

SEVESO III AND PROTECTING THE WATER ENVIRONMENT

International Association of Hydrogeologists
(IAH) Irish Group
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Buncefield – Change to SEVESO



SEVESO – Who is it applicable to?

Ireland - 92 sites

UK – 1,100 sites

Seveso III

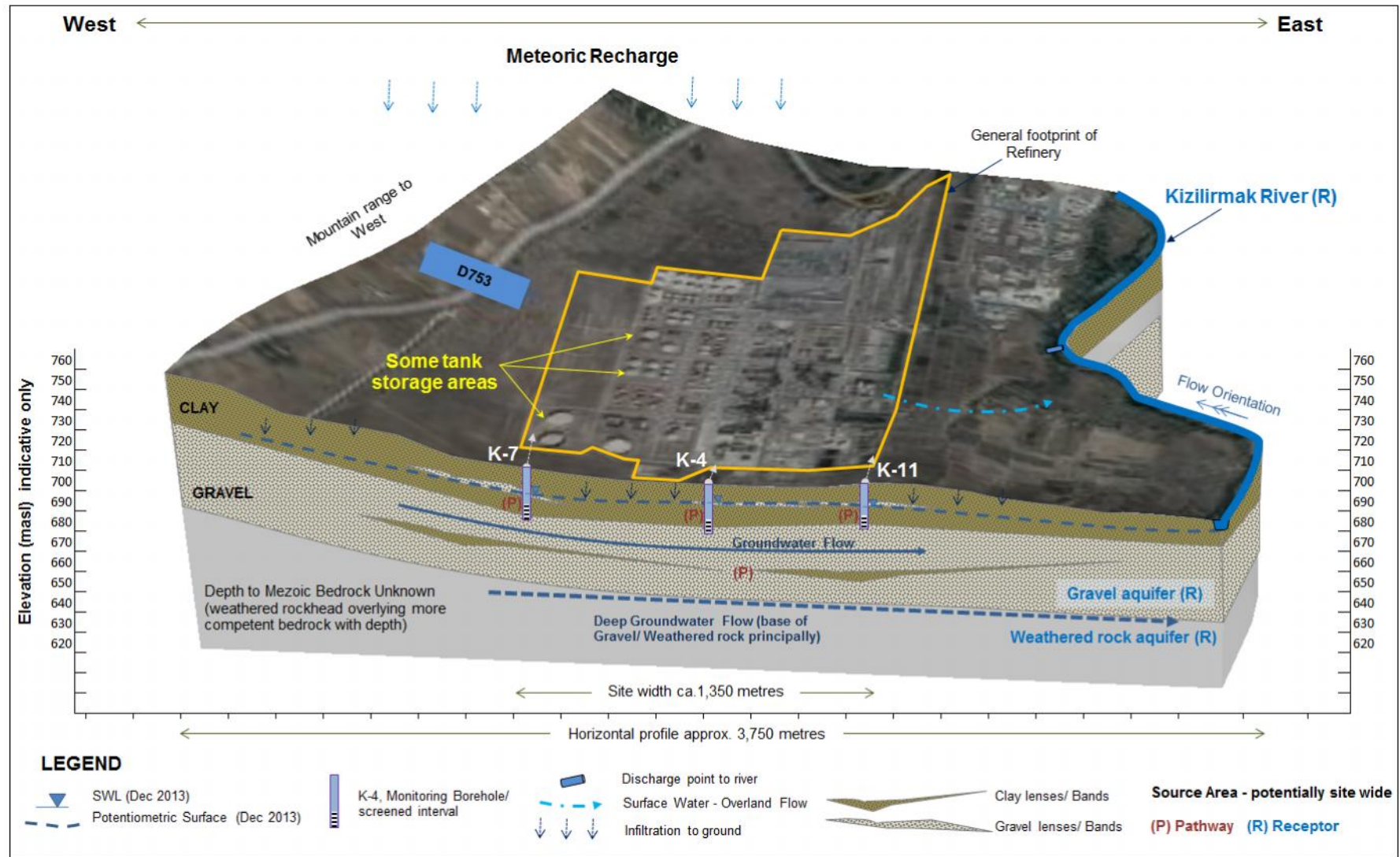
1st June 2015



Case Study – Tüpra Oil Refinery, Turkey



DEVELOPING A CONCEPTUAL SITE MODEL (CSM)



CSM: IDENTIFICATION AND QUANTIFICATION OF DANGEROUS SUBSTANCES POTENTIALLY PRESENT AT THE ESTABLISHMENT



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- Floating roof crude oil bulk storage tank (ref: T4103),
- Fixed roof diesel bulk storage tank (ref: T4311)
- Spherical pressurised LPG bulk storage tank (ref: T4803)



EVALUATION OF HAZARDS PRESENT FOR SEVESO ASSESSMENT REQUIRES AN UNDERSTANDING OF - STORAGE, OPERATING AND FORESEEABLE ACCIDENT CONDITIONS

