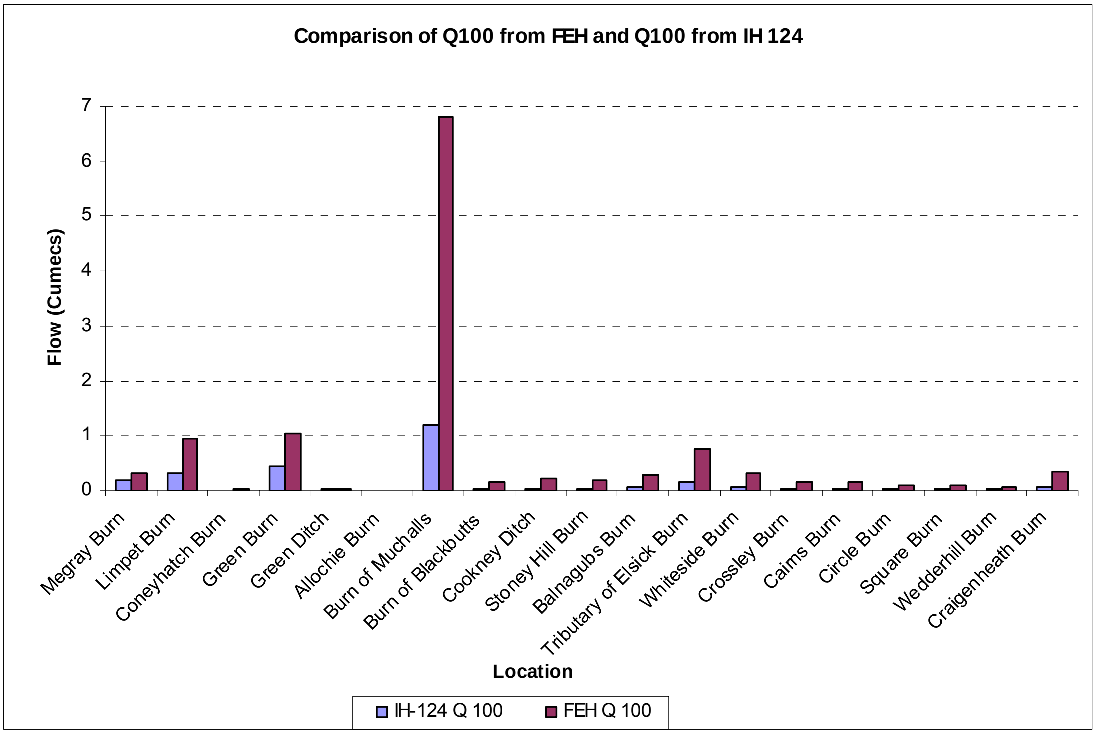
Contents

Annex 1 Hydrology – Summary of High Flow Calculations

Since the DMRB Part 1 HA 106/04 advocates the use of the IH 124 method for 'Drainage runoff from natural catchments' and the DMRB Part 4 HA 107/04 advocates the use of the FEH method for the 'Design of outfall and culvert details' both approaches were used. The results are presented here.



The differences between IH 124 and FEH are generally relatively small except for the Burn of Muchalls.

The FEH flows were used in further analysis since the FEH methodology is now largely adopted as the present industry standard and in this case the FEH calculated flow values are more conservative (viz higher) than those calculated using IH 124.

Annex 2 Hydrology Guidance Note

Annexes 3 to 21 contain a summary of the hydrological parameters calculated for each watercourse deemed as being impacted upon by the proposed road scheme. The following abbreviations/definitions are used within the annexes. For full explanation of the methodologies adopted, refer to the specialist report and glossary that accompanies these annexes.

