	B-14_1,5	B-21_1,5	B-21-R_1,5	B-22_1,5	B-23_1,5	B-24_1,5	B-24_10	B-25_1,5	B-26_1,5	B-27_1,5	B-27_10	B-27-R_1,5
Naphthalene																							
1,1,1-trichloroethane																					5,73		
1,1,2-trichloroethane																							
1,1-dichloroethane																							
1,1-dichloroethene																							
2-butanone		4,28									6,64											5,6	
2-hexanone																							
Acetone		28,65									34,73											25,58	25,51
Benzene																							
Carbon disulfide																							
Ethyl chloride																							
Chloroform																							
Chloromethane							8,42														14,76	2,23	
Ethylbenzene											11,38												
Heptane														16,19									
Methylene chloride				8,3							3,61												8,55
O-xylene											12,85												
Tetrachloroethylene																							7,26
Toluene						4,79			5,24		32,26		4,48	15,32								4,71	
Trichloroethylene							**34,5**															6,07	
Freon-11													7,42										
Xylenes (total)											59,44			4,43								6,12	
Freon-12											5,54												
Cyclohexane									3,3														
Hexane				7,61																			
Isopropyl alcohol	<24,58	66,29	<24,58	50,19	<24,58	130,27	<24,58	<24,58	<24,58	118,52	106,43	<24,58	57,27	<24,58	35,2	<24,58	<24,58	74,89	<24,58	118,42	<24,58	69,29	34,12
P+m - xylene											46,59			26,42								6,12	
Methyl tert-butyl ether																							
1,3,5-trimethylbenzene											6,24			8,65									
1,2,4-trimethylbenzene											17,21			33,23	6,1							5,95	
Freon-113																							
Propene									3,05														
Ethanol		21,67		27,06			21,78																
1-ethyl-4-methyl-Benzene											5,75			10,47									
Tetrahydrofuran																							

Pollutant	B-27-R_10	**B-2_1,5**	B-3_1,5	**B-3_10**	**B-3-R_10**	B-4_1,5	G-10_1,5	G-16_1,5	**G-13_1,5**	G-19_1,5	G-22_1,5	**G-6_1,5**	G-7_1,5	**OR-1_1,5**	OR-2_1,5	G-5_1,5	G-5_10	B-1_1,5	OR-3_1,5	**OR-3_10**	OR-4_1,5	B-5_1,5
Naphthalene												**12,32**		**9,44**								
1,1,1-trichloroethane																						
1,1,2-trichloroethane																						
1,1-dichloroethane																						
1,1-dichloroethene																28,59						
2-butanone				7,46	6,9									8,94			6,46	6,93		7,43		
2-hexanone																						
Acetone				32,78	24,82		52,62							24,85			28,6	24,73		41,24		
Benzene				6,29	6,29									5,72			4,15					
Carbon disulfide				5,01	5,29																	
Ethyl chloride																						
Chloroform																				**6,1**		
Chloromethane																	2,87	2,19				
Ethylbenzene				**78,33**	**82,98**									10,86								
Heptane																						
Methylene chloride	6,88	20,56		4,69	3,93		57,53								10,98		25,57		3,93			5,14
O-xylene				141,03	147,11									34,13	4,39		29,09					
Tetrachloroethylene																					17,57	
Toluene	4,26			111,77	117,35							4,11		38,93	11,53	14,55	15,68		8,29	9,42	5,35	9,53
Trichloroethylene	5,7	**23,81**							**16,5**						8,54				6,66	8,22		
Freon-11				131,97	134,84	7,58																
Xylenes (total)	4,78			492,88	508,21									75,77	14,51	7,95	37,08		6,86			6,34
Freon-12										5,04					5,09							
Cyclohexane																						
Hexane		93,47		9,2	8,67																	
Isopropyl alcohol	84,21		190,07	192,72	172,32	33,87	<24,58	3052	36,5	129,97	141,53	<24,58	28,81	<24,58	102,62		118,37	197,03	172,54	27,23	<24,85	34,29
P+m - xylene	4,78			351,85	361,1									41,64	10,12	7,95	7,99		6,86			6,34
Methyl tert-butyl ether			5,3	336,19	352,27							6,6		166,46	14,24	10,46	136,68		9,55			
1,3,5-trimethylbenzene				202,49	200,81									9,64			6,05					
1,2,4-trimethylbenzene	8,41			**512,19**	**525,8**							5,41		28,51	7,13		5,06				5,75	6,24
Freon-113																66,14						
Propene		1,94		78,98	74,266													2,31				
Ethanol		50,59		27,57	31		29,83		38,31								21,95					
1-ethyl-4-methyl-Benzene				206,37	194,87									5,7								
Tetrahydrofuran																						

Red bold: Exeedances of Thresold values
Fucsia bold: Exeedances of minimum of RBTL, IASL and VISL values

Table 2: Active soil gas survey results

Pollutant		IRBCA RBTL	New Jersey IASL	EPA VISL	Threshold value for establishing contamination		Threshold value ref
Naphthalene	µg/m^3	9,28	26	2,8	**9,28**	**9,28**	IRBCA
1,1,1-trichloroethane	µg/m^3	676000	260000	170000	**260000**	**260000**	New Jersey established by Yhael
1,1,2-trichloroethane	µg/m^3	-	-	5,8	**5,8**	**5,8**	EPA VISL
1,1-dichloroethane	µg/m^3	-	76	58	**76**	**76**	New Jersey established by MOE
1,1-dichloroethene	µg/m^3	-	100000	7000	**7000**	**7000**	EPA VISL
2-butanone	µg/m^3	-	26000	170000	**26000**	**26000**	New Jersey
2-hexanone	µg/m^3	-	-	1000	**1000**	**1000**	EPA VISL
Acetone	µg/m^3	-	1600000	1100000	**1100000**	**1100000**	EPA VISL
Benzene	µg/m^3	40,4	16	12	**16**	**16**	New Jersey established by Yhael
Carbon disulfide	µg/m^3	-	36000	24000	**24000**	**24000**	EPA VISL
Ethyl chloride	µg/m^3	-	-	350000	**350000**	**350000**	EPA VISL
Chloroform	µg/m^3	13,7	24	4,1	**13,7**	**13,7**	IRBCA
Chloromethane	µg/m^3	-	4700	3100	**3100**	**3100**	EPA VISL
Ethylbenzene	µg/m^3	126	49	37	**49**	**37**	New Jersey
Heptane	µg/m^3	-	-	-	**-**	**0**	-
Methylene chloride	µg/m^3	-	4800	3400	**3400**	**3400**	EPA VISL
O-xylene	µg/m^3	13500	-	3500	**13500**	**13500**	IRBCA
Tetrachloroethylene	µg/m^3	1210	-	360	**1210**	**1210**	IRBCA
Toluene	µg/m^3	676000	260000	17000	**676000**	**676000**	IRBCA
Trichloroethylene	µg/m^3	76,96	27	16	**27**	**16**	New Jersey
Freon-11	µg/m^3	-	36000	-	**-**	**36000**	New Jersey
Xylenes (total)	µg/m^3	13500	5200	3500	**5200**	**5200**	New Jersey established by Yhael
Freon-12	µg/m^3	-	5200	3500	**3500**	**3500**	EPA VISL
Cyclohexane	µg/m^3	811000	310000	35000	**310000**	**310000**	New Jersey established by Yhael
Hexane	µg/m^3	-	36000	24000	**24000**	**24000**	EPA VISL
Isopropyl alcohol	µg/m^3	-	-	7000	**7000**	**7000**	EPA VISL
P+m - xylene	µg/m^3	13500	-	3500	**13500**	**13500**	IRBCA
Methyl tert-butyl ether	µg/m^3	1210	470	360	**470**	**470**	New Jersey established by Yhael
1,3,5-trimethylbenzene	µg/m^3	-	-	-	**-**	**0**	-
1,2,4-trimethylbenzene	µg/m^3	946	-	240	**946**	**946**	IRBCA
Freon-113	µg/m^3	-	1600000	1000000	**1000000**	**1000000**	EPA VISL
Propene	µg/m^3	-	-	100000	**100000**	**100000**	EPA VISL
Ethanol	µg/m^3	-	-	-	**-**	**0**	ND
1-ethyl-4-methyl-Benzene	µg/m^3	-	-	-	**-**	**0**	ND
Tetrahydrofuran	µg/m^3	-	-	70000	**70000**	**70000**	EPA VISL

Location (continued)

Pollutant	B-6_1,5	B-7_1,5	B-8_1,5	B-9_1,5	G1_1,5	G-1_10	OR-5_1,5	OR-6_1,5	OR-7_1,5	OR-8_1,5	OR-8-R_1,5	OR-9_1,5	OR-9_10	OR-14_10	OR-15_1,5	OR-16_1,5	OR-16_10	OR-17_1,5	G-8_1,5	G-9_1,5	G-9_1,5-R	G-11_1,5
Naphthalene									**101,07**									**6,29**				
1,1,1-trichloroethane												28,15	111,69		99,52	79,82	108,96	99,96				
1,1,2-trichloroethane														**145,14**								
1,1-dichloroethane														7			4,94					
1,1-dichloroethene												10,63	102,38	155,55	56,62	86,04	116,45	42,19				
2-butanone							5,9		3,54													
2-hexanone																						
Acetone							50,29			34,75												
Benzene																						
Carbon disulfide	3,58						4,02			5,95												
Ethyl chloride							5,75															
Chloroform													**14,7**	7,37			5,32					
Chloromethane							4,87				2,13											
Ethylbenzene																		9,94				
Heptane				18,69																		
Methylene chloride							23,59			159,13	3,68				46,17							
O-xylene			5,08	6,47					9,21									8,08				
Tetrachloroethylene								11,94				15,46										
Toluene			13,94	30,49					10,89				5,43	6,9			4,71	7,01				
Trichloroethylene																						
Freon-11																						
Xylenes (total)			12,07	15,59					28,19					7,6			5,47	32,53				
Freon-12																						5,04
Cyclohexane							22,89			68,67					21,51							
Hexane				44,69						66,69												
Isopropyl alcohol	<24,58	<24,58	187,96	32,76	<24,58	94,95	195,11	30,8	<24,58	93,45	29,74	<24,58	<24,58	<24,58	37,85	<24,58	<24,58	32,98	172,54	41,74	29,57	46,45
P+m - xylene			6,99	9,12					18,98					7,6			5,47	24,45				
Methyl tert-butyl ether							4,76															
1,3,5-trimethylbenzene			12,63	13,86					10,27									7,28				
1,2,4-trimethylbenzene			42,18	51,96					44,19									30,23				
Freon-113													17,78	9,5			8,12					
Propene																						
Ethanol										121,04	24,51				85,58							
1-ethyl-4-methyl-Benzene			9,39	17,6					8,65									7,28				
Tetrahydrofuran																						

Location (continued)