Substance/ Classification		Total (tonnes)	Lower Tier Threshold (tonnes)	Upper Tier Threshold (tonnes)	Fraction of Lower Tier Threshold	Fraction of Upper Tier Threshold
Named Substances						
Liquefied Petroleum Gas (LPG)	F+; R12	1395	50	200	27.9	7
Petroleum products (Diesel)	Xn; R20, Xi; R38, Carc. Cat. 3; R40, N; R51/53	20127	2500	25000	8	0.8
Petroleum products (Crude oil)	Carc. Cat. 2; R45, N; R51/53	115,230	2500	25000	46	4.6

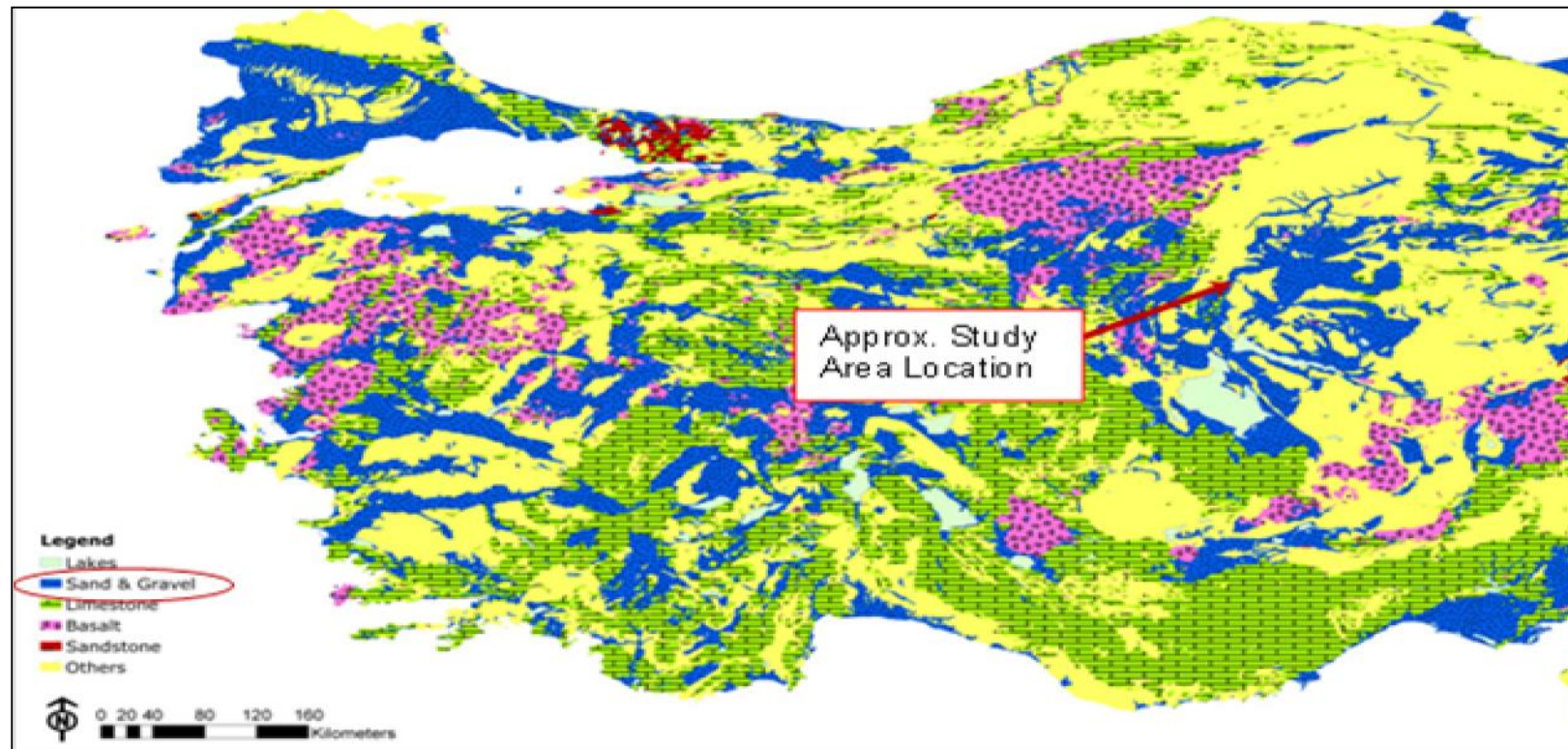
Table 1 Summary of Quantities and Categories of Dangerous Substances with Factorisation

HAZARD ASSESSMENT – FORESEEABLE ACCIDENTS

Storage Vessel	Storage conditions	Behaviour under foreseeable accident conditions
Spherical tank	Liquefied gas at moderate pressure	Gas release: Jet fire or dispersion of flammable gas and Vapour Cloud Explosion (VCE) Liquid release: Pool fire or evaporation/dispersion of flammable vapour and VCE. Catastrophic release: Boiling and rapid expansion of vapour with pressure wave (BLEVE), fireball
Fixed roof tank	Liquid at 35 to 40 °C and atmospheric pressure	Tank fire; Liquid release: Pool fire, migration of product to surrounding environment
Floating roof tank	Liquid at 15 to 25 °C and atmospheric pressure	Tank fire with boil-over, Liquid release: Pool fire, migration of product to surrounding environment, VCE involving flammable vapours

