Appendix 15.1

Drainage and Spillage Calculations

PROJECT	M8 / M73 / M74 Network Improvements Network 1	JOB No	53213 AU		
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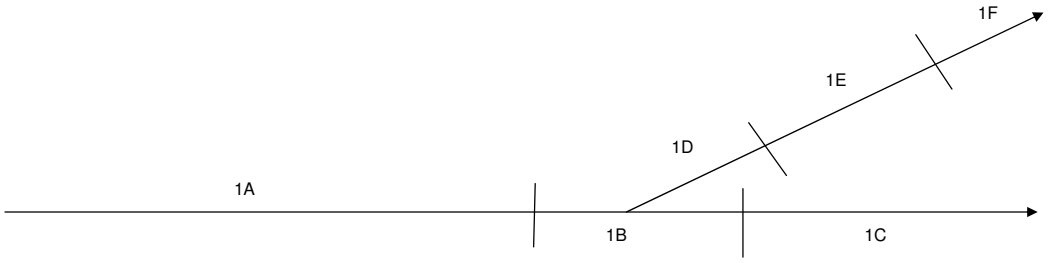
Network 1 **Receiving Watercourse** North Calder Water



Spillage Risk Pr(Spillage Causing Pollution) 0.3

Probability (Serious Accidental Spill), P_{acc} = Road Length x Serious Spillage Rate x (AADT x 365 x 10^{-9}) x (%HGV/100)

	1A	1B	1C	1D	1E	1F	
Road Length (m)	840	357	263	100	183	100	
AADT Flow (Design Flow)	77750	77750	72898	4852	4852	4852	
Serious Accidental Spillages	0.36	0.43	0.36	0.36	0.31	1.81	Billion HGV km/year
Percentage of Heavy Good Vehicles	10%	12%	12%	7%	7%	7%	
Pacc =	0.0009	0.0005	0.0003	0.0000	0.0000	0.0000	

Road Length (m)							
AADT Flow (Design Flow)							
Serious Accidental Spillages							Billion HGV km/year
Percentage of Heavy Good Vehicles							
Pacc =	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

P_{acc}= 0.0017

Risk of Serious Pollution Incident, P_{pol} = P_{acc} x Risk Reduction Factor

P_{pol} = 0.000515155

P_{pol} = 1 in 1,941 years

System	Risk Reduction Factor (R_F)	Percentage Reduction
Oil Separator	0.5	50%
Filter Drain	0.6	40%
Penstock	0.4	60%

With Mitigation P_{pol} = 1 in 16,176 years

Mouchel FAIRHURST

PROJECT	M8 / M73 / M74 Network Improvements Network 2	JOB No	53213 AU		
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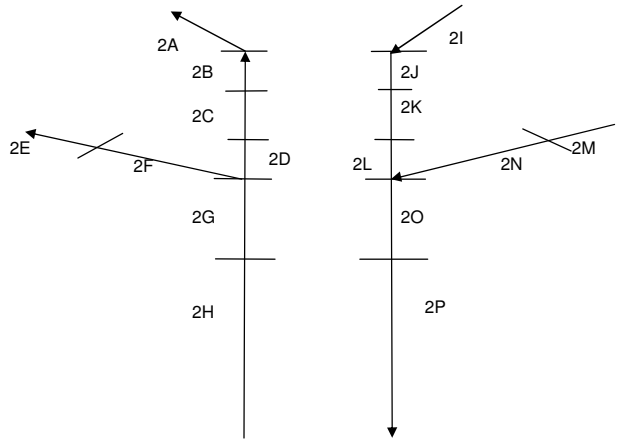
refer to DMRB Vol 11 Sec 3 Part 10 CIRIA report 142 method in Annex III		Calculated by	VC	Checked by	RMH

Network 2 **Receiving Watercourse** North Calder Water



Spillage Risk Pr(Spillage Causing Pollution) 0.3

Probability (Serious Accidental Spill), P_{acc} = Road Length x Serious Spillage Rate x (AADT x 365 x 10^{-9}) x (%HGV/100)