Pollutant	G-12_1,5	G-14_1,5	G-15_1,5	G-17_1,5	G-18_1,5	G-20_1,5	G-21_1,5	G-23_1,5	G-24_1,5	G-24_10	G-25_1,5	OR-11_1,5	OR-11_10	OR-12_1,5	G-2_1,5	G-29_1,5	G-29_10	G-3_1,5	G-30_1,5	G-30_10	G-31_10	G-33_1,5	G-34_1,5
Naphthalene									**9,28**				**4,52**										
1,1,1-trichloroethane												527,18	787,66							9,98			
1,1,2-trichloroethane																							
1,1-dichloroethane												52,62	**111,91**										
1,1-dichloroethene												794,4	1416,85										
2-butanone		12,68		6,55									5,6						5,49				
2-hexanone		9,3																					
Acetone				37,82									25,23			29,1							
Benzene																							
Carbon disulfide												3,67	5,88						6,29				
Ethyl chloride																							
Chloroform				7,67								5,71	7,67										
Chloromethane																							
Ethylbenzene																							
Heptane																							
Methylene chloride				78,51	5,7									4,52	3,72								5,14
O-xylene	5,91												15,72			6,17							
Tetrachloroethylene		10,85						9,43					15,74										
Toluene	35,84	8,89			14,89					6,75	9,87	7,39			9,8	9,5							
Trichloroethylene													**24,61**										
Freon-11																							
Xylenes (total)	15,07	5,99			7,99					11,2		11,46	20,24		9,03	6,17							
Freon-12																							
Cyclohexane																							
Hexane	46,77																						
Isopropyl alcohol	<24,58	232,15	<24,58	6340,05	89,79	26,64	136,68	<24,58	104,19	47,27	86,4	115,45	155,22	<24,58	49,31	101,02	<24,58	<24,58	59,38	62,55	<24,58	<24,58	27,23
P+m - xylene	9,16	5,99			7,99					11,2		11,46			9,03								
Methyl tert-butyl ether									5,3			3,89	5,12										
1,3,5-trimethylbenzene													6,64										
1,2,4-trimethylbenzene	8,31	9,54			7,42							14,8	20,11		10,08	12,88							
Freon-113												107,37	224,01										
Propene																							
Ethanol			31,62	55,19		36,53								21,46			22,8						19,29
1-ethyl-4-methyl-Benzene	11,75																						
Tetrahydrofuran																							

Red bold: Exeedances of Thresold values
Fucsia bold: Exeedances of minimum of RBTL, IASL and VISL values

Table 2: Active soil gas survey results

Pollutant		IRBCA RBTL	New Jersey IASL	EPA VISL	Threshold value for establishing contamination		Threshold value ref
Naphthalene	µg/m³	9,28	26	2,8	**9,28**	**9,28**	IRBCA
1,1,1-trichloroethane	µg/m³	676000	260000	170000	**260000**	**260000**	New Jersey established by Yhael
1,1,2-trichloroethane	µg/m³	-	-	5,8	**5,8**	**5,8**	EPA VISL
1,1-dichloroethane	µg/m³	-	76	58	**76**	**76**	New Jersey established by MOE
1,1-dichloroethene	µg/m³	-	100000	7000	**7000**	**7000**	EPA VISL
2-butanone	µg/m³	-	26000	170000	**26000**	**26000**	New Jersey
2-hexanone	µg/m³	-	-	1000	**1000**	**1000**	EPA VISL
Acetone	µg/m³	-	1600000	1100000	**1100000**	**1100000**	EPA VISL
Benzene	µg/m³	40,4	16	12	**16**	**16**	New Jersey established by Yhael
Carbon disulfide	µg/m³	-	36000	24000	**24000**	**24000**	EPA VISL
Ethyl chloride	µg/m³	-	-	350000	**350000**	**350000**	EPA VISL
Chloroform	µg/m³	13,7	24	4,1	**13,7**	**13,7**	IRBCA
Chloromethane	µg/m³	-	4700	3100	**3100**	**3100**	EPA VISL
Ethylbenzene	µg/m³	126	49	37	**49**	**37**	New Jersey
Heptane	µg/m³	-	-	-	**-**	**0**	-
Methylene chloride	µg/m³	-	4800	3400	**3400**	**3400**	EPA VISL
O-xylene	µg/m³	13500	-	3500	**13500**	**13500**	IRBCA
Tetrachloroethylene	µg/m³	1210	-	360	**1210**	**1210**	IRBCA
Toluene	µg/m³	676000	260000	17000	**676000**	**676000**	IRBCA
Trichloroethylene	µg/m³	76,96	27	16	**27**	**16**	New Jersey
Freon-11	µg/m³	-	36000	-	**-**	**36000**	New Jersey
Xylenes (total)	µg/m³	13500	5200	3500	**5200**	**5200**	New Jersey established by Yhael
Freon-12	µg/m³	-	5200	3500	**3500**	**3500**	EPA VISL
Cyclohexane	µg/m³	811000	310000	35000	**310000**	**310000**	New Jersey established by Yhael
Hexane	µg/m³	-	36000	24000	**24000**	**24000**	EPA VISL
Isopropyl alcohol	µg/m³	-	-	7000	**7000**	**7000**	EPA VISL
P+m - xylene	µg/m³	13500	-	3500	**13500**	**13500**	IRBCA
Methyl tert-butyl ether	µg/m³	1210	470	360	**470**	**470**	New Jersey established by Yhael
1,3,5-trimethylbenzene	µg/m³	-	-	-	**-**	**0**	-
1,2,4-trimethylbenzene	µg/m³	946	-	240	**946**	**946**	IRBCA
Freon-113	µg/m³	-	1600000	1000000	**1000000**	**1000000**	EPA VISL
Propene	µg/m³	-	-	100000	**100000**	**100000**	EPA VISL
Ethanol	µg/m³	-	-	-	**-**	**0**	ND
1-ethyl-4-methyl-Benzene	µg/m³	-	-	-	**-**	**0**	ND
Tetrahydrofuran	µg/m³	-	-	70000	**70000**	**70000**	EPA VISL

Pollutant	G-35_1,5	G-35_1,5-R	G-36_1,5	G-37_1,5	G-37_10	G-38_1,5	G-44_1,5	G-45_1,5	G-45_10	G-46_1,5	G-47_1,5	G-39_1,5	G-4_1,5	G-40_1,5	G-41_1,5	G-43_1,5	G-43_10	G-48_1,5	G-48_10	G-49_1,5	G-51_1,5	G-52_1,5
Naphthalene						**13,94**																
1,1,1-trichloroethane					6,77																	
1,1,2-trichloroethane																						
1,1-dichloroethane																						
1,1-dichloroethene																						
2-butanone					3,83				14,66		6,72	8,17					7,46			3,51		
2-hexanone									23,92								8,48					
Acetone					26,99		51,21		31,05													
Benzene										3,8												
Carbon disulfide																	7,69					
Ethyl chloride																						
Chloroform				**14,94**			6,25								6,93							
Chloromethane				13,53							6,32											
Ethylbenzene						9,86				5,56												
Heptane										48,24												
Methylene chloride					3,79	12,02	94,76													19,8		
O-xylene						14,16				15,94												
Tetrachloroethylene	11,87																				9,29	
Toluene			4,67		4,07		4,26		6,14	70,7												4,52
Trichloroethylene																		**16,5**				
Freon-11																71,3	82,36					6,63
Xylenes (total)						52,81				38,56												5,34
Freon-12																						
Cyclohexane							28,16			26,26												
Hexane										117,55												
Isopropyl alcohol	<24,58	<24,58	201,6	59,04	138,45	46,41	<24,58	157,28	187,91	221,01	192,08	<24,58	<24,58	<24,58	47,9	<24,58	27,41	<24,58	<24,58	143,61	<24,58	<24,58
P+m - xylene						38,65																5,34
Methyl tert-butyl ether																						
1,3,5-trimethylbenzene						19,07				32,49												
1,2,4-trimethylbenzene						66,66			6,59	113,51												12,29
Freon-113																						
Propene																						2,2
Ethanol		30,98				19,2	150,57													36,18		
1-ethyl-4-methyl-Benzene						17,99				42,92												
Tetrahydrofuran																						

Pollutant	OR-10_1,5	OR-13_1,5	OR-13_10	G-26_1,5	G-28_1,5	OR-18_1,5	OR-18_10	OR-19_1,5	OR-20_1,5	OR-21_1,5	OR-21_10	OR-22_1,5	OR-22_10	OR-23_1,5	OR-24_1,5	OR-25_1,5	OR-25_10	OR-26_1,5	OR-26_10	OR-27_1,5	OR-28_1,5
Naphthalene											**7,08**				**7,76**						
1,1,1-trichloroethane	31,97		101,81		8,4	137,93	1563,7	56,31	563,36	110,11	861,48	5133,27	1297,33	260,1	355,09		877,91	24,77	450,63		8,78
1,1,2-trichloroethane												**23,68**									
1,1-dichloroethane							**342,86**		**27,77**		**107,14**	**1673,73**	**149,59**		4,13		**133,44**		8,26		
1,1-dichloroethene	25,02		193,77			60,86		50,08	266,05	52,81	700,14	2598,05	576,59	153,25	138,3		1085,44		420,92		
2-butanone						5,57	3,69			4,6		5,69			8,04		35,24		4,81		
2-hexanone																					
Acetone															27,34		338,62	43,28	24,28		
Benzene															4,5			9,78			
Carbon disulfide																					
Ethyl chloride																					
Chloroform			9,57				**18,46**				**25,63**	**100,63**	**7,18**		**6,69**				**10,74**		
Chloromethane																					
Ethylbenzene																		8,77			5,64
Heptane				23,11														95,94			42,21
Methylene chloride																	47,52				
O-xylene				8,51							5,47							21,84			16,8
Tetrachloroethylene					18,18		37,76	<470			10,04		14,38	19,13		29,3	12,48				
Toluene			5,8	41,45		4,03	8,74				12,1				9,87	5,13	8,71	124,7	6,52		66,06
Trichloroethylene							**35,57**				11,77	**103,28**	6,45				**14,72**				
Freon-11																					
Xylenes (total)				20,67							11,11	8,64			6,56	4,65		56,49			40,81
Freon-12				5,24																	
Cyclohexane																					
Hexane				53,75														237,42			92,87
Isopropyl alcohol	<24,58	<24,58	39,4	94,41	98,29	<24,58		112,08	<24,58	<24,58	105,24	45,13	125,18	<24,58	54,59	53,71	221,85	178,76	213,52	204,55	79,49
P+m - xylene				12							5,64	8,64			6,56	4,65		34,65			24,01
Methyl tert-butyl ether												24,77									
1,3,5-trimethylbenzene				15,88							12,44							35,35			34,26
1,2,4-trimethylbenzene				59,38							44,44	11,06			7,28	7,13		115,77			116,7
Freon-113			73,95			10,88	247,31	8,89	20,31		68,36	518,22	46,67	11,96	11,88		88,97		42,53		
Propene				16													36,45	7,62			
Ethanol												30,09					42,79			23,5	
1-ethyl-4-methyl-Benzene				20,65							10,13							47,49			44,88
Tetrahydrofuran			2,98				3,63														

Red bold: Exeedances of Thresold values
Fucsia bold: Exeedances of minimum of RBTL, IASL and VISL values