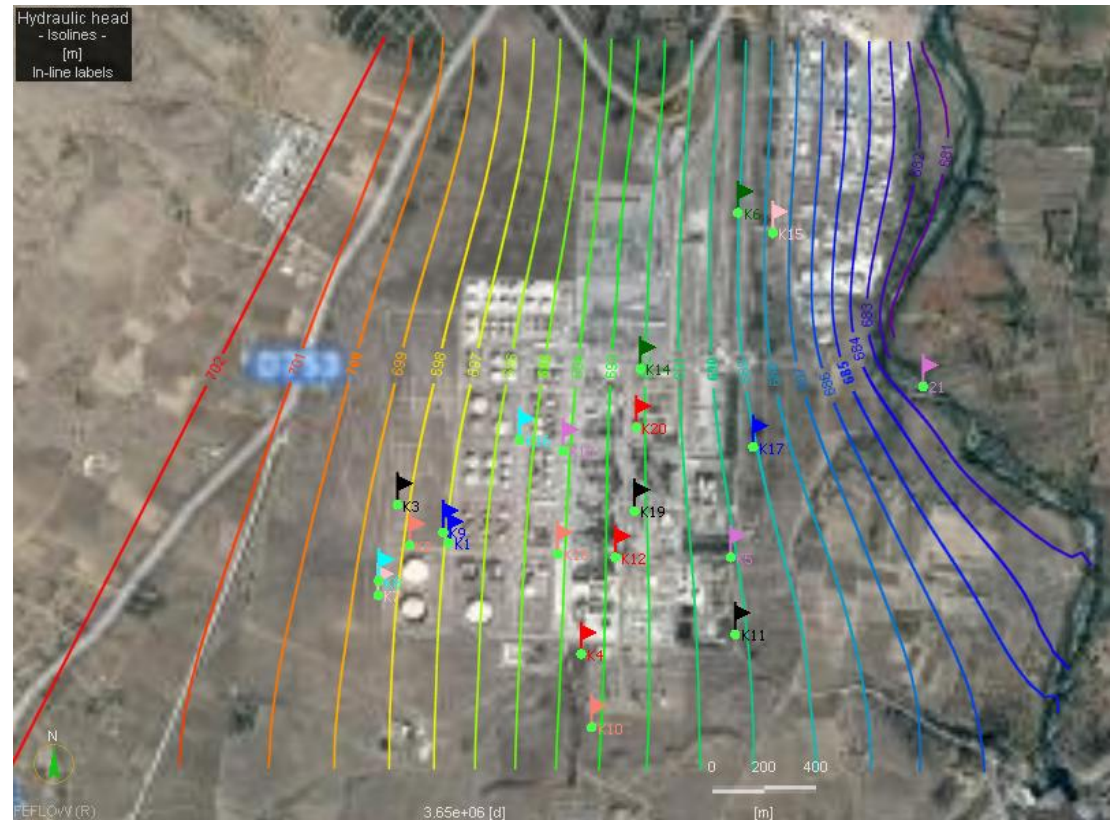
AQUIFER (PATHWAY) CHARACTERISTICS – REGIONAL HYDROGEOLOGY

- Precipitation within the Kirikkale region indicates on average 368.9mm/pa.
- Region underlain by extensive Quaternary sand & gravel aquifer



AQUIFER PATHWAY CHARACTERISTICS – SITE SPECIFIC DATA

- Boreholes data show a clay layer with discontinuous gravel lenses (up to 20m)
- Hydraulic gradient is 0.008
- $K = 8.5 \times 10^{-7} \text{ m/s}$
(approx. 0.073m/day)



IDENTIFYING POLLUTANT LINKAGES

2007 Hydrocarbons	Ref./ Unit	K6	K9	K12	K13	K14	K15	K16	K18	K19	K20
Total Aromatic Hydrocarbons	ug/l	0	0	0	2.5	0	0	0	0	0.9	0
Total Aliphatic Hydrocarbons	ug/l	0	0	121	1228	0	0	0	0	2760	0
Total Petroleum Hydrocarbons (TPH)	ug/l	0	0	121	1230.5	0	0	0	0	2760.1	0
BTEX	ug/l	0	0	0	931	0	0	0	0	23.6	0
TOC	mg/l	-	95	150	140	120	120	140	150	220	120