	2A	2B	2C	2D	2E	2F	
Road Length (m)	54	100	132	100	60	100	
AADT Flow (Design Flow)	19806	47660	47660	47660	19633	19633	
Serious Accidental Spillages	0.36	0.36	0.31	0.36	0.31	0.36	Billion HGV km/year
Percentage of Heavy Good Vehicles	17%	16%	16%	16%	14%	14%	
Pacc =	0.0000	0.0001	0.0001	0.0001	0.0000	0.0000	

	2G	2H	2I	2J	2K	2L	
Road Length (m)	100	216	39	100	136	100	
AADT Flow (Design Flow)	67294	67294	18461	48910	48910	48910	
Serious Accidental Spillages	0.43	0.36	0.36	0.36	0.31	0.36	Billion HGV km/year
Percentage of Heavy Good Vehicles	15%	15%	16%	16%	16%	16%	
Pacc =	0.0002	0.0003	0.0000	0.0001	0.0001	0.0001	

	2M	2N	2O	2P			
Road Length (m)	29	100	100	195			
AADT Flow (Design Flow)	24136	24136	73046	73046			
Serious Accidental Spillages	0.31	0.36	0.43	0.36			Billion HGV km/year
Percentage of Heavy Good Vehicles	13%	13%	15%	15%			
Pacc =	0.0000	0.0000	0.0002	0.0003	0.0000	0.0000	

P_{acc}= 0.0012

Risk of Serious Pollution Incident, P_{pol} = P_{acc} x Risk Reduction Factor

P_{pol} = 0.000353731

P_{pol} = 1 in 2,827 years

System	Risk Reduction Factor (R_F)	Percentage Reduction
Oil Separator	0.5	50%
Filter Drain	0.6	40%
Sediment Trap	0.6	40%
Pond	0.5	50%

With Mitigation P_{pol} = 1 in 31,411 years

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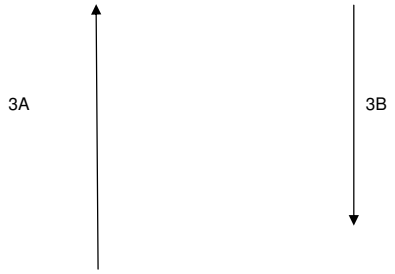
Network 3 **Receiving Watercourse** North Calder Water



Spillage Risk Pr(Spillage Causing Pollution) 0.3

Probability (Serious Accidental Spill), P_{acc} = Road Length x Serious Spillage Rate x (AADT x 365 x 10^{-9}) x (%HGV/100)

	3A	3B					
Road Length (m)	780	569					
AADT Flow (Design Flow)	67294	73046					
Serious Accidental Spillages	0.36	0.36					Billion HGV km/year
Percentage of Heavy Good Vehicles	15%	15%					
Pacc =	0.0010	0.0008	0.0000	0.0000	0.0000	0.0000	

Road Length (m)							
AADT Flow (Design Flow)							
Serious Accidental Spillages							Billion HGV km/year
Percentage of Heavy Good Vehicles							
Pacc =	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

P_{acc}= 0.0019

Risk of Serious Pollution Incident, P_{pol} = P_{acc} x Risk Reduction Factor

P_{pol} = 0.000556132

P_{pol} = 1 in 1,798 years

System	Risk Reduction Factor (R_F)	Percentage Reduction
Oil Separator	0.5	50%
Filter Drain	0.6	40%
Sediment Trap	0.6	40%
Pond	0.5	50%