Table 2: Active soil gas survey results

Pollutant		IRBCA RBTL	New Jersey IASL	EPA VISL	Threshold value for establishing contamination		Threshold value ref	OR-29_1,5	OR-30_1,5	OR-31_1,5	OR-32_1,5	OR-33_1,5	OR-33_10	OR-35_1,5	G-41_1,5-R	G-41_10	G-42_1,5	G-32_1,5	G-50_1,5	OR-34_1,5	OR-34_10	OR-36_1,5	OR-37_1,5	OR-37_10	OR-38_1,5	OR-38_10	OR-38-R_1,5	OR-38-R_10	OR-39_1,5
Naphthalene	μg/m³	9,28	26	2,8	**9,28**	**9,28**	IRBCA										**17,19**	**161,14**											
1,1,1-trichloroethane	μg/m³	676000	260000	170000	**260000**	**260000**	New Jersey established by Yhael										<5,46												
1,1,2-trichloroethane	μg/m³	-	-	5,8	**5,8**	**5,8**	EPA VISL																						
1,1-dichloroethane	μg/m³	-	76	58	**76**	**76**	New Jersey established by MOE										<4,05												
1,1-dichloroethene	μg/m³	-	100000	7000	**7000**	**7000**	EPA VISL										<3,96												
2-butanone	μg/m³	-	26000	170000	**26000**	**26000**	New Jersey	3,77			7,34		8,17				13,71			8,76									3,66
2-hexanone	μg/m³	-	-	1000	**1000**	**1000**	EPA VISL										28,27												
Acetone	μg/m³	-	1600000	1100000	**1100000**	**1100000**	EPA VISL				27,7		227,62				<23,75			30,81									
Benzene	μg/m³	40,4	16	12	**16**	**16**	New Jersey established by Yhael										<3,19	13,77											
Carbon disulfide	μg/m³	-	36000	24000	**24000**	**24000**	EPA VISL										<3,11												
Ethyl chloride	μg/m³	-	-	350000	**350000**	**350000**	EPA VISL																						
Chloroform	μg/m³	13,7	24	4,1	**13,7**	**13,7**	IRBCA										<4,88				7,96								
Chloromethane	μg/m³	-	4700	3100	**3100**	**3100**	EPA VISL				7						<2,06												2,56
Ethylbenzene	μg/m³	126	49	37	**49**	**37**	New Jersey										<4,34	**1858**											7,82
Heptane	μg/m³	-	-	-	**-**	**0**	-										<4,1												
Methylene chloride	μg/m³	-	4800	3400	**3400**	**3400**	EPA VISL	3,89		3,86				4,79			<3,47						5,11	4,76	4,17		5		
O-xylene	μg/m³	13500	-	3500	**13500**	**13500**	IRBCA										4,34												9,55
Tetrachloroethylene	μg/m³	1210	-	360	**1210**	**1210**	IRBCA										34,52			39,61									
Toluene	μg/m³	676000	260000	17000	**676000**	**676000**	IRBCA									6,71	<3,77			5,39		4,41		5,62		5,69		6,82	22,08
Trichloroethylene	μg/m³	76,96	27	16	**27**	**16**	New Jersey				6,13						<5,37												
Freon-11	μg/m³	-	36000	-	**-**	**36000**	New Jersey										<5,62									10,34		10,62	
Xylenes (total)	μg/m³	13500	5200	3500	**5200**	**5200**	New Jersey established by Yhael											8,81	6,47										33,39
Freon-12	μg/m³	-	5200	3500	**3500**	**3500**	EPA VISL										<4,95												
Cyclohexane	μg/m³	811000	310000	35000	**310000**	**310000**	New Jersey established by Yhael										<3,44												
Hexane	μg/m³	-	36000	24000	**24000**	**24000**	EPA VISL										<3,52												
Isopropyl alcohol	μg/m³	-	-	7000	**7000**	**7000**	EPA VISL	37,73	173,65	130,91	<24,58	<24,58	**7604,32**	35,2	38,29	<24,58	40,75	59,87	145,48	<24,58	188,64	<24,58	80,2	29,1	<24,58	59,19	133,59	62,92	<24,58
P+m - xylene	μg/m³	13500	-	3500	**13500**	**13500**	IRBCA										<4,34	8,81	6,47										23,84
Methyl tert-butyl ether	μg/m³	1210	470	360	**470**	**470**	New Jersey established by Yhael										3,61	30,14											4,47
1,3,5-trimethylbenzene	μg/m³	-	-	-	**-**	**0**	-										11,45	5,11											13,81
1,2,4-trimethylbenzene	μg/m³	946	-	240	**946**	**946**	IRBCA										<7,42	44,19	9,19			6,19							41,34
Freon-113	μg/m³	-	1600000	1000000	**1000000**	**1000000**	EPA VISL										<7,66												
Propene	μg/m³	-	-	100000	**100000**	**100000**	EPA VISL						42,41				<1,72			3,25		2,96		22,61					
Ethanol	μg/m³	-	-	-	**-**	**0**	ND							22,87			<18,84									23,74		22,65	
1-ethyl-4-methyl-Benzene	μg/m³	-	-	-	**-**	**0**	ND										5,46	7,87											9,54
Tetrahydrofuran	μg/m³	-	-	70000	**70000**	**70000**	EPA VISL																						

Red bold: Exeedances of Thresold values
Fucsia bold: Exeedances of minimum of RBTL, IASL and VISL values

Table 3: General assumptions of the Human Health Risk Assessment

RISK ASSESSMENT OBJECTIVES		
Evaluation of human health risk associated with concentrations of contaminants detected in soil gas		
SOFTWARE		
Risk net 2.1 (Italian software) RISC 5 (BPOil)		
PRINCIPAL ASSUMPTIONS		
Exposure patways	. Outdoor vapors inhalation (source S1)	
	· Indoor vapors inhalation	
Receptors	On site	Future residential users (adult and child)
Presence of buildings	Yes (planned)	Residential building
Presence of pavment	Yes	
CRITERIA OF RISK ACCEPTABILITY		
Acceptable cumulative carcinogenic risk	10^{-5}	IRBCA
Acceptable risk index with reference to the exposure to the sum of toxic agent (Hazard Quotient, HQ)	<1	IRBCA

Table 4: Secondary source geometry

Source	PARAMETER	Value [m]
S1	LENGTH OF THE SOURCE AREA ALONG THE PREDOMINANT WIND DIRECTION [m]	500
S1÷S7	DEPTH OF THE SOURCES BASE [m b.g.l.]	1,5
	SOURCE THICKNESS	10
S2÷S7	DISTANCE BETWEEN THE SOURCE AND FOUNDATION [m]	0,00001

Table 5a:Representative concentrations- Source S1

Contamimants of concern	Threshold Values [µg/m3]	Representative concentration [µg/m3]
Naphthalene	9,28	**12,32**
1,1-dichloroethene	7000	28,59
2-butanone	26000	8,94
Acetone	1100000	52,62
Benzene	16	6,29
Carbon disulfide	24000	5,29
Chloroform	13,7	6,1
Chloromethane	3100	2,87
Ethylbenzene	49	**82,98**
Methylene chloride	3400	57,53
O-xylene	13500	147,11
Tetrachloroethylene	1210	17,57
Toluene	676000	117,35
Trichloroethylene	27	23,81
Freon-11	ND	134,84
Xylenes (total)	5200	508,21
Freon-12	3500	5,09
Hexane	24000	93,47
Isopropyl alcohol	7000	3052
P+m - xylene	13500	361,1
Methyl tert-butyl ether	470	352,27
1,3,5-trimethylbenzene	ND	202,49
1,2,4-trimethylbenzene	946	525,8
Freon-113	1000000	66,14
Propene	100000	78,98
Ethanol	ND	50,59
1-ethyl-4-methyl-Benzene	ND	206,37

Table 5b: Representative concentrations- Source S2

Contamimants of concern	Threshold Values [μg/m3]	Representative concentration [μg/m3]
Naphthalene	9,28	**9,28**
1,1,1-trichloroethane	260000	527,18
1,1-dichloroethane	76	**111,91**
1,1-dichloroethene	7000	794,4
2-butanone	26000	6,55
Acetone	1100000	37,82
Carbon disulfide	24000	3,67
Chloroform	13,7	7,67
Methylene chloride	3400	78,51
O-xylene	13500	15,72
Tetrachloroethylene	1210	15,74
Toluene	676000	14,89
Trichloroethylene	27	24,61
Xylenes (total)	5200	11,46
Isopropyl alcohol	7000	6340,05
P+m - xylene	13500	11,46
Methyl tert-butyl ether	470	5,3
1,3,5-trimethylbenzene	ND	6,64
1,2,4-trimethylbenzene	946	14,8
Freon-113	1000000	107,37
Ethanol	ND	55,19

Table 5c: Representative concentrations- Source S3

Contamimants of concern	Threshold Values [µg/m3]	Representative concentration [µg/m3]
Naphthalene	9,28	7,76
1,1,1-trichloroethane	260000	5133,27
1,1,2-trichloroethane	5,8	**23,68**
1,1-dichloroethane	76	**1673,73**
1,1-dichloroethene	7000	2598,05
2-butanone	26000	35,24
Acetone	1100000	338,62
Benzene	16	4,5
Chloroform	13,7	**100,63**
Ethylbenzene	49	9,94
Heptane	ND	23,11
Methylene chloride	3400	47,52
O-xylene	13500	8,51
Tetrachloroethylene	1210	37,76
Toluene	676000	41,45
Trichloroethylene	27	**103,28**
Xylenes (total)	5200	32,53
Freon-12	3500	5,24
Hexane	24000	53,75
Isopropyl alcohol	7000	221,85
P+m - xylene	13500	24,45
Methyl tert-butyl ether	470	24,77
1,3,5-trimethylbenzene	ND	15,88
1,2,4-trimethylbenzene	946	59,38
Freon-113	1000000	518,22
Propene	100000	36,45
Ethanol	ND	42,79
1-ethyl-4-methyl-Benzene	ND	20,65

Table 5d: Representative concentrations- Source S4

Contamimants of concern	Threshold Values [µg/m3]	Representative concentration [µg/m3]
Naphthalene	9,28	**13,94**
1,1,1-trichloroethane	260000	6,77
2-butanone	26000	14,66
2-hexanone	1000	23,92
Acetone	1100000	51,21
Benzene	16	3,8
Chloroform	13,7	**14,94**
Chloromethane	3100	13,53
Ethylbenzene	49	9,86
Heptane	ND	48,24
Methylene chloride	3400	94,76
O-xylene	13500	15,94
Toluene	676000	70,7
Xylenes (total)	5200	52,81
Cyclohexane	310000	28,16
Hexane	24000	117,55
Isopropyl alcohol	7000	221,01
P+m - xylene	13500	38,65
1,3,5-trimethylbenzene	ND	32,49
1,2,4-trimethylbenzene	946	113,51
Ethanol	ND	150,57
1-ethyl-4-methyl-Benzene	ND	42,92

Table 5e: Representative concentrations- Source S5

Contamimants of concern	Threshold Values [μg/m3]	Representative concentration [μg/m3]
2-butanone	26000	6,64
Acetone	1100000	34,73
Chloromethane	3100	8,42
Ethylbenzene	49	11,38
Methylene chloride	3400	8,3
O-xylene	13500	12,85
Toluene	676000	32,26
Trichloroethylene	27	**34,5**
Xylenes (total)	5200	59,44
Freon-12	3500	5,54
Cyclohexane	310000	3,3
Hexane	24000	7,61
Isopropyl alcohol	7000	130,27
P+m - xylene	13500	46,59
1,3,5-trimethylbenzene	ND	6,24
1,2,4-trimethylbenzene	946	17,21
Propene	100000	3,05
Ethanol	ND	27,06
1-ethyl-4-methyl-Benzene	ND	5,75

Table 5f: Representative concentrations- Source S6

Contamimants of concern	Threshold Values [µg/m3]	Representative concentration [µg/m3]
Naphthalene	9,28	**101,07**
1,1,1-trichloroethane	260000	99,96
1,1,2-trichloroethane	5,8	**145,14**
1,1-dichloroethane	76	7
1,1-dichloroethene	7000	102,38
2-butanone	26000	12,68
2-hexanone	1000	9,3
Acetone	1100000	50,29
Carbon disulfide	24000	5,95
Ethyl chloride	350000	5,75
Chloroform	13,7	**14,7**
Chloromethane	3100	4,87
Ethylbenzene	49	9,94
Methylene chloride	3400	159,13
O-xylene	13500	9,21
Tetrachloroethylene	1210	15,46
Toluene	676000	35,84
Xylenes (total)	5200	32,53
Freon-12	3500	5,04
Cyclohexane	310000	68,67
Hexane	24000	66,69
Isopropyl alcohol	7000	232,15
P+m - xylene	13500	24,45
Methyl tert-butyl ether	470	4,76
1,3,5-trimethylbenzene	ND	10,27
1,2,4-trimethylbenzene	946	44,19
Freon-113	1000000	17,78
Ethanol	ND	121,04
1-ethyl-4-methyl-Benzene	ND	11,75