IDENTIFYING PATHWAYS



ENVIRONMENTAL RECEPTORS

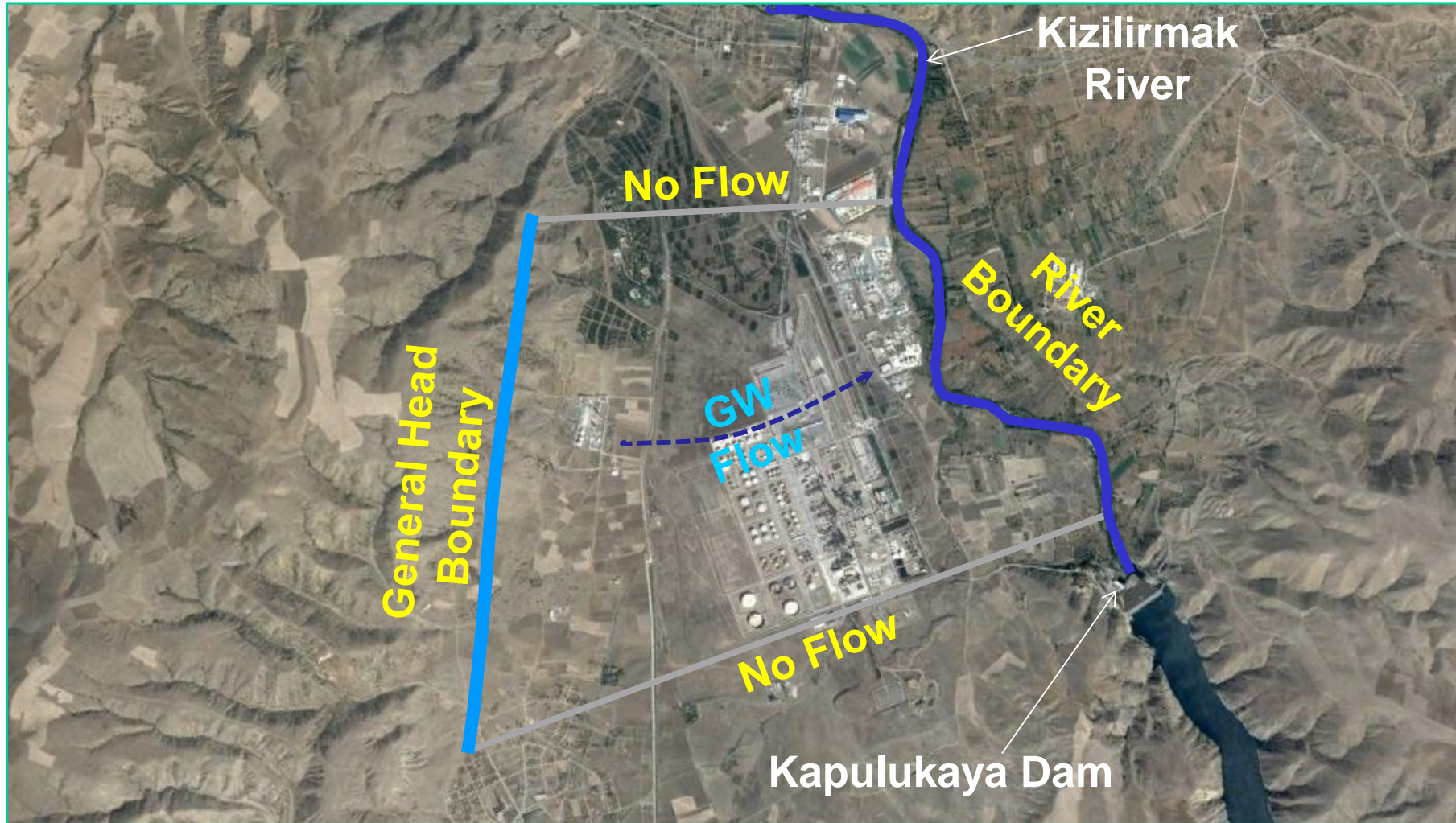
- The Kizilirmak River
- Water Supply

Outfall from refinery

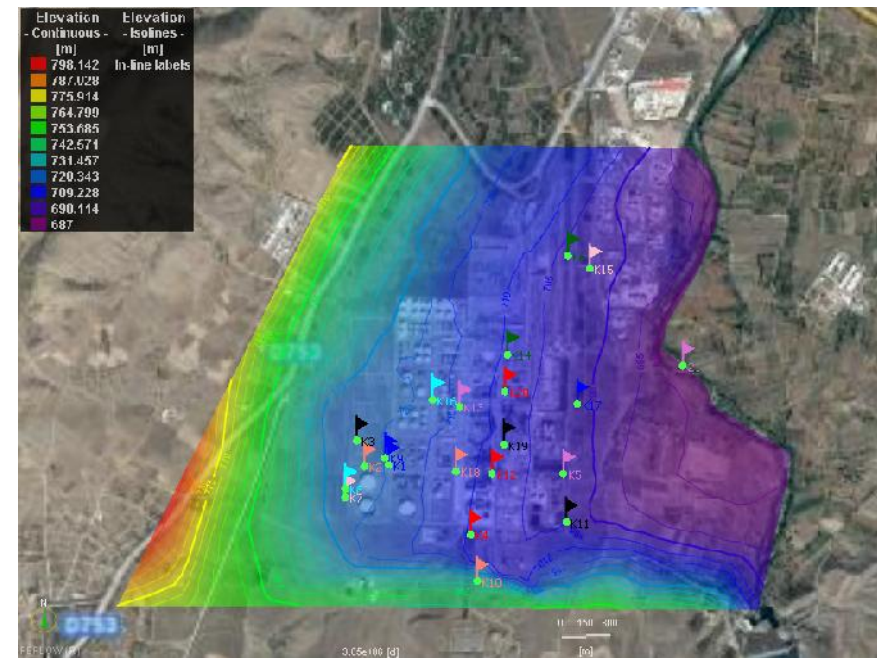