With Mitigation P_{pol} = 1 in 19,979 years

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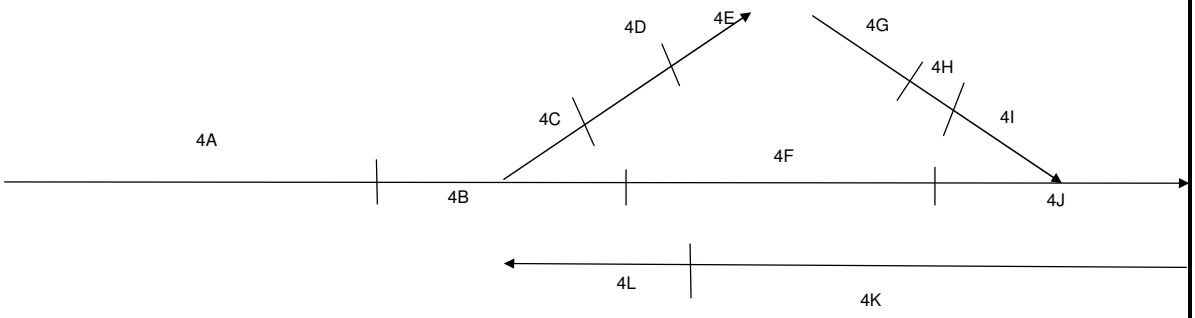
Network 4 **Receiving Watercourse** North Calder Water



Spillage Risk Pr(Spillage Causing Pollution) 0.3

Probability (Serious Accidental Spill), P_{acc} = Road Length x Serious Spillage Rate x (AADT x 365 x 10^{-9}) x (%HGV/100)

	4A	4B	4C	4D	4E	4F	
Road Length (m)	724	260	100	136	100	354	
AADT Flow (Design Flow)	59771	59771	8882	8882	8882	50889	
Serious Accidental Spillages	0.36	0.43	0.36	0.31	1.81	0.36	Billion HGV km/year
Percentage of Heavy Good Vehicles	16%	16%	3%	3%	3%	19%	
Pacc =	0.0009	0.0004	0.0000	0.0000	0.0000	0.0004	

	4G	4H	4I	4J	4K	4L	
Road Length (m)	200	100	24	100	467	200	
AADT Flow (Design Flow)	50889	3695	3695	3695	59307	70545	
Serious Accidental Spillages	0.43	1.81	0.31	0.36	0.36	0.43	Billion HGV km/year
Percentage of Heavy Good Vehicles	19%	13%	13%	13%	11%	10%	
Pacc =	0.0003	0.0000	0.0000	0.0000	0.0004	0.0002	

P_{acc}= 0.0027

Risk of Serious Pollution Incident, P_{pol} = P_{acc} x Risk Reduction Factor

P_{pol} = 0.000821889

P_{pol} = 1 in 1,217 years

System	Risk Reduction Factor (R_F)	Percentage Reduction
Oil Separator	0.5	50%
Filter Drain	0.6	40%
Sediment Trap	0.6	40%
Pond	0.5	50%

With Mitigation P_{pol} = 1 in 13,519 years

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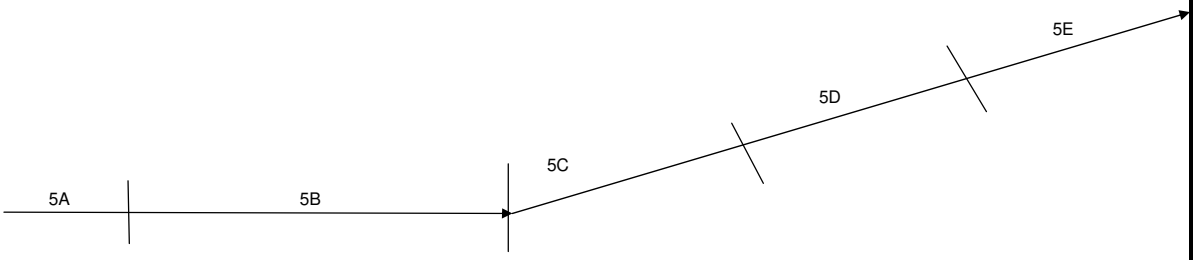
Network 5 **Receiving Watercourse** North Calder Water