Table 5g: Representative concentrations- Source S7

Contamimants of concern	Threshold Values [µg/m3]	Representative concentration [µg/m3]
Naphthalene	9,28	**161,14**
2-butanone	26000	13,71
2-hexanone	1000	28,27
Acetone	1100000	227,62
Benzene	16	13,77
Ethylbenzene	49	**1858**
Methylene chloride	3400	4,79
O-xylene	13500	4,34
Tetrachloroethylene	1210	34,52
Toluene	676000	6,71
Xylenes (total)	5200	8,81
Isopropyl alcohol	7000	**7604,32**
P+m - xylene	13500	8,81
Methyl tert-butyl ether	470	30,14
1,3,5-trimethylbenzene	ND	11,45
1,2,4-trimethylbenzene	946	44,19
Propene	100000	42,41
Ethanol	ND	22,87
1-ethyl-4-methyl-Benzene	ND	7,87

Table 6: Input parameters for the vadose zone used in the HHRA

Parameter	Value	Notes (References)
USDA soil type	Sand	Most representative texture based on the stratigraphic information obtained during the drilling of the borehole performed in 2016 in Ta'as site
Effective porosity (-)	0,4	IRBCA
Volumetric water content vadose zone (mobile and residual) (-)	0,100	
Volumetric air content vadose zone (-)	0,300	
*Dry bulk density (kg/l) **	1,65	IRBCA
Fraction organic carbon - vadose zone (-)	0.001	IRBCA
*pH vadose zone **	6.80	Required by RISK NET

** This parameter do not influence the environmental behaviour of CoC*

Table 7: building parameters considered for the indoor inhalation pathway

Parameter	Value	Notes (References)
Slab thickness (m)	0,15	IRBCA
Foundation crack fraction (-)	0.002	EPA
Enclosed space volume/infiltration area ratio (m)	2	IRBCA
Lenght of encolsed space (m)	10	Site specific
Width of encolsed space (m)	6,3	Site specific
Crack fraction total porosity (-)	0,4	IRBCA
Crack fraction water content (-)	0,1	IRBCA
Enclosed space air exchange rate (1/h)	0,5	IRBCA

Table 8: Human exposure factors

EXPOSURE PARAMETERS	Adult worker - commercial/industrial exposition	Notes (References)
Average time of exposure to carcinogenic compounds (years)	70	IRBCA
Body weight (kg)	70	IRBCA
Frequency of annual indoor exposure (days/year)	360	IRBCA
Outdoor Frequency of daily exposure (hours/day)	16	IRBCA
Indoor Frequency of daily exposure (hours/day)	18	IRBCA
Hourly inhalation rate (m^3/h)-Adult	0,9	EPA
Hourly inhalation rate (m^3/h)-Child	0,7	EPA
Average time of exposure to non-carcinogenic compounds (years)-Adult	24	IRBCA
Average time of exposure to non-carcinogenic compounds (years)-Child	6	IRBCA

Table 9: Physical and toxicological parameters

Contamimants of concern	CAS number	Class	Molecular weight [g/mole]	Solubility [mg/L]	Rif.	Vapor Pression [mm Hg]	Rif.	Henry's Law constant [adim.]	Rif.	Koc [mg/kg/mg/L]	log Kow [adim.]	Rif.	Diffusion coefficient in air [cm^2/sec]	Rif.	Diffusion coefficient in water [cm^2/sec]	Rif.	SF Oral. [mg/kg/day]-1	Rif.	SF Inhal. [mg/kg/day]-1	Rif.	RfD Oral [mg/kg/day]	Rif.	RfD Inhal. [mg/kg/day]	Rif.
Acetone	67-64-1	Organic	58,00	1,00E+06	EPA region 9 2017	2,30E+02	EPA region 9 2017	1,40E-03	EPA region 9 2017	2,40E+00	-2,40E-01	EPA region 9 2017	1,10E-01	EPA region 9 2017	1,20E-05	EPA region 9 2017		EPA region 9 2017		EPA region 9 2017	9,00E-01	EPA region 9 2017	1,43E+00	EPA region 9 2017
Benzene	71-43-2	Organic	78,00	1,79E+03	IRBCA	9,50E+01	IRBCA	2,27E-01	IRBCA	1,46E+02	2,10E+00	EPA region 9 2017	8,95E-02	IRBCA	1,03E-05	IRBCA	5,50E-02	IRBCA	2,73E-02	IRBCA	4,00E-03	IRBCA	8,57E-03	IRBCA
Carbon Disulfide	75-15-0	Organic	76,10	2,20E+03	EPA region 9 2017	3,60E+02	EPA region 9 2017	5,89E-01	EPA region 9 2017	2,20E+01	1,90E+00	EPA region 9 2017	1,06E-01	EPA region 9 2017	1,30E-05	EPA region 9 2017		EPA region 9 2017		EPA region 9 2017	1,00E-01	EPA region 9 2017	2,00E-01	EPA region 9 2017
Chloroform	67-66-3	Organic	119,40	7,95E+03	IRBCA	1,98E+02	IRBCA	1,50E-01	IRBCA	3,18E+01	2,00E+00	EPA region 9 2017	7,70E-02	IRBCA	1,10E-05	IRBCA	3,10E-02	IRBCA	8,05E-02	IRBCA	1,00E-02	IRBCA	2,80E-02	IRBCA
Dichloroethylene (1,1)	75-35-4	Organic	96,90	2,42E+03	IRBCA	5,91E+02	IRBCA	1,07E+00	IRBCA	3,18E+01	2,10E+00	EPA region 9 2017	8,63E-02	IRBCA	1,10E-05	IRBCA		IRBCA		IRBCA	5,00E-02	IRBCA	5,71E-02	IRBCA
Ethylbenzene	100-41-4	Organic	106,20	1,69E+02	IRBCA	9,60E+00	IRBCA	3,22E-01	IRBCA	4,46E+02	3,20E+00	EPA region 9 2017	6,85E-02	IRBCA	8,46E-06	IRBCA	1,10E-02	IRBCA	8,75E-03	IRBCA	1,00E-01	IRBCA	2,86E-01	IRBCA
Hexane (n-)	110-54-3	Organic	86,18	9,50E+00	IRBCA	1,52E+02	IRBCA	7,36E+01	IRBCA	1,32E+02	3,90E+00	EPA region 9 2017	7,31E-02	IRBCA	8,17E-06	IRBCA		IRBCA		IRBCA	6,00E-02	IRBCA	2,00E-01	IRBCA
Methylene chloride	75-09-2	Organic	84,93	1,30E+04	EPA region 9 2017	4,40E+02	EPA region 9 2017	1,13E-01	EPA region 9 2017	2,20E+01	1,30E+00	EPA region 9 2017	9,99E-02	EPA region 9 2017	1,30E-05	EPA region 9 2017	2,00E-03	EPA region 9 2017	3,50E-05	EPA region 9 2017	6,00E-03	EPA region 9 2017	1,71E-01	EPA region 9 2017
Methyl ethyl ketone	78-93-3	Organic	72,10	2,23E+05	EPA region 9 2018	9,53E+01	EPA region 9 2018	2,33E-03	EPA region 9 2018	4,51E+00	2,90E-01	EPA region 9 2018	9,10E-02	EPA region 9 2018	1,00E-05	EPA region 9 2018		EPA region 9 2018		EPA region 9 2018	6,00E-01	EPA region 9 2018	1,43E+00	EPA region 9 2018
MTBE	1634-04-4	Organic	88,17	5,10E+04	IRBCA	2,50E+02	IRBCA	2,41E-02	IRBCA	1,16E+01	9,40E-01	EPA region 9 2019	7,53E-02	IRBCA	8,59E-06	IRBCA	1,80E-03	IRBCA	9,10E-04	IRBCA		IRBCA	8,57E-01	IRBCA
Naphthalene	91-20-3	Organic	128,20	3,10E+01	IRBCA	8,89E-02	IRBCA	1,80E-02	IRBCA	1,54E+03	3,30E+00	EPA region 9 2020	6,05E-02	IRBCA	8,38E-06	IRBCA		IRBCA	1,19E-01	IRBCA	2,00E-02	IRBCA	8,57E-04	IRBCA
Tetrachloroethylene (PCE)	127-18-4	Organic	165,80	2,06E+02	IRBCA	1,84E+01	IRBCA	7,24E-01	IRBCA	9,49E+01	3,40E+00	EPA region 9 2021	5,05E-02	IRBCA	9,46E-06	IRBCA	2,10E-03	IRBCA	9,10E-04	IRBCA	6,00E-03	IRBCA	1,14E-02	IRBCA
Toluene	108-88-3	Organic	92,10	5,26E+02	IRBCA	2,82E+01	IRBCA	2,72E-01	IRBCA	2,34E+02	2,70E+00	EPA region 9 2022	7,78E-02	IRBCA	9,20E-06	IRBCA		IRBCA		IRBCA	8,00E-02	IRBCA	1,43E+00	IRBCA
Trichloroethane (1,1,1)	71-55-6	Organic	133,40	1,29E+03	IRBCA	1,24E+02	IRBCA	7,03E-01	IRBCA	4,39E+01	2,50E+00	EPA region 9 2023	6,48E-02	IRBCA	9,60E-06	IRBCA		IRBCA		IRBCA	2,00E+00	IRBCA	1,43E+00	IRBCA
Trichloroethane (1,1,2)	79-00-5	Organic	133,40	4,42E+03	EPA region 9 2017	2,30E+01	EPA region 9 2017	3,74E-02	EPA region 9 2017	5,01E+01	2,05E+00	EPA region 9 2024	7,80E-02	EPA region 9 2017	8,80E-06	EPA region 9 2017	5,70E-02	EPA region 9 2017	5,60E-02	EPA region 9 2017	4,00E-03	EPA region 9 2017		EPA region 9 2017
Trichloroethylene (TCE)	79-01-6	Organic	131,40	1,28E+03	IRBCA	7,20E+01	IRBCA	4,03E-01	IRBCA	6,07E+01	2,40E+00	EPA region 9 2017	6,87E-02	IRBCA	1,02E-05	IRBCA	4,60E-02	IRBCA	1,44E-02	IRBCA	5,00E-04	IRBCA	5,71E-04	IRBCA
Trimethylbenzene (1,3,5)	85-63-6	Organic	120,00	5,70E+01	EPA region 9 2017	2,10E+00	EPA region 9 2017	2,50E-01	EPA region 9 2017	6,10E+02	3,60E+00	EPA region 9 2017	6,10E-02	EPA region 9 2017	7,90E-06	EPA region 9 2017		EPA region 9 2017		EPA region 9 2017	1,00E-02	EPA region 9 2017	1,71E-02	EPA region 9 2017
Trimethylbenzene (1,2,4)	95-63-6	Organic	120,20	1,39E+03	IRBCA	1,59E+00	IRBCA	2,52E-01	IRBCA	6,14E+02	3,60E+00	EPA region 9 2017	6,07E-02	IRBCA	7,92E-06	IRBCA		IRBCA		IRBCA		IRBCA	2,00E-03	IRBCA
Xylenes (total)	1330-20-7	Organic	106,17	1,06E+02	IRBCA	8,06E+00	IRBCA	2,12E-01	IRBCA	3,83E+02	3,20E+00	EPA region 9 2017	8,47E-02	IRBCA	9,90E-06	IRBCA		IRBCA		IRBCA	2,00E-01	IRBCA	2,86E-02	IRBCA
Xylenes (m-)	108-38-3	Organic	106,17	1,61E+02	IRBCA	8,00E+00	IRBCA	2,94E-01	IRBCA	3,75E+02	3,20E+00	EPA region 9 2017	6,84E-02	IRBCA	8,44E-06	IRBCA		IRBCA		IRBCA	2,00E-01	IRBCA	2,86E-02	IRBCA
Xylenes (o-)	95-47-6	Organic	106,17	1,78E+02	IRBCA	6,75E+00	IRBCA	2,12E-01	IRBCA	3,83E+02	3,13E+00	EPA region 9 2017	6,89E-02	IRBCA	8,53E-06	IRBCA		IRBCA		IRBCA	2,00E-01	IRBCA	2,86E-02	IRBCA
Xylenes (p-)	106-42-3	Organic	106,17	1,62E+02	IRBCA	8,76E+00	IRBCA	2,82E-01	IRBCA	3,75E+02	3,17E+00	EPA region 9 2017	6,82E-02	IRBCA	8,42E-06	IRBCA		IRBCA		IRBCA	2,00E-01	IRBCA	2,86E-02	IRBCA
2-butatone (Metyl Ethyl Ketone)	78-93-3	Organic	72,00	2,20E+05	EPA	9,10E+01	EPA	2,30E-03	EPA	4,50E+00	2,90E-01	EPA region 9 2017	9,10E-02	EPA	1,00E-05	EPA		EPA		EPA	6,00E-01	EPA		EPA
2-Hexanone	591-78-6	Organic	100,00	1,70E+04	EPA region 9 2017	1,20E+01	EPA region 9 2017	3,80E-03	EPA region 9 2017	1,50E+01	1,40E+00	EPA region 9 2017	7,00E-02	EPA region 9 2017	8,40E-06	EPA region 9 2017		EPA region 9 2017		EPA region 9 2017	5,00E-03	EPA region 9 2017		EPA region 9 2017
Cyclohexane	110-82-7	Organic	84,16	5,50E+01	IRBCA	2,21E-13	IRBCA	6,13E+00	IRBCA	1,46E+02	2,90E+00	EPA region 9 2017	8,00E-02	IRBCA	9,11E-02	IRBCA		IRBCA		IRBCA		IRBCA	1,71E+00	IRBCA
Chlorometane	74-87-3	Organic	50,50	5,30E+03	EPA region 9 2017	4,30E+03	EPA region 9 2017	3,61E-01	EPA region 9 2017	1,30E+01	1,12E+00	EPA region 9 2017	1,24E-01	EPA region 9 2017	1,36E-05	EPA region 9 2017		EPA region 9 2017		EPA region 9 2017		EPA region 9 2017	2,57E-02	EPA region 9 2017
Freon 11	75-69-4	Organic	137.37	1,10E+03	EPA region 9 2017	1,10E+03	EPA region 9 2017	3,97E+00	EPA region 9 2017	4,39E+01	2,53E+00	EPA region 9 2017	6,50E-02	EPA region 9 2017	1,00E-05	EPA region 9 2017		EPA region 9 2017		EPA region 9 2017	3,00E-01	EPA region 9 2017		EPA region 9 2017
Freon 12	75-71-8	Organic	120,91	2,80E+02	EPA region 9 2017	4,85E+03	EPA region 9 2017	1,40E+01	EPA region 9 2017	4,39E+01	2,16E+00	EPA region 9 2017	7,60E-02	EPA region 9 2017	1,08E-05	EPA region 9 2017		EPA region 9 2017		EPA region 9 2017	2,00E-01	EPA region 9 2017	5,71E-02	EPA region 9 2017
Freon 113	76-13-1	Organic	187,38	1,70E+02	EPA region 9 2017	3,63E+02	EPA region 9 2017	2,15E+01	EPA region 9 2017	1,97E+02	3,16E+00	EPA region 9 2017	3,80E-02	EPA region 9 2017	8,59E-06	EPA region 9 2017		EPA region 9 2017		EPA region 9 2017	3,00E+01	EPA region 9 2017	1,43E+00	EPA region 9 2017
Isopropylnalchol	67-63-0	Organic	60,00	1,00E+06	EPA region 9 2017	4,50E+01	EPA region 9 2017	3,30E-04	EPA region 9 2017	1,50E+00	5,00E-02	EPA region 9 2017	1,00E-01	EPA region 9 2017	1,10E-05	EPA region 9 2017		EPA region 9 2017		EPA region 9 2017	2,00E+00	EPA region 9 2017	5,71E-02	EPA region 9 2017
Propene (Propylene)	115-07-1	Organic	42,00	2,00E+02	EPA region 9 2017	8,69E+03	EPA region 9 2017	8,00E+00	EPA region 9 2017	2,20E+01	1,80E+00	EPA region 9 2017	1,10E-01	EPA region 9 2017	1,10E-05	EPA region 9 2017		EPA region 9 2017		EPA region 9 2017		EPA region 9 2017	8,57E-01	EPA region 9 2017
Dichloroethane (1,1)	75-34-3	Organic	99,00	5,06E+03	EPA region 9 2018	2,30E+02	EPA region 9 2018	2,30E-01	EPA region 9 2018	3,20E+01	1,80E+00	EPA region 9 2017	8,40E-02	EPA region 9 2017	1,10E-05	EPA region 9 2017	5,70E-03	EPA region 9 2017	5,60E-03	EPA region 9 2017	2,00E-01	EPA region 9 2017		EPA region 9 2017