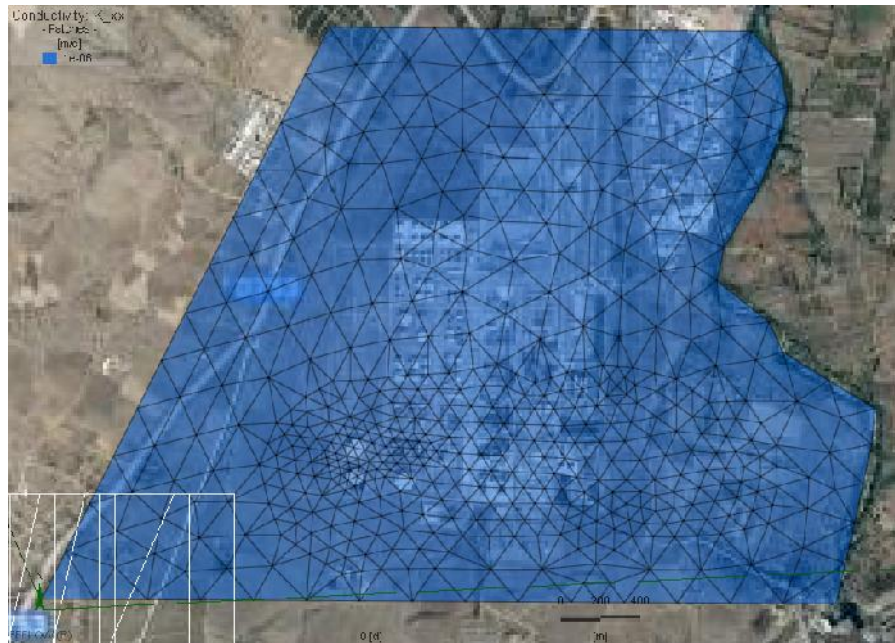


CONSEQUENCE MODELLING- GROUNDWATER

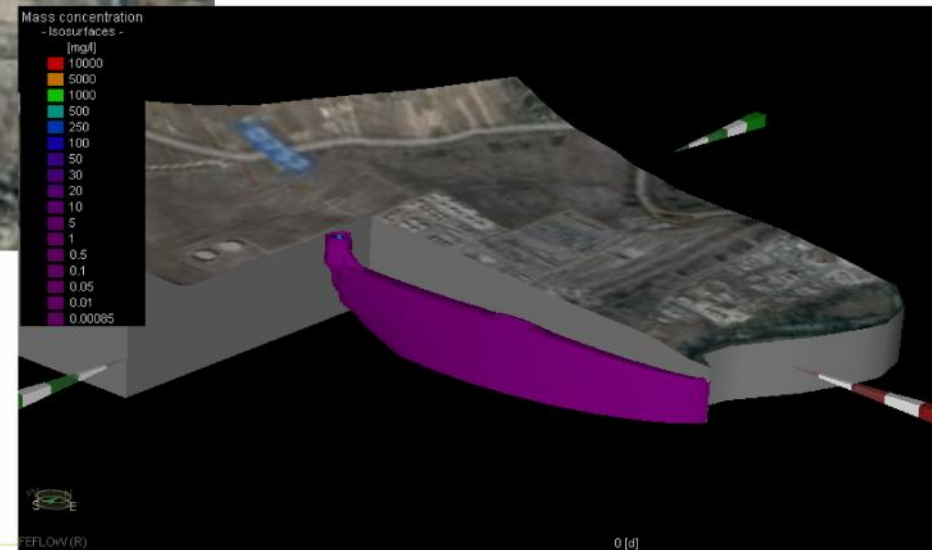
Groundwater Model – Tüpra Oil Refinery
(sample set-up)