Spillage Risk Pr(Spillage Causing Pollution) 0.3

Probability (Serious Accidental Spill), P_{acc} = Road Length x Serious Spillage Rate x (AADT x 365 x 10^{-9}) x (%HGV/100)

	5A	5B	5C	5D	5E		
Road Length (m)	38	100	100	83	100		
AADT Flow (Design Flow)	50889	50889	30104	30104	30104		
Serious Accidental Spillages	0.36	0.43	0.36	0.31	0.36		Billion HGV km/year
Percentage of Heavy Good Vehicles	19%	19%	14%	14%	14%		
Pacc =	0.0000	0.0002	0.0001	0.0000	0.0001	0.0000	

Road Length (m)							
AADT Flow (Design Flow)							
Serious Accidental Spillages							Billion HGV km/year
Percentage of Heavy Good Vehicles							
Pacc =	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

P_{acc}= 0.0004

Risk of Serious Pollution Incident, P_{pol} = P_{acc} x Risk Reduction Factor

P_{pol} = 0.000105112

P_{pol} = 1 in 9,514 years

System	Risk Reduction Factor (R_F)	Percentage Reduction
Oil Separator	0.5	50%
Filter Drain	0.6	40%
Sediment Trap	0.6	40%
Pond	0.5	50%

With Mitigation P_{pol} = 1 in 105,708 years

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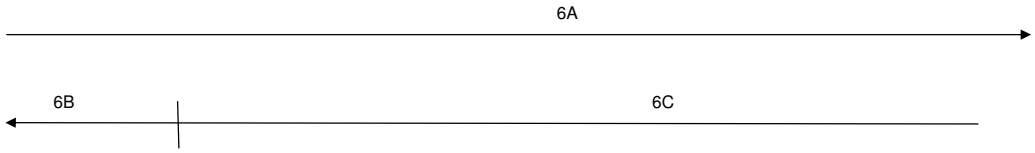
CIRIA report 142 method in Annex III					

Network 6 **Receiving Watercourse** Clyde



Spillage Risk Pr(Spillage Causing Pollution) 0.3

Probability (Serious Accidental Spill), P_{acc} = Road Length x Serious Spillage Rate x (AADT x 365 x 10^{-9}) x (%HGV/100)

Road Length (m)	1400	100	1236				
AADT Flow (Design Flow)	66407	70885	70885				
Serious Accidental Spillages	0.36	0.43	0.36				Billion HGV km/year
Percentage of Heavy Good Vehicles	19%	14%	14%				
Pacc =	0.0023	0.0002	0.0016	0.0000	0.0000	0.0000	

Road Length (m)							
AADT Flow (Design Flow)							
Serious Accidental Spillages							Billion HGV km/year
Percentage of Heavy Good Vehicles							
Pacc =	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

P_{acc}= 0.0041

Risk of Serious Pollution Incident, P_{pol} = P_{acc} x Risk Reduction Factor

P_{pol} = 0.001226575

P_{pol} = 1 in 815 years

System	Risk Reduction Factor (R_F)	Percentage Reduction
Oil Separator	0.5	50%
Filter Drain	0.6	40%
Sediment Trap	0.6	40%
Pond	0.5	50%

With Mitigation P_{pol} = 1 in 9,059 years

Mouchel FAIRHURST

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Network 7 **Receiving Watercourse** Myers Burn / Pow Burn

	River Classification	RE3			
	Hardness	130.48	(mg/l)		
(EQS)	Dissolved Copper $_{Cu}$	28	(ug/l)		
(EQS)	Total Zinc $_{Zn}$	75	(ug/l)		
Upstream dissolved Copper	$C_b C_u$	3.72	(ug/l)	0.0037151	(mg/l)
Upstream total Zinc	$C_b Z_n$	14.01	(ug/l)	0.0140074	(mg/l)

Low Flow in River 95%ile (Q_{95}) 17.00 (l/s) 1468.8 (m^3/day)