Chainage	Locations crossed by the proposed road can be identified by their chainage. This is a distance in meters, measured from a specified reference point.
AREA	Catchment Drainage Area (km^2)
SAAR	1961-90 standard-period average annual rainfall (mm)
BFIHOST	Base Flow Index derived using the HOST classification
SPRHOST	Standard Percentage Runoff (%) derived using HOST classification
FARL	Index of Flood Attenuation due to Reservoirs and Lakes
URBEXT1990	FEH index of fractional urban extent for 1990
Q_{95}	Flow that is expected to be exceeded 95% of the time (m^3/s)
Qmean	Mean Flow (m^3/s)
Q_{BF}	Bankfull Flow: the bank is defined at the point where vegetation/soil cover obviously changes between water and air
Q_{EBF}	Embankmentfull Flow: the embankment (top of) is defined as the point where water would spill into wider areas (fields/road)
QMED	Median Flood Flow (m^3/s) (flow with a two year return period)
QBAR	Mean Annual Flood (m^3/s)
Q-Tyr (eg Q-5yr)	Flood flow associated with a T-year return period (e.g. five year flow)
V	Velocity (m/s)

Annex 3 Megray Burn

Location: Proposed culvert, associated realignment and outfall location
Chainage: ch0 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 874 876
Area	km^2	0.60
SAAR	mm	781
BFIHOST	-	0.565
SPRHOST	%	40.7
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.007	Q-5yr	m^3/s	0.16
Q_{95}	m^3/s	0.002	Q-10yr	m^3/s	0.19
QMED	m^3/s	0.11	Q-25yr	m^3/s	0.24
QBAR	m^3/s	0.23	Q-50yr	m^3/s	0.28
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.32
Q_{EFB}	m^3/s	25.72	Q-200yr	m^3/s	0.37

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.011	0.010	0.009	0.007	0.006	0.004	0.003	0.003	0.004	0.007	0.010	0.011
V	m/s	0.60	0.57	0.54	0.51	0.46	0.40	0.57	0.60	0.41	0.50	0.58	0.60

Annex 4 Limpet Burn

Location: Proposed buried bridge structure and associated realignment
Chainage: ch1500 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 876 888
Area	km^2	1.3
SAAR	mm	808
BFIHOST	-	0.559
SPRHOST	%	34.2
FARL	-	1
URBEXT1990	-	0

Summary of design parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.018	Q-5yr	m^3/s	0.46
Q_{95}	m^3/s	0.004	Q-10yr	m^3/s	0.55
QMED	m^3/s	0.32	Q-25yr	m^3/s	0.69
QBAR	m^3/s	0.35	Q-50yr	m^3/s	0.82
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.94
Q_{EFB}	m^3/s	8714.86	Q-200yr	m^3/s	1.08

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Qmean	m3/s	0.027	0.024	0.021	0.018	0.013	0.009	0.008	0.008	0.010	0.017	0.026	0.027
V	m/s	0.12	0.12	0.11	0.11	0.10	0.09	0.09	0.09	0.09	0.11	0.12	0.12

Annex 5 Coneyhatch Burn

Location: Proposed area of catchment taken into pre-earthworks.
Chainage: ch2600 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 871 899
Area	km^2	0.02
SAAR	mm	814
BFIHOST	-	0.553
SPRHOST	%	33.9
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0	Q-5yr	m^3/s	0.01
Q95	m^3/s	0	Q-10yr	m^3/s	0.01
QMED	m^3/s	0.01	Q-25yr	m^3/s	0.01
QBAR	m^3/s	0.012	Q-50yr	m^3/s	0.02
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.02
Q_{EFB}	m^3/s	3.36	Q-200yr	m^3/s	0.02

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

Not calculated for this site.

Annex 6 Green Burn

Location: Two proposed culverts, associated realignment and outfall location
Chainage: Culvert 1 located on mainline at ch3125

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 869 903
Area	km^2	0.8
SAAR	mm	834
BFIHOST	-	0.307
SPRHOST	%	50.1
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.010	Q-5yr	m^3/s	0.50
Q_{95}	m^3/s	0.002	Q-10yr	m^3/s	0.61
QMED	m^3/s	0.35	Q-25yr	m^3/s	0.76
QBAR	m^3/s	0.49	Q-50yr	m^3/s	0.90
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	1.03
Q_{EFB}	m^3/s	0.32	Q-200yr	m^3/s	1.19

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01
V	m/s	0.41	0.39	0.39	0.37	0.33	0.29	0.28	0.30	0.33	0.37	0.40	0.40

Green Burn Continued

Location: Two proposed culverts, associated realignment and outfall location
Chainage: Culvert 2 located on side road at ch213