Table 10a: Risk and Hazard Index for outdoor inhalation pathway - Sorce S1

Contamimants of concern	Representative Concentration soil-gas [mg/m³]	Carcinogenic Risk (IELCR)	Hazard Quotient (Child) (HQ)
2Naphthalene	**1,23E-02**	1,11E-08	6,05E-04
2Dichloroethylene (1,1)	2,86E-02	---	3,01E-05
2bis 2-butatone (Metyl Ethyl Ketone)	8,94E-03	---	---
2Acetone	5,26E-02	---	2,83E-06
2Benzene	6,29E-03	1,93E-09	4,57E-05
2Carbon Disulfide	5,29E-03	---	1,95E-06
2Chloroform	6,10E-03	4,74E-09	1,17E-05
2Chlorometane	2,87E-03	---	9,63E-06
2Ethylbenzene	**8,30E-02**	6,24E-09	1,38E-05
2Methylene chloride	5,75E-02	2,52E-11	2,33E-05
2Xylenes (o-)	1,47E-01	---	2,47E-04
2Tetrachloroethylene (PCE)	1,76E-02	1,01E-10	5,40E-05
2Toluene	1,17E-01	---	4,45E-06
2Trichloroethylene (TCE)	2,38E-02	5,74E-09	1,99E-03
2Freon 11	1,35E-01	---	---
2Xylenes (total)	5,08E-01	---	1,05E-03
2Freon 12	5,09E-03	---	4,71E-06
2Hexane (n-)	9,35E-02	---	2,38E-05
2Isopropylnalchol	3,05E+00	---	3,75E-03
2Xylenes (m-)	3,61E-01	---	6,02E-04
2Xylenes (p-)	3,61E-01	---	6,00E-04
2MTBE	3,52E-01	3,03E-09	2,15E-05
2Trimethylbenzene (1,3,5)	2,02E-01	---	5,02E-04
2Trimethylbenzene (1,2,4)	5,26E-01	---	1,11E-02
2Freon 113	6,61E-02	---	1,22E-06
2Propene (Propylene)	7,90E-02	---	7,06E-06
Cumulative IELCR and HI		**3,29E-08**	**2,07E-02**

Table 10b: Risk and Hazard Index for indoor inhalation pathway - Sorce S2

Contamimants of concern	Representative Concentration soil-gas [mg/m³]	Carcinogenic Risk (IELCR)	Hazard Quotient (Child) (HQ)
Naphthalene	**9,28E-03**	5,35E-09	2,89E-04
1,1,1-trichloroethane	5,27E-01	---	1,06E-05
1,1-dichloroethane	**1,12E-01**	4,22E-09	---
1,1-dichloroethene	7,94E-01		5,30E-04
2-butanone	6,55E-03	---	---
Acetone	3,78E-02	---	---
Carbon disulfide	3,67E-03	---	8,59E-07
Chloroform	7,67E-03	3,81E-09	9,32E-06
Methylene chloride	7,85E-02	2,20E-11	2,02E-05
O-xylene	1,57E-02	---	1,68E-05
Tetrachloroethylene	1,57E-02	5,80E-12	3,07E-06
Toluene	1,49E-02	---	3,58E-07
Trichloroethylene	2,46E-02	1,94E-09	1,31E-03
Xylenes (total)	1,15E-02	---	1,50E-05
Isopropyl alcohol	6,34E+00	---	4,94E-03
P+m - xylene	1,15E-02	---	2,42E-05
Methyl tert-butyl ether	5,30E-03	2,91E-11	2,06E-07
1,3,5-trimethylbenzene	6,64E-03	---	1,04E-05
1,2,4-trimethylbenzene	1,48E-02	---	1,98E-04
Freon-113	1,07E-01	---	1,26E-06
Ethanol	5,52E-02	---	---
Cumulative IELCR and HI		**1,54E-08**	**7,38E-03**

Table 10c: Risk and Hazard Index for indoor inhalation pathway - Sorce S3

Contamimants of concern	Representative Concentration soil-gas [mg/m³]	Carcinogenic Risk (IELCR)	Hazard Quotient (Child) (HQ)
Naphthalene	7,76E-03	4,48E-08	2,42E-03
1,1,1-trichloroethane	**5,13E+00**	---	1,03E-04
1,1,2-trichloroethane	**2,37E-02**	8,29E-09	---
1,1-dichloroethane	1,67E+00	6,31E-08	---
1,1-dichloroethene	2,60E+00	---	1,73E-03
2-butanone	3,52E-02	---	---
Acetone	3,39E-01	---	---
Benzene	4,50E-03	8,81E-10	2,08E-05
Chloroform	**1,01E-01**	5,00E-08	1,22E-04
Ethylbenzene	9,94E-03	4,77E-10	1,05E-06
Heptane	2,31E-02	---	---
Methylene chloride	4,75E-02	1,33E-11	1,22E-05
O-xylene	8,51E-03	---	9,07E-06
Tetrachloroethylene	3,78E-02	1,39E-10	7,37E-05
Toluene	4,15E-02	---	9,97E-07
Trichloroethylene	**1,03E-01**	8,16E-09	5,49E-03
Xylenes (total)	3,25E-02	---	4,26E-05
Freon-12	5,24E-03	---	3,08E-06
Hexane	5,38E-02	---	8,68E-06
Isopropyl alcohol	2,22E-01	---	1,73E-04
P+m - xylene	2,45E-02	---	5,18E-05
Methyl tert-butyl ether	2,48E-02	1,36E-10	9,62E-07
1,3,5-trimethylbenzene	1,59E-02	---	2,50E-05
1,2,4-trimethylbenzene	5,94E-02	---	7,96E-04
Freon-113	5,18E-01	---	6,09E-06
Propene	3,65E-02	---	2,07E-06
Ethanol	4,28E-02	---	---
1-ethyl-4-methyl-Benzene	2,07E-02		
Cumulative IELCR and HI		**1,76E-07**	**1,11E-02**