Rainfall 12.7 (mm/day) 0.0127 (m/day)
Run-off Co-efficient 0.84

	7A	7B				Total Area	
Road Length (m)	565	639					
Road Width (m)	17.9	17.9					
Road area (m^2)	10113.5	11438.1	0	0	0	21551.6	(m^2)
						2.16	(ha)
AADT Flow (Design Flow)	66407	70885					
Pollutant Build-up Rates							
Copper Soluble	1.2	1.2	0.2	0.2	0.2		(Kg/ha/year)
Zinc Total	5.0	5.0	0.4	0.4	0.4		(Kg/ha/year)

Road Length (m)							
Road area (m^2)						0	(m^2)
						0.00	(ha)
AADT Flow (Design Flow)							
Pollutant Build-up Rates							
Copper Soluble	0.2	0.2	0.2	0.2	0.2		(Kg/ha/year)
Zinc Total	0.4	0.4	0.4	0.4	0.4		(Kg/ha/year)

Water Quality

Total Run-off Volume, V = road area x run-off co-efficient x rainfall

V= **229.91** (m^3/day)

Total Area 21551.6 (m^2) 2.16 (ha)

Dilution=Q_{95}/V = **6.4**

Build-up Rates for <u>DISSOLVED</u> Copper

Dissolved Copper 5 Day Build-up, Mcu = Daily Build-up x 5 days x Drainage Area

M C_u= **0.035** (kg)

D/S River Conc· Copper, $C_r C_u = [(C_b C_u \times Q95) + (1000 \times MC_u)]/(Q95 + V)$

$C_r C_u$= **24.07** (ug/l) **Copper <EQS OK**

Build-up Rates for <u>TOTAL</u> Zinc

Total Zinc 5 Day Build-up, M Z_n = Daily Build-up x 5 days x Drainage Area

M Z_n = **0.148** (kg)

D/S River Conc· fo Zinc, $C_r Z_n = [(C_b Z_n \times Q95) + (1000 \times M Z_n)]/(Q95 + V)$

$C_r Z_n$ = **99.01** (ug/l) **<u>** Zinc Concentration > EQS **</u>**

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Network 7 **Receiving Watercourse** Myers Burn / Pow Burn

US Dissolved Copper =	3.715116	(ug/l)	US Total Zinc =	14.007442	(ug/l)
DS Dissolved Copper =	24.07	(ug/l)	DS Total Zinc =	99.01	(ug/l)
Difference =	20.35	(ug/l)	Difference =	85.00	(ug/l)
EQS Dissolved Copper =	28	(ug/l)	EQS Total Zinc =	75	(ug/l)

Incorporating Filter / French Drains

Percentage Reduction:

Dissolved Copper	30%
Total Zinc	30%

US Dissolved Copper =	3.715116	(ug/l)	US Total Zinc =	14.007442	(ug/l)
DS Dissolved Copper =	17.81	(ug/l)	DS Total Zinc =	72.94	(ug/l)
Difference =	14.10	(ug/l)	Difference =	58.93	(ug/l)

Further Incorporating Biofiltration

Percentage Reduction:

Dissolved Copper	80%
Total Zinc	80%

US Dissolved Copper =	3.715116	(ug/l)	US Total Zinc =	14.007442	(ug/l)
DS Dissolved Copper =	6.13	(ug/l)	DS Total Zinc =	24.28	(ug/l)
Difference =	2.42	(ug/l)	Difference =	10.27	(ug/l)

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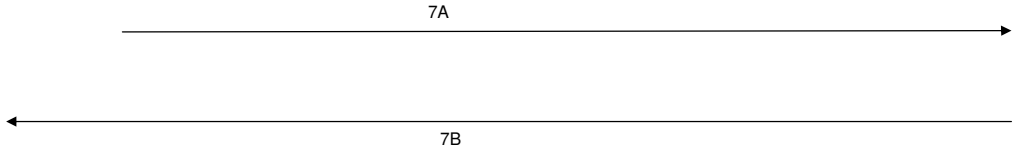
Network 7 **Receiving Watercourse** Myers Burn / Pow Burn