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 869 903
Area	km^2	0.8
SAAR	mm	834
BFIHOST	-	0.307
SPRHOST	%	50.1
FARL	-	1
URBEXT1990	-	0

Summary of design parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.010	Q-5yr	m^3/s	0.50
Q_{95}	m^3/s	0.002	Q-10yr	m^3/s	0.61
QMED	m^3/s	0.35	Q-25yr	m^3/s	0.76
QBAR	m^3/s	0.49	Q-50yr	m^3/s	0.90
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	1.03
Q_{EFB}	m^3/s	0.32	Q-200yr	m^3/s	1.19

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01
V	m/s	0.41	0.39	0.39	0.37	0.33	0.29	0.28	0.30	0.33	0.37	0.40	0.40

Annex 7 Green Ditch

Location: Channel realignment.
Chainage: ch3150 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 869 903
Area	km^2	0.020
SAAR	mm	834
BFIHOST	-	0.307
SPRHOST	%	50.1
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0	Q-5yr	m^3/s	0.01
Q_{95}	m^3/s	0	Q-10yr	m^3/s	0.02
QMED	m^3/s	0.01	Q-25yr	m^3/s	0.02
QBAR	m^3/s	0.023	Q-50yr	m^3/s	0.02
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.03
Q_{EFB}	m^3/s	0.58	Q-200yr	m^3/s	0.03

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

Not calculated for this site.

Annex 8 Allochie Burn

Location: Proposed area of catchment taken into pre-earthworks.
Chainage: ch4000 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 871 914
Area	km^2	<0.01
SAAR	mm	883
BFIHOST	-	0.468
SPRHOST	%	32.9
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0	Q-5yr	m^3/s	0
Q_{95}	m^3/s	0	Q-10yr	m^3/s	0
QMED	m^3/s	0	Q-25yr	m^3/s	0
QBAR	m^3/s	0.002	Q-50yr	m^3/s	0
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0
Q_{EFB}	m^3/s	1.83	Q-200yr	m^3/s	0

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

Not calculated for this site.

Annex 9 Burn of Muchalls

Location: Proposed buried bridge structure and outfall location.
Chainage: ch4700 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 873 919
Area	km^2	6.7
SAAR	mm	868
BFIHOST	-	0.48
SPRHOST	%	31.7
FARL	-	1
URBEXT1990	-	0.001

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.103	Q-5yr	m^3/s	3.32
Q_{95}	m^3/s	0.024	Q-10yr	m^3/s	4.02
QMED	m^3/s	2.34	Q-25yr	m^3/s	5.03
QBAR	m^3/s	1.34	Q-50yr	m^3/s	5.94
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	6.81
Q_{EFB}	m^3/s	3.16	Q-200yr	m^3/s	7.86

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

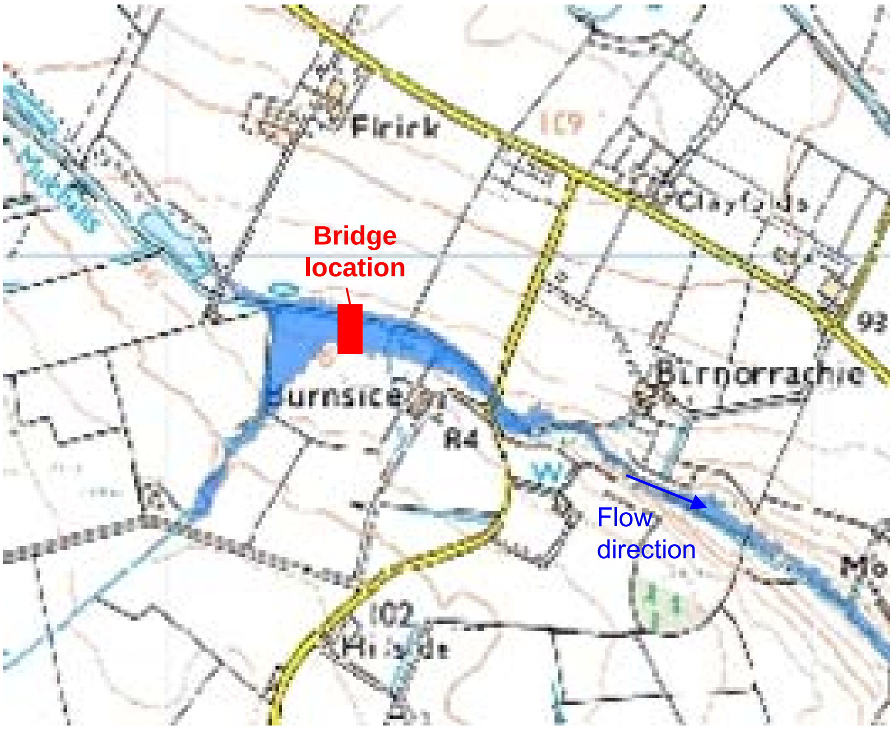
		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m3/s	0.154	0.136	0.132	0.119	0.079	0.057	0.051	0.055	0.068	0.106	0.132	0.147
V	m/s	0.7	0.67	0.66	0.63	0.54	0.48	0.45	0.47	0.51	0.61	0.66	0.69