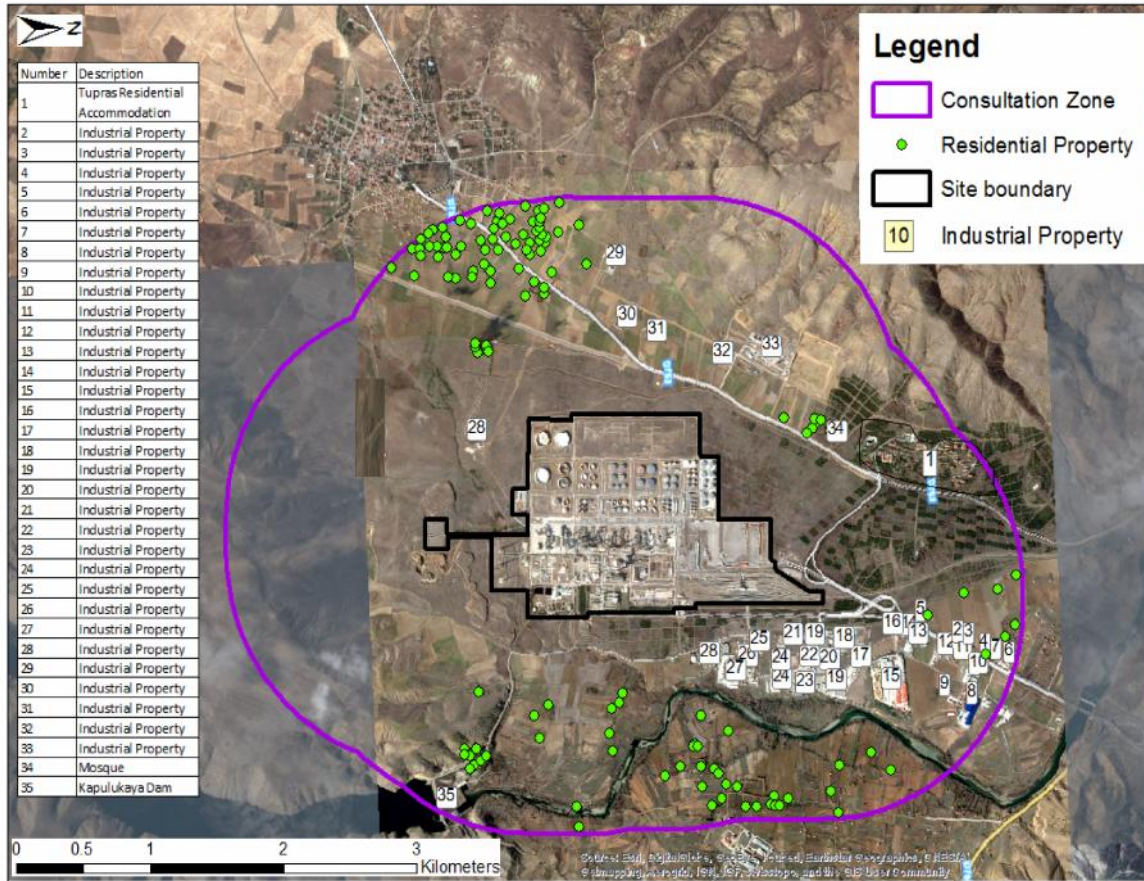
CONSEQUENCE MODELLING- GROUNDWATER



CONSEQUENCE MODELLING- GROUNDWATER

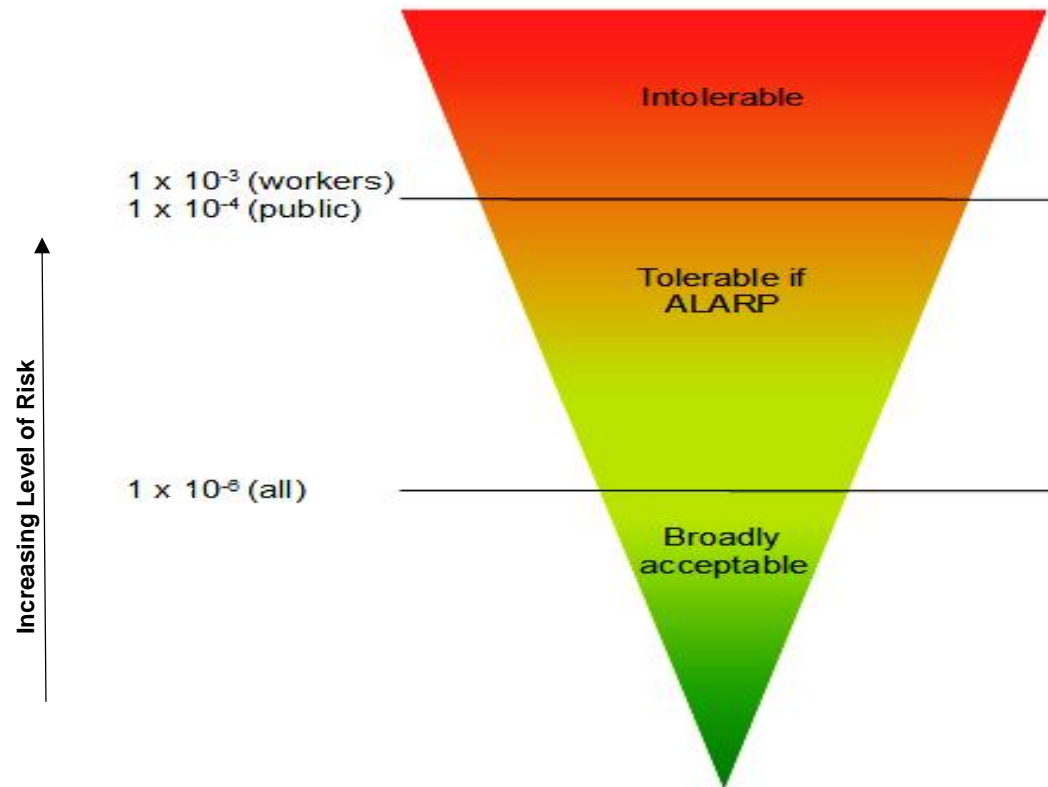


CONSEQUENCE MODELLING – HUMAN RECEPTORS



CONSEQUENCE MODELLING – Risk Assessment

Three-tier framework
for risk tolerability
(UK HSE)



Approach for Assessing MATTEs (major accidents to the environment)

- Environmental risk can be assessed within the established 'As low as reasonably practicable' (ALARP) framework and evaluated to be either: Intolerable, Tolerable if ALARP (TifALARP) or Broadly Acceptable.
- The level of environmental risk can be used to guide the type and depth of assessment that would be expected and this may include either qualitative or quantitative risk assessment depending on the assessed environmental risk.