Table 10d: Risk and Hazard Index for indoor inhalation pathway - Sorce S4

Contamimants of concern	Representative Concentration soil-gas [mg/m³]	Carcinogenic Risk (IELCR)	Hazard Quotient (Child) (HQ)
Naphthalene	**1,39E-02**	8,04E-09	4,35E-04
1,1,1-trichloroethane	6,77E-03	---	1,36E-07
2-butanone	1,47E-02	---	---
2-hexanone	2,39E-02	---	---
Acetone	5,12E-02	---	---
Benzene	3,80E-03	7,44E-10	1,75E-05
Chloroform	**1,49E-02**	7,42E-09	1,82E-05
Chloromethane	1,35E-02	---	2,88E-05
Ethylbenzene	9,86E-03	4,74E-10	1,04E-06
Heptane	4,82E-02	---	---
Methylene chloride	9,48E-02	2,66E-11	2,44E-05
O-xylene	1,59E-02	---	1,70E-05
Toluene	7,07E-02	---	1,70E-06
Xylenes (total)	5,28E-02	---	6,92E-05
Cyclohexane	2,82E-02	---	5,83E-07
Hexane	1,18E-01	---	1,90E-05
Isopropyl alcohol	2,21E-01	---	1,72E-04
P+m - xylene	3,87E-02	---	8,18E-05
1,3,5-trimethylbenzene	3,25E-02	---	5,11E-05
1,2,4-trimethylbenzene	1,14E-01	---	1,52E-03
Ethanol	1,51E-01	---	---
1-ethyl-4-methyl-Benzene	4,29E-02	---	---
Cumulative IELCR and HI		**1,67E-08**	**2,46E-03**

Table 10e: Risk and Hazard Index for indoor inhalation pathway - Sorce S5

Contamimants of concern	Representative Concentration soil-gas [mg/m³]	Carcinogenic Risk (IELCR)	Hazard Quotient (Child) (HQ)
2-butanone	6,64E-03	---	---
Acetone	3,47E-02	---	---
Chloromethane	8,42E-03	---	1,79E-05
Ethylbenzene	1,14E-02	5,47E-10	1,21E-06
Methylene chloride	8,30E-03	2,33E-12	2,14E-06
O-xylene	1,29E-02	---	1,37E-05
Toluene	3,23E-02	---	7,76E-07
Trichloroethylene	**3,45E-02**	2,73E-09	1,83E-03
Xylenes (total)	5,94E-02	---	7,79E-05
Freon-12	5,54E-03	---	3,26E-06
Cyclohexane	3,30E-03	---	6,84E-08
Hexane	7,61E-03	---	1,23E-06
Isopropyl alcohol	1,30E-01	---	1,02E-04
P+m - xylene	4,66E-02	---	9,86E-05
1,3,5-trimethylbenzene	6,24E-03	---	9,81E-06
1,2,4-trimethylbenzene	1,72E-02	---	2,31E-04
Propene	3,05E-03	---	1,73E-07
Ethanol	2,71E-02	---	---
1-ethyl-4-methyl-Benzene	5,75E-03	---	---
Cumulative IELCR and HI		**3,28E-09**	**2,39E-03**

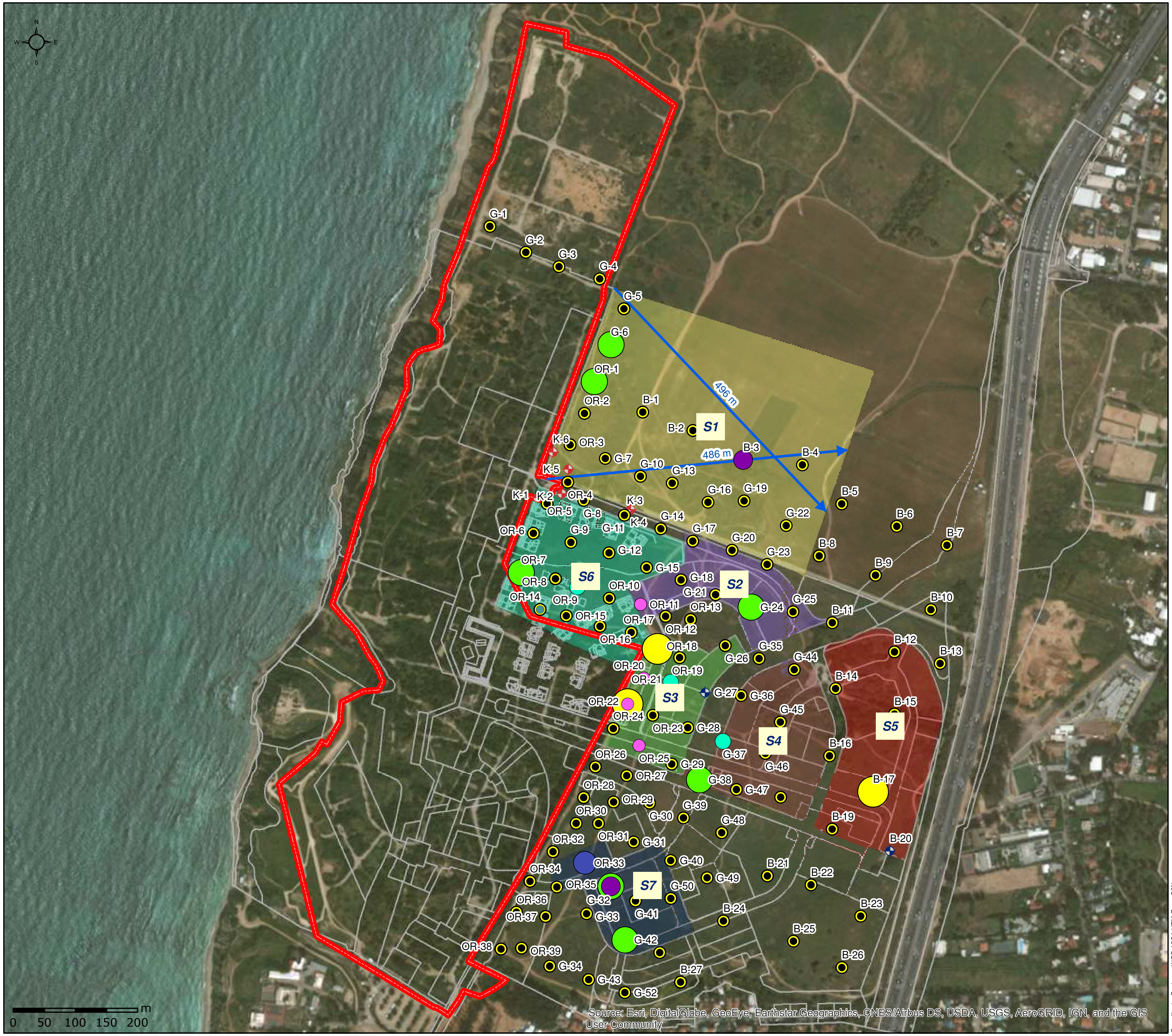
Table 10f: Risk and Hazard Index for indoor inhalation pathway - Sorce S6

Contamimants of concern	Representative Concentration soil-gas [mg/m³]	Carcinogenic Risk (IELCR)	Hazard Quotient (Child) (HQ)
Naphthalene	**1,01E-01**	5,83E-08	8,71E-04
1,1,1-trichloroethane	1,00E-01	---	5,53E-07
1,1,2-trichloroethane	**1,45E-01**	5,08E-08	---
1,1-dichloroethane	7,00E-03	2,64E-10	---
1,1-dichloroethene	1,02E-01	---	1,89E-05
2-butanone	1,27E-02	---	---
2-hexanone	9,30E-03	---	---
Acetone	5,03E-02	---	---
Carbon disulfide	5,95E-03	---	3,85E-07
Ethyl chloride	5,75E-03	---	---
Chloroform	**1,47E-02**	7,30E-09	4,93E-06
Chloromethane	4,87E-03	---	2,86E-06
Ethylbenzene	9,94E-03	4,77E-10	2,91E-07
Methylene chloride	1,59E-01	4,46E-11	1,13E-05
O-xylene	9,21E-03	---	2,71E-06
Tetrachloroethylene	1,55E-02	5,69E-11	8,34E-06
Toluene	3,58E-02	---	2,38E-07
Xylenes (total)	3,25E-02	---	1,18E-05
Freon-12	5,04E-03	---	8,18E-07
Cyclohexane	6,87E-02	---	3,93E-07
Hexane	6,67E-02	---	2,97E-06
Isopropyl alcohol	2,32E-01	---	5,00E-05
P+m - xylene	2,45E-02	---	1,42E-05
Methyl tert-butyl ether	4,76E-03	2,61E-11	5,10E-08
1,3,5-trimethylbenzene	1,03E-02	---	4,46E-06
1,2,4-trimethylbenzene	4,42E-02	---	1,64E-04
Freon-113	1,78E-02	---	5,77E-08
Ethanol	1,21E-01	---	---
1-ethyl-4-methyl-Benzene	1,18E-02	---	---
Cumulative IELCR and HI		**1,17E-07**	**1,17E-03**

Table 10g: Risk and Hazard Index for indoor inhalation pathway - Sorce S7

Contamimants of concern	Representative Concentration soil-gas [mg/m³]	Carcinogenic Risk (IELCR)	Hazard Quotient (Child) (HQ)
Naphthalene	**1,61E-01**	9,30E-08	5,03E-03
2-butanone	1,37E-02	---	---
2-hexanone	2,83E-02	---	---
Acetone	2,28E-01	---	---
Benzene	1,38E-02	2,70E-09	6,35E-05
Ethylbenzene	**1,86E+00**	8,92E-08	1,97E-04
Methylene chloride	4,79E-03	1,34E-12	1,23E-06
O-xylene	4,34E-03	---	4,62E-06
Tetrachloroethylene	3,45E-02	1,27E-10	6,74E-05
Toluene	6,71E-03	---	1,61E-07
Xylenes (total)	8,81E-03	---	1,15E-05
Isopropyl alcohol	**7,60E+00**	---	5,93E-03
P+m - xylene	8,81E-03	---	1,86E-05
Methyl tert-butyl ether	3,01E-02	1,66E-10	1,17E-06
1,3,5-trimethylbenzene	1,15E-02	---	1,80E-05
1,2,4-trimethylbenzene	4,42E-02	---	5,93E-04
Propene	4,24E-02	---	2,40E-06
Ethanol	2,29E-02	---	---
1-ethyl-4-methyl-Benzene	7,87E-03	---	---
Cumulative IELCR and HI		**1,85E-07**	**1,19E-02**

DRAWING



Coordinate System: WGS 1984 UTM Zone 36N

Legend

Exceedances - SGS

- 1,1,2-trichloroethane
- 1,1-dichloroethane
- Chloroform
- Ethylbenzene
- Isopropyl alcohol
- Naphthalene
- Trichloroethylene

Investigation point

- SGS
- SOIL
- SGS Analysis
- S1
- S2
- S3
- S4
- S5
- S6
- S7
- source extension in wind direction
- TAAS site