Indicative River and Coastal Flood Maps (Scotland)

The flood maps have been developed by SEPA using numerical modelling. SEPA Indicative River and Coastal Flood Maps (Scotland) are limited to predicting flood risk in catchments greater than $3km^2$. The model results indicate areas that may be affected by flooding from either rivers or the sea. The scale of a flood can depend on a variety of things including:

- the rate and intensity of rainfall;
- catchment conditions such as, topography, vegetation and ground water conditions can affect how much rain soaks into the ground and how much water runs directly into the river;
- if there is a particularly high tide; or
- if there is a tidal surge or waves caused by strong winds and currents.

The flood maps indicate the areas of Scotland with a 0.5% or greater probability of being flooded in any given year, or put another way the areas that are estimated to have a 1 in 200 or greater chance of being flooded in any given year. For more information regarding the SEPA Indicative River and Coastal Flood Maps (Scotland), refer to the SEPA website.



At the proposed crossing point of the road, the Indicative River and Coastal Flood Maps (Scotland) indicate that the Burn of Muchalls will flood at the 0.5% AEP (200 year return period event). At this location and for approximately 200m upstream and downstream of the culvert, flooding is predicted to be predominantly confined to the right bank. The Burn of Muchalls is predicted to flood land within 100m of the channel. There appears to be no properties in the flood risk area as the floodplain consisting of arable and pasture farmland. Aberdeenshire Council advised that the predicted flood risk at this location is likely to be overestimated by the SEPA indicative flood risk maps.

Annex 10 Burn of Blackbutts

Location: Proposed area of catchment taken into pre-earthworks.
Chainage: ch5600 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 875 927
Area	km^2	0.2
SAAR	mm	833
BFIHOST	-	0.524
SPRHOST	%	27.8
FARL	-	1
URBEXT1990	-	0.002

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.002	Q-5yr	m^3/s	0.08
Q_{95}	m^3/s	0	Q-10yr	m^3/s	0.09
QMED	m^3/s	0.05	Q-25yr	m^3/s	0.12
QBAR	m^3/s	0.04	Q-50yr	m^3/s	0.14
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.16
Q_{EFB}	m^3/s	0.74	Q-200yr	m^3/s	0.18

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.002	0.003	0.003
V	m/s	0.27	0.26	0.24	0.22	0.20	0.18	0.18	0.19	0.23	0.27	0.28	0.24

Annex 11 Cookney Ditch

Location: Two proposed culverts and associated realignment
Chainage: Culvert 1 located on mainline at ch6480

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 874 936
Area	km^2	0.2
SAAR	mm	833
BFIHOST	-	0.504
SPRHOST	%	27.4
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.003	Q-5yr	m^3/s	0.10
Q_{95}	m^3/s	0.001	Q-10yr	m^3/s	0.12
QMED	m^3/s	0.07	Q-25yr	m^3/s	0.16
QBAR	m^3/s	0.05	Q-50yr	m^3/s	0.18
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.21
Q_{EFB}	m^3/s	1.45	Q-200yr	m^3/s	0.24

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.005	0.004	0.004	0.004	0.003	0.002	0.002	0.002	0.002	0.003	0.004	0.005
V	m/s	0.24	0.23	0.23	0.22	0.19	0.16	0.16	0.16	0.18	0.21	0.23	0.24