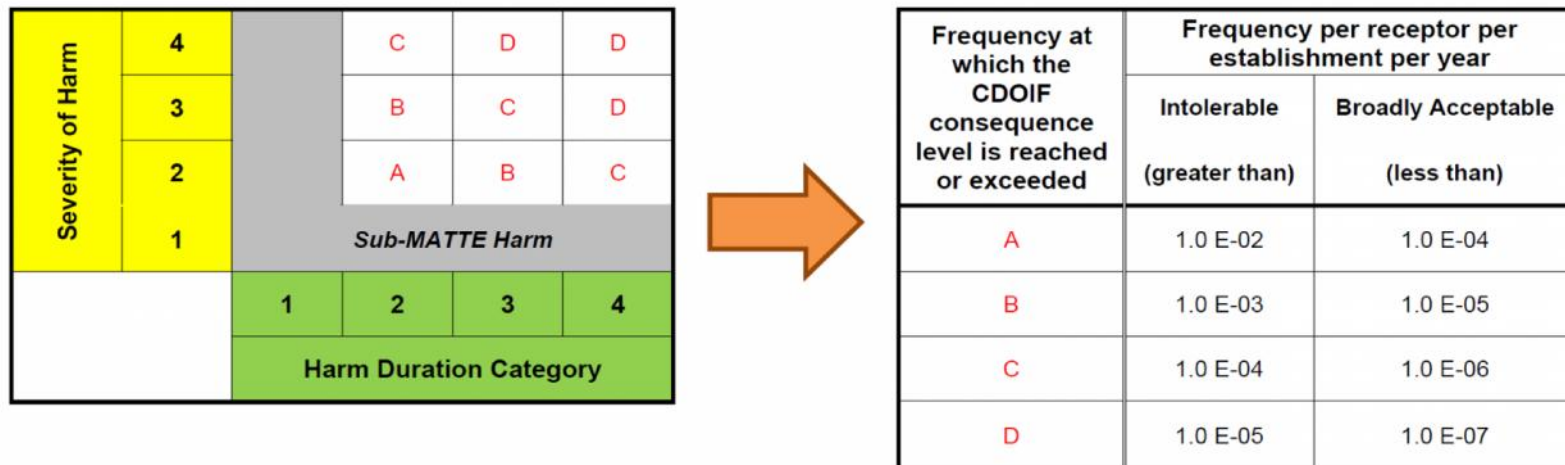
Frequency at which CDOIF Consequence Level is equalled or exceeded	Frequency per establishment per receptor per year (unmitigated)						
	10^{-8} - 10^{-7}	10^{-7} - 10^{-6}	10^{-6} - 10^{-5}	10^{-5} - 10^{-4}	10^{-4} - 10^{-3}	10^{-3} - 10^{-2}	$>10^{-2}$
D - MATTE	Green	Yellow	Yellow	Red	Red	Red	Red
C - MATTE	Green	Green	Yellow	TifALARP	Red	Red	Red
B - MATTE	Broadly Acceptable		Green	Yellow	Yellow	Red	Red
A - MATTE	Green	Green	Green	Green	Yellow	Yellow	Red
Sub MATTE	Tolerability not considered by CDOIF						

MATTE MATRIX

For credible scenarios which have MATTE potential, their risks to the relevant receptors should be determined;

These should then each be categorised using the MATTE tolerability matrix to give a consequence level of either A, B, C or D;

This in turn provides the frequency per receptor per establishment per year and thus the thresholds for 'Broadly Acceptable' and 'Intolerable'.



POSSIBLE MATTE SCENARIOS - Tüpra Oil Refinery

For the diesel tanks, the following scenarios were considered following review with Tüpra Engineering staff....



MATTE – Significant for Groundwater Impact – SEVERE 2

Row	DETR Table Ref	Receptor Type	Severity of Harm				Reference to Table 2	Comments
			Significant	Severe	Major	Catastrophic		
			Severity Level →	1	2	3		
			<i>While this level of harm might be significant pollution, it is not considered a MATTE.</i>	<i>DETR Criteria - the lowest level of harm that might be considered MATTE.</i>				<i>The 'Severe' to 'Catastrophic' levels of harm are considered to be included as 'Serious' with respect to the COMAH definition of a major accident.</i>
								<i>Receptors include:</i>
8	6	Groundwater Body (non- Drinking Water Source)	<1ha	1-100ha of groundwater body where the WFD status has been lowered	100-10,000ha	>10,000ha	Groundwater body or Surface Water Public Drinking Water Source	UKTAG has determined that to qualify as a body of groundwater, an aquifer must be capable of supplying 10m ³ per day or 50 people (on a continuous basis) and that such aquifers/groundwater bodies have future resource value which must be protected. Groundwater Bodies have been identified and mapped in accordance with guidance under the Water Framework Directive – see 3.2.3 and appendix 3 for further information
9	6	Other Groundwater (outside of groundwater bodies)	Groundwater not a pathway to another receptor.	<i>Where the groundwater is a pathway for another receptor assess against relevant criteria for the receptor.</i>			N/A	