DATE	REV.	DESCRIPTION	DR.	CH.	APP.
21/12/2017	0	FIRST ISSUE	ECA	ADF	RSA

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CLIENT: NOF-YAM

SITE: TAAS NOF-YAM SITE

PROJECT: HHRA

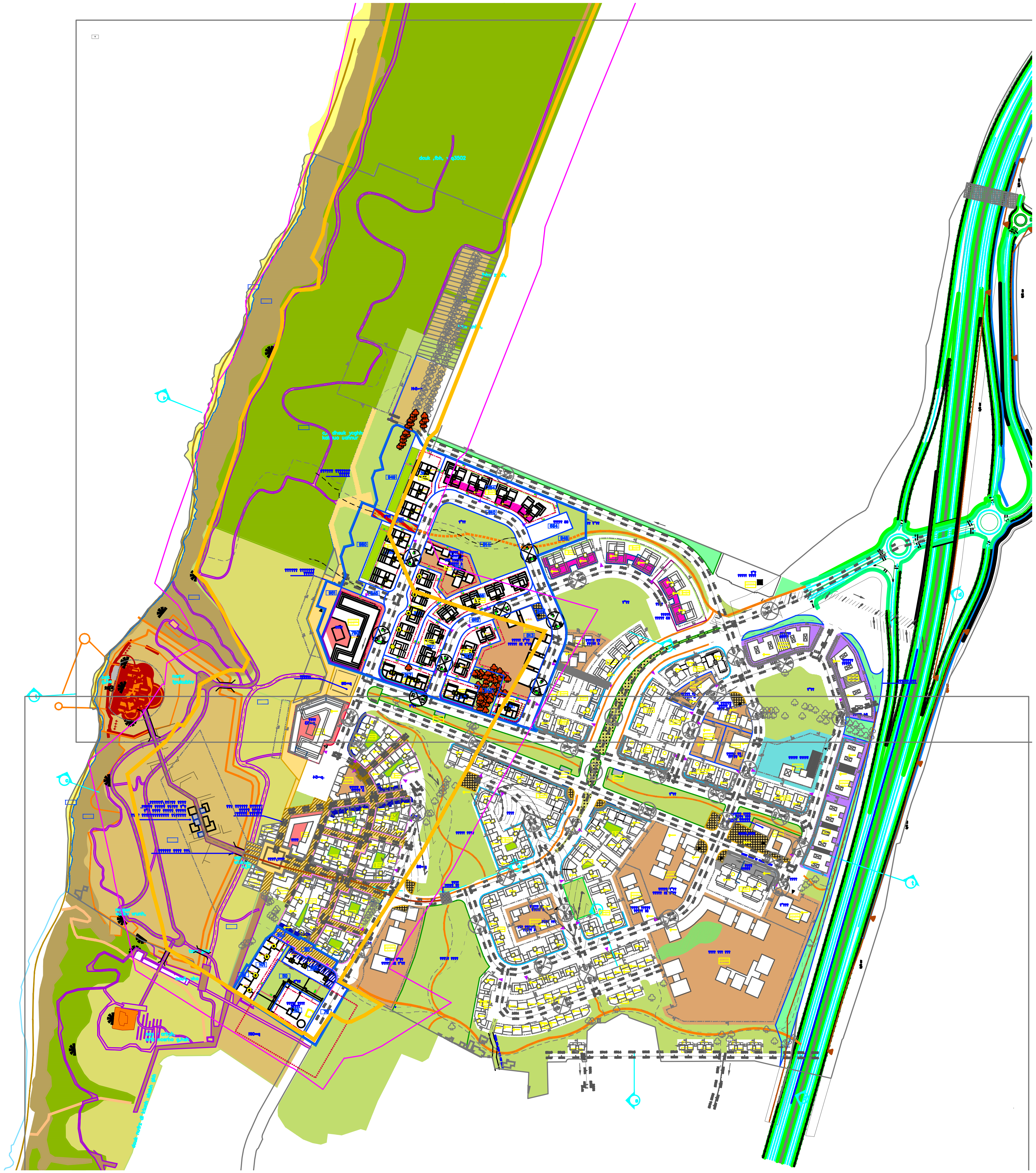
DRAWING: 2

Identification of soil gas secondary sources

Scale: //	[A3]	Proj.# IT1001150	Filename: IT1001394_Fig01_Sorgenti

MSGI-49 Ed.02 Rev.00 Issue: 22/05/15

ANNEX 1



ANNEX 2 (CD ROM)

ANNEX 3

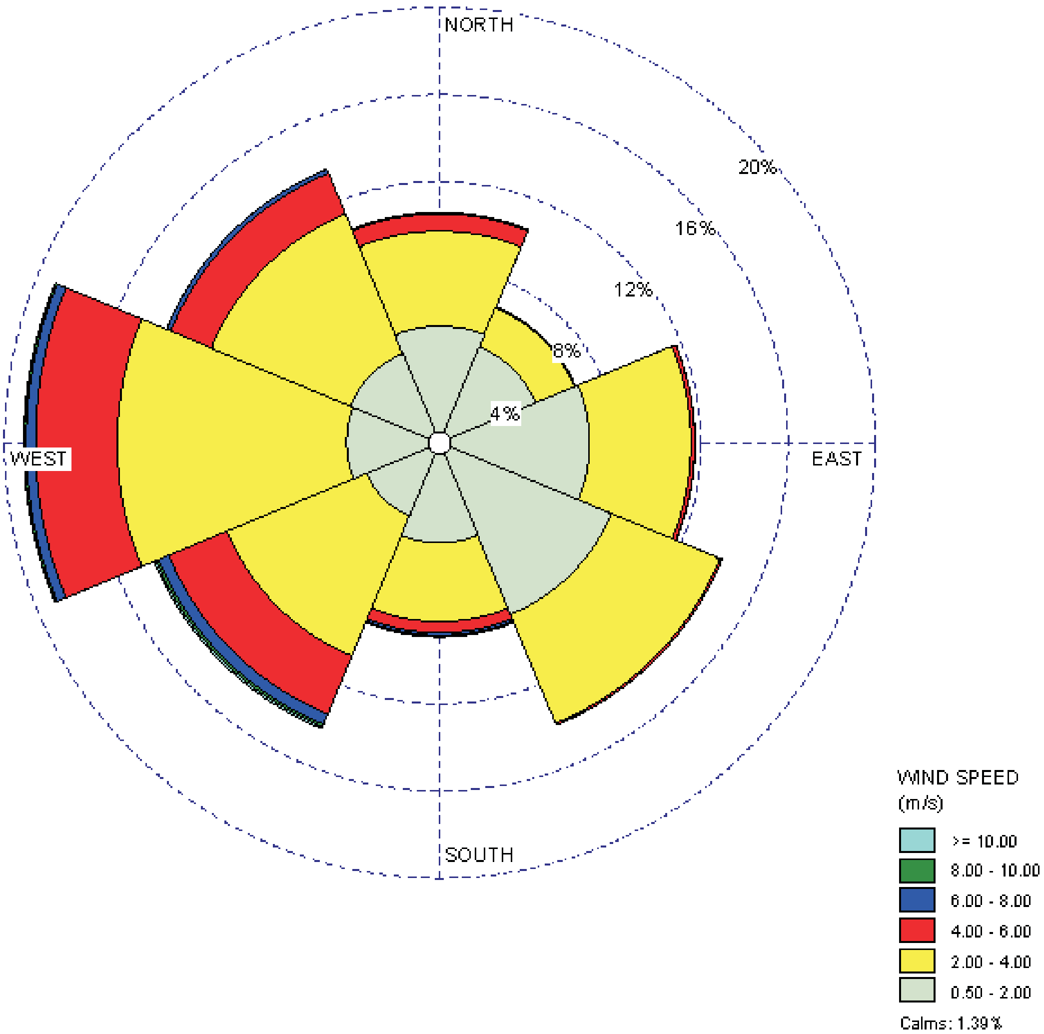
לשם שפר
איכות סביבה בע"מ

WIND ROSE PLOT:

שושנת רוח - יד אבנר
2010-2014

DISPLAY:

Wind Speed
Direction (blowing from)



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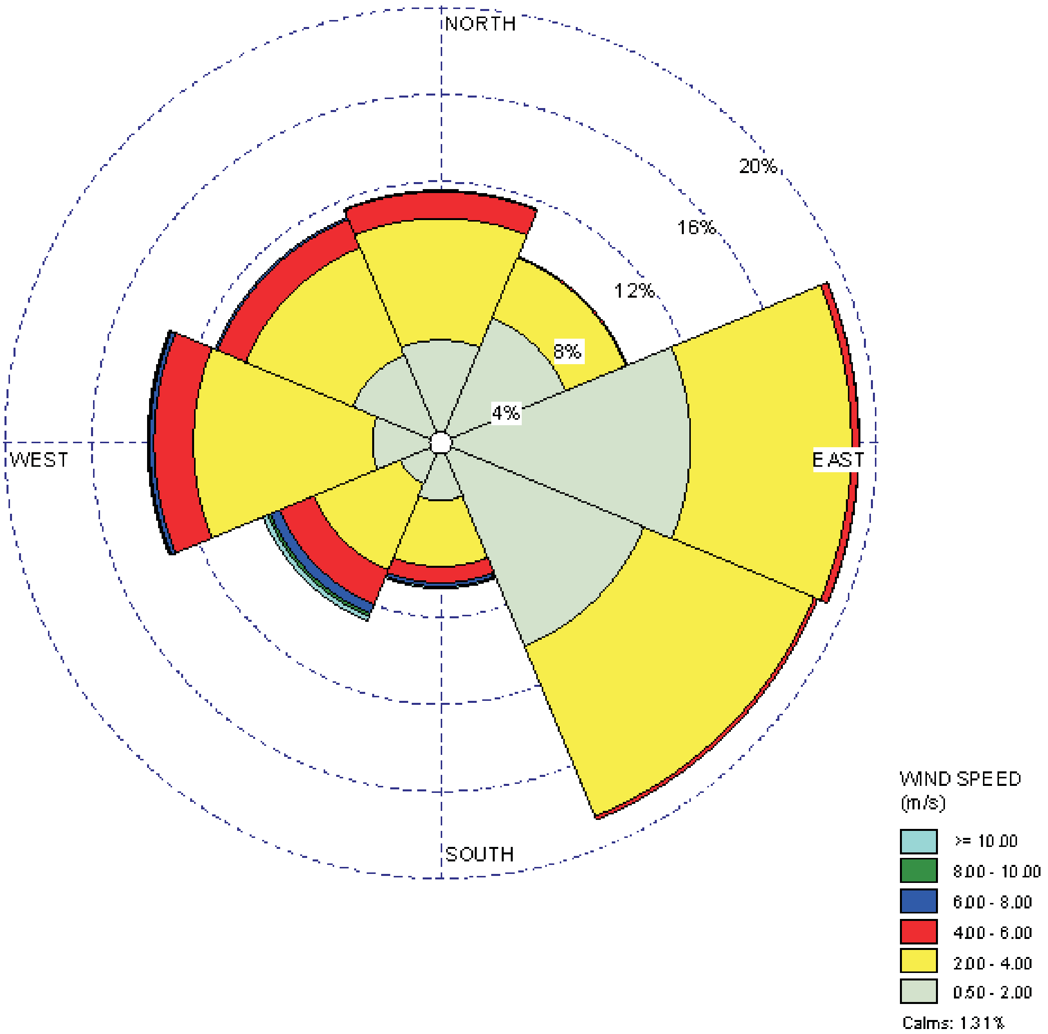
	AVG. WIND SPEED: **2.39 m/s**	DATE: **24/03/2015**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

שושנות רוח שנתיות ועונתיות

WIND ROSE PLOT:
שושנת רוח - יד אבנר - סתיו
2010-2014

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:

DATA PERIOD:
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End Date: 20/12/2014 - 23:00

COMPANY NAME:

MODELER:

CALM WINDS:
1.31%

TOTAL COUNT:
10920 hrs.