Cookney Ditch Continued

Location: Two proposed culverts and associated realignment
Chainage: Culvert 2 located on north side at ch6480

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 874 936
Area	km^2	0.2
SAAR	mm	833
BFIHOST	-	0.504
SPRHOST	%	27.4
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.003	Q-5yr	m^3/s	0.10
Q_{95}	m^3/s	0.001	Q-10yr	m^3/s	0.12
QMED	m^3/s	0.07	Q-25yr	m^3/s	0.16
QBAR	m^3/s	0.05	Q-50yr	m^3/s	0.18
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.21
Q_{EFB}	m^3/s	1.45	Q-200yr	m^3/s	0.24

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.005	0.004	0.004	0.004	0.003	0.002	0.002	0.002	0.002	0.003	0.004	0.005
V	m/s	0.24	0.23	0.23	0.22	0.19	0.16	0.16	0.16	0.18	0.21	0.23	0.24

Annex 12 Stoneyhill Ditch

Location: One proposed culverts and associated realignment.
Chainage: ch6930 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 874 941
Area	km^2	0.2
SAAR	mm	843
BFIHOST	-	0.457
SPRHOST	%	29
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.002	Q-5yr	m^3/s	0.09
Q_{95}	m^3/s	0.001	Q-10yr	m^3/s	0.11
QMED	m^3/s	0.06	Q-25yr	m^3/s	0.14
QBAR	m^3/s	0.04	Q-50yr	m^3/s	0.16
Q_{BF}	m^3/s	3.17	Q-100yr	m^3/s	0.18
Q_{EFB}	m^3/s	8.03	Q-200yr	m^3/s	0.21

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.003	0.003	0.003	0.002	0.002	0.001	0.001	0.001	0.002	0.002	0.003	0.003
V	m/s	0.20	0.18	0.19	0.17	0.15	0.13	0.13	0.14	0.15	0.17	0.19	0.19

Annex 13 Balnagubs Burn

Location: Proposed culvert and associated realignment.
Chainage: ch7550 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 874 946
Area	km^2	0.234
SAAR	mm	843
BFIHOST	-	0.457
SPRHOST	%	29
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.003	Q-5yr	m^3/s	0.13
Q_{95}	m^3/s	0.001	Q-10yr	m^3/s	0.16
QMED	m^3/s	0.09	Q-25yr	m^3/s	0.20
QBAR	m^3/s	0.05	Q-50yr	m^3/s	0.23
Q_{BF}	m^3/s	0.11	Q-100yr	m^3/s	0.27
Q_{EFB}	m^3/s	16.85	Q-200yr	m^3/s	0.31

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.005	0.004	0.004	0.003	0.002	0.002	0.002	0.002	0.002	0.003	0.004	0.004
V	m/s	0.49	0.47	0.47	0.45	0.39	0.34	0.33	0.35	0.39	0.45	0.48	0.49

Annex 14 Tributary of the Burn of Elsick

Location: Proposed culvert, associated realignment and outfall location.
Chainage: ch7975 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 874 952
Area	km^2	1.0
SAAR	mm	847
BFIHOST	-	0.566
SPRHOST	%	28.5
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.013	Q-5yr	m^3/s	0.37
Q_{95}	m^3/s	0.003	Q-10yr	m^3/s	0.44
QMED	m^3/s	0.26	Q-25yr	m^3/s	0.56
QBAR	m^3/s	0.17	Q-50yr	m^3/s	0.66
Q_{BF}	m^3/s	1.75	Q-100yr	m^3/s	0.75
Q_{EFB}	m^3/s	17.84	Q-200yr	m^3/s	0.87

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.019	0.017	0.015	0.013	0.010	0.007	0.006	0.006	0.007	0.012	0.018	0.019
V	m/s	0.68	0.64	0.61	0.58	0.52	0.45	0.43	0.43	0.47	0.56	0.66	0.66