MATTE - Surface Water as Drinking Water - MAJOR- 3

Row	DETR Table Ref	Receptor Type	Severity of Harm				Reference to Table 2	Comments
			Significant <i>While this level of harm might be significant pollution, it is not considered a MATTE.</i>	Severe <i>DETR Criteria - the lowest level of harm that might be considered MATTE.</i>	Major	Catastrophic		
		Severity Level →	1	2	3	4		
7	6	Source of Public or Private Drinking Water (Groundwater or Surface Water)	Interruption of drinking water supply <1000 person-hours or For England & Wales only <1ha SPZ	Interruption of drinking water supplied from a ground or surface source (where persons affected x duration in hours [at least 2] > 1,000) or For England & Wales only 1-10ha of SPZ where drinking water standards are breached	>1 x 10 ⁷ person-hours interruption of drinking water (a town of ~100,000 people losing supply for month) or For England & Wales only 10-100ha SPZ drinking water standards breached	>1 x 10 ⁹ person-hours interruption of drinking (~1 million people losing supply for 1 month) or For England & Wales only >100ha SPZ drinking water standards breached	Groundwater body or Surface Water Public Drinking Water Source	The 'Severe' to 'Catastrophic' levels of harm are considered to be included as 'Serious' with respect to the COMAH definition of a major accident. Receptors include:

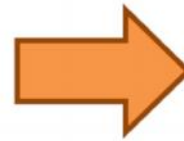
MATTE – Harm Duration- 3

Table 2 – Duration/Recovery criteria (based on unmitigated consequence)

Description	Short term	Medium term	Long term	Very long term
	Harm with such short recovery is not considered a MATTE.			
Harm Duration Category →	1	2	3	4
LAND	≤ 3 years	> 3 years or > 2 growing seasons for agricultural land	> 20 years	> 50 years
SURFACE WATER (ALL EXCEPT PUBLIC OR PRIVATE DRINKING WATER SOURCE)	≤ 1 year	> 1 year	>10 years	>20 years
GROUNDWATER BODY OR SURFACE WATER PUBLIC OR PRIVATE DRINKING WATER SOURCE	N/A	Harm affecting non-public drinking water source.	Harm affecting public drinking water source or SPZ.	N/A
BUILT ENVIRONMENT	Can be repaired in < 3 years, such that its designation can be reinstated	Can be repaired in > 3 years, such that its designation can be reinstated	Feature destroyed, cannot be rebuilt, all features except world heritage site	Feature destroyed, cannot be rebuilt, world heritage site

MATTE

Severity of Harm	4	Sub-MATTE Harm	C	D	D
	3		B	C	D
	2		A	B	C
	1		Sub-MATTE Harm		
		1	2	3	4
		Harm Duration Category			



Frequency at which the CDOIF consequence level is reached or exceeded	Frequency per receptor per establishment per year	
	Intolerable (greater than)	Broadly Acceptable (less than)
A	1.0 E-02	1.0 E-04
B	1.0 E-03	1.0 E-05
C	1.0 E-04	1.0 E-06
D	1.0 E-05	1.0 E-07

- Major leak from Tank Frequency of 1 E-4/annum, Guidelines for Quantitative Risk Assessment, 'Purple Book', CPR18E 1999

MATTE – Conclusion Scenario TYPE C

These can then be compared to the tolerability criteria as follows:

Frequency at which CDOIF Consequence Level is equalled or exceeded	Frequency per establishment per receptor per year (mitigated)						
	10^{-8} – 10^{-7}	10^{-7} – 10^{-6}	10^{-6} – 10^{-5}	10^{-5} – 10^{-4}	10^{-4} – 10^{-3}	10^{-3} – 10^{-2}	$>10^{-2}$
D - MATTE						Intolerable	
C - MATTE				TifALARP			
B - MATTE	Broadly Acceptable				X		
A - MATTE					X		
Sub MATTE	Tolerability not considered by CDOIF						

The mitigated risk is depicted above by **X**.

CONCLUSIONS & RECOMMENDATIONS

- The Risk is Acceptable if 'ALARP'
- ALARP is 'As Low As Reasonably Practicable'
- 'Reasonably Practicable' is taken to be automatic detection of contamination in surface water run-off and automatic diversion
- Therefore, it is recommended that such a system be installed



SEVESO III - Ireland

- Deadline for completion 30th May 2016
- Most need a hydrogeological risk assessment (if they store liquids)
- UK – have a specialist Environment Agency team to support the UK HSE, including joint inspections and report review
- How will the HSA assess the environmental aspects of these reports without specific in-house environmental expertise?

More Information see www.awnconsulting.com