Spillage Risk Pr(Spillage Causing Pollution) 0.3

Probability (Serious Accidental Spill), P_{acc} = Road Length x Serious Spillage Rate x (AADT x 365 x 10^{-9}) x (%HGV/100)

Road Length (m)	565	639					
AADT Flow (Design Flow)	66407	70885					
Serious Accidental Spillages	0.36	0.36					Billion HGV km/year
Percentage of Heavy Good Vehicles	19%	14%					
Pacc =	0.0009	0.0008	0.0000	0.0000	0.0000	0.0000	

Road Length (m)							
AADT Flow (Design Flow)							
Serious Accidental Spillages							Billion HGV km/year
Percentage of Heavy Good Vehicles							
Pacc =	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

P_{acc}= 0.0018

Risk of Serious Pollution Incident, P_{pol} = P_{acc} x Risk Reduction Factor

P_{pol} = 0.000530994

P_{pol} = 1 in 1,883 years

System	Risk Reduction Factor (R_F)	Percentage Reduction
Oil Separator	0.5	50%
Filter Drain	0.6	40%
Swale	0.6	40%

With Mitigation P_{pol} = 1 in 10,463 years

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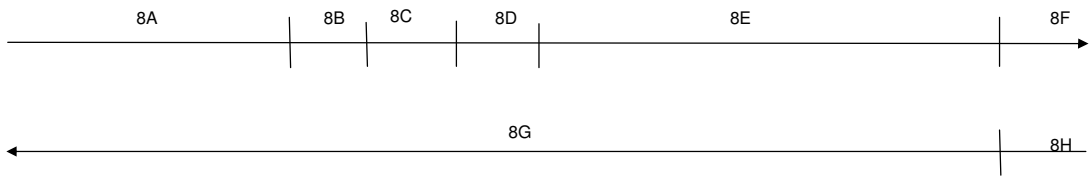
refer to DMRB Vol 11 Sec 3 Part 10		Calculated by	VC	Checked by	RMH
CIRIA report 142 method in Annex III					

Network 8 **Receiving Watercourse** Clyde



Spillage Risk Pr(Spillage Causing Pollution) 0.3

Probability (Serious Accidental Spill), P_{acc} = Road Length x Serious Spillage Rate x (AADT x 365 x 10^{-9}) x (%HGV/100)

	8A	8B	8C	8D	8E	8F	
Road Length (m)	595	100	125	100	555	100	
AADT Flow (Design Flow)	66407	66407	66407	66939	66939	66939	
Serious Accidental Spillages	0.36	0.43	0.43	0.43	0.36	0.43	Billion HGV km/year
Percentage of Heavy Good Vehicles	19%	19%	19%	19%	19%	19%	
Pacc =	0.0010	0.0002	0.0002	0.0002	0.0009	0.0002	

	8G	8H					
Road Length (m)	1475	100					
AADT Flow (Design Flow)	70885	70885					
Serious Accidental Spillages	0.36	0.43					Billion HGV km/year
Percentage of Heavy Good Vehicles	14%	14%					
Pacc =	0.0019	0.0002	0.0000	0.0000	0.0000	0.0000	

P_{acc}= 0.0048

Risk of Serious Pollution Incident, P_{pol} = P_{acc} x Risk Reduction Factor

P_{pol} = 0.001451379

P_{pol} = 1 in 689 years

System	Risk Reduction Factor (R_F)	Percentage Reduction
Oil Separator	0.5	50%
Filter Drain	0.6	40%
Sediment Trap	0.6	40%
Pond	0.5	50%

With Mitigation P_{pol} = 1 in 7,656 years

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Network 9 **Receiving Watercourse** Clyde

9A

Spillage Risk Pr(Spillage Causing Pollution) 0.3

Probability (Serious Accidental Spill), P_{acc} = Road Length x Serious Spillage Rate x (AADT x 365 x 10^{-9}) x (%HGV/100)