Annex 15 Whiteside Burn

Location: Proposed culvert and associated realignment.
Chainage: ch8850 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 874 959
Area	km^2	0.4
SAAR	mm	843
BFIHOST	-	0.568
SPRHOST	%	28.5
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.005	Q-5yr	m^3/s	0.15
Q_{95}	m^3/s	0.001	Q-10yr	m^3/s	0.18
QMED	m^3/s	0.10	Q-25yr	m^3/s	0.22
QBAR	m^3/s	0.08	Q-50yr	m^3/s	0.26
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.30
Q_{EFB}	m^3/s	2.07	Q-200yr	m^3/s	0.35

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.002	0.003	0.005	0.007	0.008
V	m/s	0.39	0.37	0.35	0.33	0.30	0.26	0.25	0.25	0.27	0.33	0.38	0.39

Annex 16 Crossley Burn

Location: Proposed culvert and associated realignment.
Chainage: ch9170 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 873 963
Area	km^2	0.2
SAAR	mm	843
BFIHOST	-	0.568
SPRHOST	%	28.5
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.003	Q-5yr	m^3/s	0.07
Q_{95}	m^3/s	0.001	Q-10yr	m^3/s	0.09
QMED	m^3/s	0.05	Q-25yr	m^3/s	0.11
QBAR	m^3/s	0.04	Q-50yr	m^3/s	0.13
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.15
Q_{EFB}	m^3/s	1.04	Q-200yr	m^3/s	0.17

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.004	0.003	0.003	0.003	0.002	0.001	0.001	0.001	0.002	0.002	0.004	0.004
V	m/s	0.51	0.49	0.47	0.44	0.40	0.34	0.32	0.32	0.36	0.43	0.50	1.10

Annex 17 Cairns Burn

Location: Proposed realignment.
Chainage: ch9200 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 869 970
Area	km^2	0.08
SAAR	mm	883
BFIHOST	-	0.482
SPRHOST	%	30.2
FARL	-	1
URBEXT1990	-	0.001

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.001	Q-5yr	m^3/s	0.04
Q_{95}	m^3/s	0	Q-10yr	m^3/s	0.05
QMED	m^3/s	0.03	Q-25yr	m^3/s	0.06
QBAR	m^3/s	0.024	Q-50yr	m^3/s	0.07
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.09
Q_{EFB}	m^3/s	0.19	Q-200yr	m^3/s	0.10

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.001	0.002
V	m/s	0.47	0.45	0.46	0.44	0.38	0.34	0.33	0.35	0.38	0.44	0.46	0.47

Annex 18 Circle Burn

Location: Proposed area of catchment taken into pre-earthworks.
Chainage: ch9950 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 869 970
Area	km^2	0.1
SAAR	mm	883
BFIHOST	-	0.482
SPRHOST	%	30.2
FARL	-	1
URBEXT1990	-	0.001

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.001	Q-5yr	m^3/s	0.05
Q95	m^3/s	0	Q-10yr	m^3/s	0.06
QMED	m^3/s	0.04	Q-25yr	m^3/s	0.08
QBAR	m^3/s	0.029	Q-50yr	m^3/s	0.09
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.11
Q_{EFB}	m^3/s	0.68	Q-200yr	m^3/s	0.12

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002
V	m/s	0.39	0.36	0.37	0.35	0.31	0.28	0.27	0.28	0.30	0.35	0.37	0.38

Annex 19 Square Burn

Location: Proposed area of the catchment taken into pre-earthworks.
Chainage: ch10150 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 872 970
Area	km^2	0.1
SAAR	mm	883
BFIHOST	-	0.482
SPRHOST	%	30.2
FARL	-	1
URBEXT1990	-	0.001

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.001	Q-5yr	m^3/s	0.05
Q_{95}	m^3/s	0	Q-10yr	m^3/s	0.06
QMED	m^3/s	0.04	Q-25yr	m^3/s	0.08
QBAR	m^3/s	0.029	Q-50yr	m^3/s	0.09
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.11
Q_{EFB}	m^3/s	0.37	Q-200yr	m^3/s	0.12

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002
V	m/s	0.30	0.27	0.27	0.25	0.21	0.18	0.17	0.18	0.21	0.25	0.28	0.29

Annex 20 Wedderhill Burn

Location: Watercourse source lost through catchment severance.
Chainage: ch10400 on main carriageway