AVG. WIND SPEED:
2.29 m/s

DATE:
24/03/2015

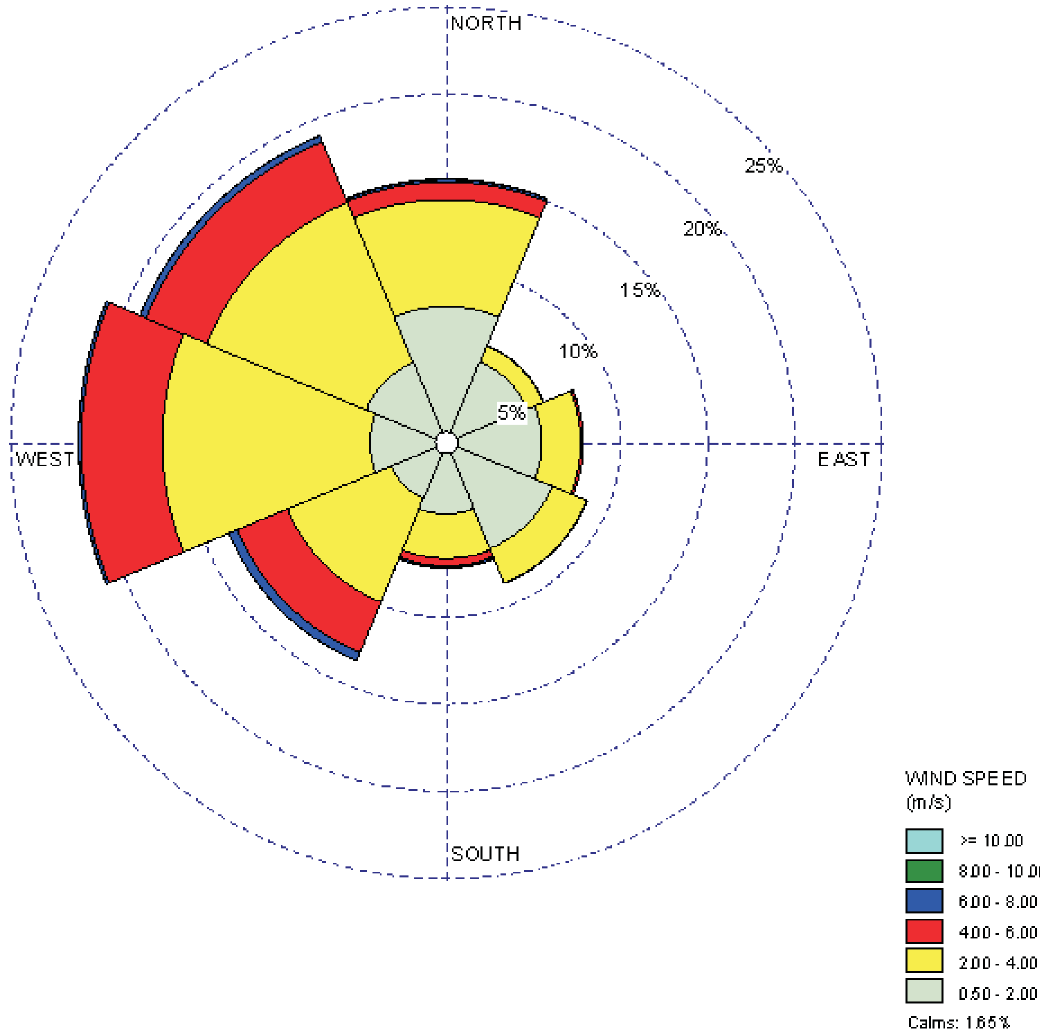
PROJECT NO.:

WRPLOT View - Lakes Environmental Software

שושנות רוח שנתיות ועונתיות

WIND ROSE PLOT:
שושנת רוח - יד אבנר - אביב
2010-2014

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: Start Date: 21/03/2010 - 00:00 End Date: 20/06/2014 - 23:00	COMPANY NAME:	
		MODELER:	
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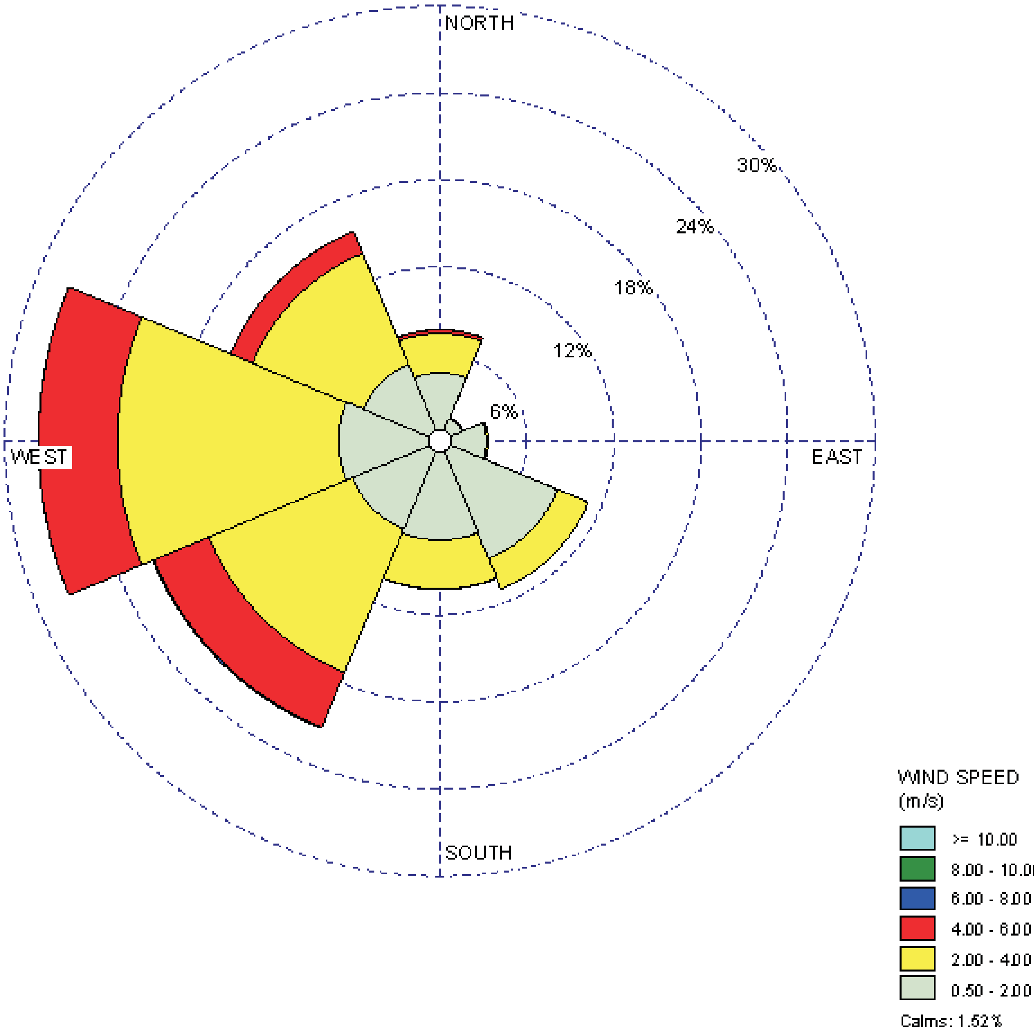
	AVG. WIND SPEED: **2.44 m/s**	DATE: **24/03/2015**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

שושנות רוח שנתיות ועונתיות

WIND ROSE PLOT:
שושנת רוח - יד אבנר - קיץ
2010-2014

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
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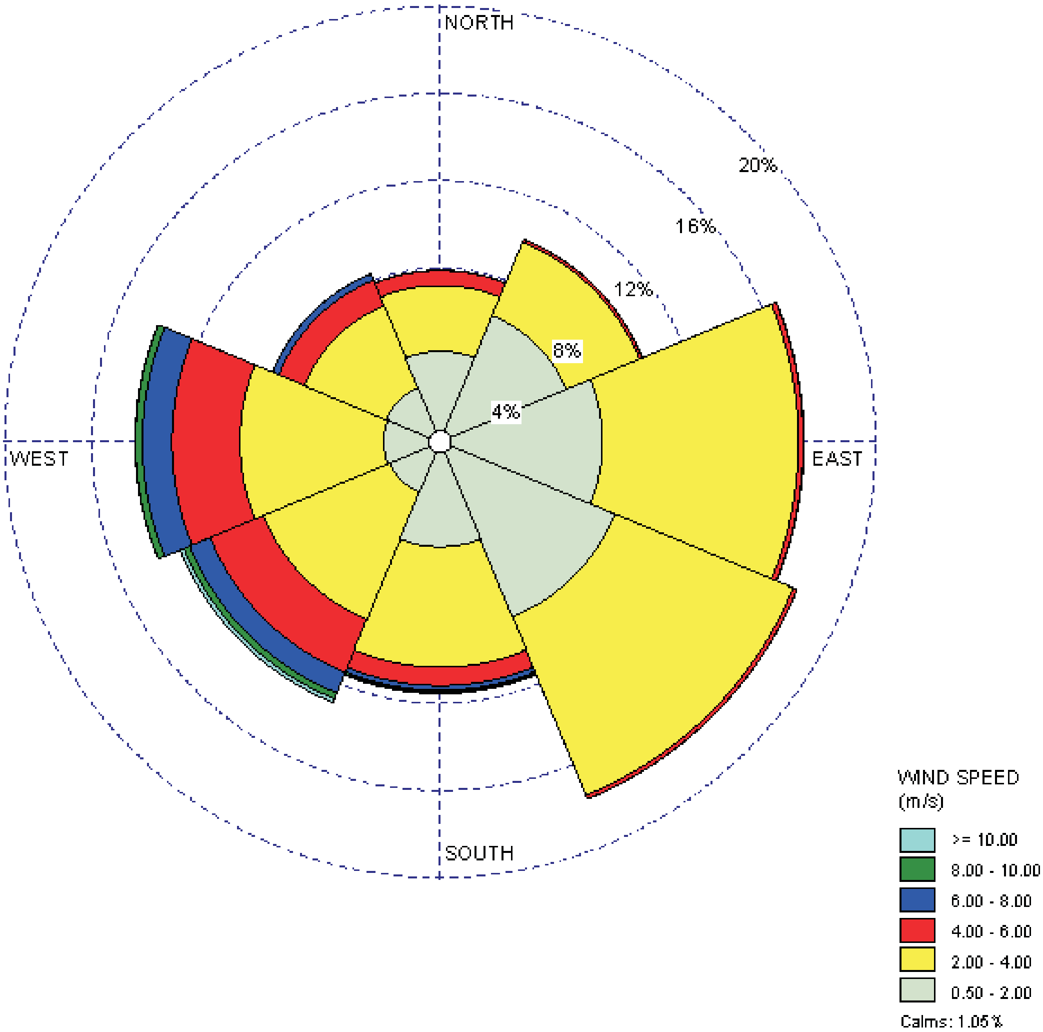
	AVG. WIND SPEED: **2.33 m/s**	DATE: **24/03/2015**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:
שושנת רוח - יד אבנר - חורף
2010-2014

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: Start Date: 01/01/2010 - 00:00 End Date: 31/12/2014 - 23:00	COMPANY NAME:	
		MODELER:	
	CALM WINDS: **1.05%**	TOTAL COUNT: **10824 hrs.**	
	AVG. WIND SPEED: **2.51 m/s**	DATE: **24/03/2015**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software