	9A						
Road Length (m)	1680						
AADT Flow (Design Flow)	67701						
Serious Accidental Spillages	0.36						Billion HGV km/year
Percentage of Heavy Good Vehicles	18%						
Pacc =	0.0027	0.0000	0.0000	0.0000	0.0000	0.0000	

Road Length (m)							
AADT Flow (Design Flow)							
Serious Accidental Spillages							Billion HGV km/year
Percentage of Heavy Good Vehicles							
Pacc =	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

P_{acc}= 0.0027

Risk of Serious Pollution Incident, P_{pol} = P_{acc} x Risk Reduction Factor

P_{pol} = 0.000807037

P_{pol} = 1 in 1,239 years

System	Risk Reduction Factor (R_F)	Percentage Reduction
Oil Separator	0.5	50%
Filter Drain	0.6	40%
Sediment Trap	0.6	40%
Pond	0.5	50%

With Mitigation P_{pol} = 1 in 13,768 years

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CIRIA report 142 method in Annex III					

Network 10 **Receiving Watercourse** Clyde

10A

Spillage Risk Pr(Spillage Causing Pollution) 0.3

Probability (Serious Accidental Spill), P_{acc} = Road Length x Serious Spillage Rate x (AADT x 365 x 10^{-9}) x (%HGV/100)

Road Length (m)	115						
AADT Flow (Design Flow)	67701						
Serious Accidental Spillages	0.36						Billion HGV km/year
Percentage of Heavy Good Vehicles	18%						
Pacc =	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	

Road Length (m)							
AADT Flow (Design Flow)							
Serious Accidental Spillages							Billion HGV km/year
Percentage of Heavy Good Vehicles							
Pacc =	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

P_{acc}= 0.0002

Risk of Serious Pollution Incident, P_{pol} = P_{acc} x Risk Reduction Factor

P_{pol} = 5.52436E-05

P_{pol} = 1 in 18,102 years

System	Risk Reduction Factor (R_F)	Percentage Reduction
Oil Separator	0.5	50%
Filter Drain	0.6	40%
Penstock	0.4	60%

With Mitigation P_{pol} = 1 in 150,847 years

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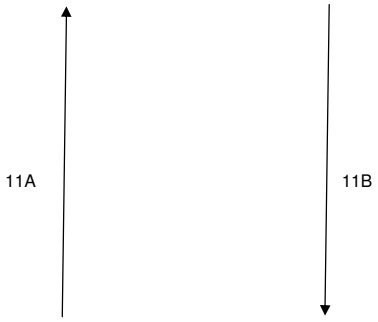
		PAGE	13		
TITLE	Water Quality & Drainage	DATE	27/02/2008		
refer to DMRB Vol 11 Sec 3 Part 10 CIRIA report 142 method in Annex III		Calculated by	VC	Checked by	RMH

Network 12 **Receiving Watercourse** North Calder Water



Spillage Risk Pr(Spillage Causing Pollution) 0.3

Probability (Serious Accidental Spill), P_{acc} = Road Length x Serious Spillage Rate x (AADT x 365 x 10^{-9}) x (%HGV/100)

	11A	11B					
Road Length (m)	130	130					
AADT Flow (Design Flow)	52255	53122					
Serious Accidental Spillages	0.36	0.36					Billion HGV km/year
Percentage of Heavy Good Vehicles	10%	8%					
Pacc =	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	

Road Length (m)							
AADT Flow (Design Flow)							
Serious Accidental Spillages							Billion HGV km/year
Percentage of Heavy Good Vehicles							
Pacc =	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

P_{acc}= 0.0002

Risk of Serious Pollution Incident, P_{pol} = P_{acc} x Risk Reduction Factor

P_{pol} = 4.85569E-05

P_{pol} = 1 in 20,594 years

System	Risk Reduction Factor (R_F)	Percentage Reduction
Oil Separator	0.5	50%
Filter Drain	0.6	40%
Sediment Trap	0.6	40%
Pond	0.5	50%

With Mitigation P_{pol} = 1 in 228,827 years