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 870 975
Area	km^2	0.1
SAAR	mm	818
BFIHOST	-	0.541
SPRHOST	%	28.1
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.001	Q-5yr	m^3/s	0.04
Q_{95}	m^3/s	0	Q-10yr	m^3/s	0.04
QMED	m^3/s	0.03	Q-25yr	m^3/s	0.05
QBAR	m^3/s	0.02	Q-50yr	m^3/s	0.06
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.07
Q_{EFB}	m^3/s	9.41	Q-200yr	m^3/s	0.08

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002
V	m/s	0.28	0.26	0.25	0.24	0.22	0.20	0.19	0.19	0.20	0.23	0.26	0.27

Annex 21 Craigentath Burn

Location: Proposed culvert and associated realignment.
Chainage: Culvert located on main carriageway at ch10630

Catchment Descriptors

Parameter	Unit	Value
Grid Reference		NO 870 977
Area	km^2	0.4
SAAR	mm	818
BFIHOST	-	0.541
SPRHOST	%	28.1
FARL	-	1
URBEXT1990	-	0

Summary of Design Parameters

Parameter	Unit	Value	Parameter	Unit	Value
Qmean	m^3/s	0.005	Q-5yr	m^3/s	0.18
Q_{95}	m^3/s	0.001	Q-10yr	m^3/s	0.21
QMED	m^3/s	0.12	Q-25yr	m^3/s	0.27
QBAR	m^3/s	0.09	Q-50yr	m^3/s	0.31
Q_{BF}	m^3/s	N/A	Q-100yr	m^3/s	0.36
Q_{EFB}	m^3/s	0.37	Q-200yr	m^3/s	0.41

Seasonal Flow Duration Curve

Not calculated for this site.

Mean Monthly Flow Velocities

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Qmean	m^3/s	0.009	0.008	0.007	0.006	0.004	0.003	0.003	0.003	0.003	0.005	0.008	0.009
V	m/s	0.10	0.10	0.09	0.09	008	0.07	0.07	0.07	0.07	0.09	0.10	0.10

Annex 22 Fluvial Geomorphology: Background

A22.1 Fluvial processes operate over a range of spatial and temporal scales and involve the interaction of a range of processes and landforms. Sediment regime (erosion, transport and deposition) is a key element of the fluvial system which varies in response to external and internal controls, usually in conjunction with the hydrological regime. A key concern with the construction and operation of this road scheme is the potential consequences of an increase in fine sediment supply on the sensitive ecological communities of the river. Changes in the sediment and hydrological regime can also lead to changes in channel morphology. The diversity of morphological features in a river channel is a key control on habitat quality. Salmon, for example, require variable flow conditions generated by alternating sequences of pools and riffles. Pools act as holding grounds for mature fish, while the riffles provide habitat for fry and par (juveniles). Morphological diversity also extends to exposed features such as the channel deposits (bars) and bank and riparian areas. Dynamic (laterally active) gravel-bed rivers for example support a range of habitats, as the morphological forms they contain are variable in age. Such rivers can support a range of ecological communities from pioneer communities on exposed gravel bars to mature vegetation communities on older bars and islands.

A22.2 Man-made structures can alter morphological quality either directly, through features such as concrete banks or bed, or indirectly by altering natural fluvial processes such as the distribution of erosion and deposition, or those of channel planform evolution, such as migration. Bank and bed protection can inhibit the ability of a river to migrate or adjust its planform in response to external influences, and this can lead to a reduction in morphological diversity. In contrast however, realigning river channels can lead to an increase in fluvial processes (erosion and deposition) as the river channel adjusts to changes in cross-sectional form and gradient.

A22.3 The division of fluvial geomorphology into sediment regime, channel morphology and natural fluvial processes is a simplification to suit the WFD criteria and provide clarity. In reality each of the elements are intimately interrelated (see Figure 10.1). For the purposes of this investigation changes to the sediment regime are considered in terms of the potential increase in sediment supply caused by the construction and operation of the proposed scheme. Other, indirect changes to the sediment regime might occur and these are considered in terms of changes to natural fluvial processes, such as erosion and deposition.

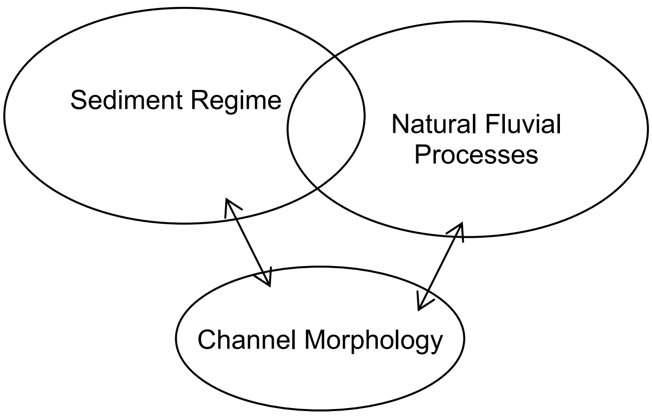


Figure A22.1: Simplified Interrelationships in the Fluvial System

Annex 23 Fluvial Geomorphology: Additional Baseline Information

Table 1 – Geomorphological Characteristics of Each Watercourse

Watercourse	Bankfull Width (m)	Wetted Width (m)	Depth (m)	Bed Material	Bank Material	Existing Modification	Gradient (average over 1 km)	Flow/ Morphological Diversity
Megray Burn	0.5-3.0	1.5	1.5	Fine gravel	Walled and natural (fine material)	Realigned, resectioned, culverted, flow regulation	0.039	Poor
Limpet Burn	0.4-1.0	0.54	0.5	Gravel and sand	Natural (fine material – peaty soil)	Artificial fishing ponds	0.011	Good
Coneyhatch Burn	2	0.5	1	Grasses/ rushes	Natural (fine material)	Realigned, resectioned	0.005	Poor
Green Burn	0.3-0.5	0.3	0.2-0.3	Gravel, some sand and cobble	Natural (fine material)	Realigned, resectioned, culverted	0.007	Good
Green Ditch	Ephemeral ditch – difficult to assess character							
Allochie Burn	2.5	0.5	1	Grasses/ rushes	Walled and natural (fine material)	Realigned, resectioned	Negligible	Poor
Burn of Muchalls	1.5-2	1.5	0.5	Gravel, cobble, boulder	Natural (fine material) and walled	Realigned, resectioned, walled	0.024	Good
Burn of Blackbutts	2	0.25	1	Grasses/ rushes	Natural (fine material)	Realigned, resectioned	0.014	Poor
Cookney Ditch	3	0.25	1	Grasses/ rushes	Natural (fine material)	Realigned, resectioned, artificial drainage	0.013	Poor
Stoneyhill Burn	Ephemeral ditch – difficult to assess character							
Balnagubs Burn	5	1.5	1.8	Silt	Natural (fine material)	Realigned, resectioned	0.015	Poor
Tributary of Burn of Elsick	Ephemeral ditch – difficult to assess character							
Whiteside Burn	4	1	1.25	Gravel	Natural (fine material)	Realigned, resectioned, culverted	0.018	Poor
Crossley Burn	3	1	1	Silt	Natural (fine material)	Realigned, resectioned, artificial drainage	0.02	Poor

Watercourse	Bankfull Width (m)	Wetted Width (m)	Depth (m)	Bed Material	Bank Material	Existing Modification	Gradient (average over 1 km)	Flow/ Morphological Diversity
Cairns Burn	1	0.25	0.25	Silt	Natural (fine material)	Realigned, resectioned, artificial drainage	Negligible	Poor
Circle Burn	Ephemeral ditch – difficult to assess character							
Square Burn	Ephemeral ditch – difficult to assess character							
Wedderhill Burn	1.25	0.75	1	Gravel, cobble and silt	Walled and natural (fine material)	Realigned, resectioned	0.015	Poor
Craigentath Burn	1.5	0.2	1.5	Grasses/ rushes	Natural (fine material)	Realigned, resectioned	0.031	Poor

Table 2 – Surface Geology at each crossing point based on the geological maps of the area

Watercourse/Water Feature Within Route Corridor	Grid Reference	Geology
Megray Burn	NO875876	Till (Mill of Forest Till Formation)
Limpet Burn	NO876886	Peaty soil overlies bedrock (Glen Lethnot Grit Formation)
Coneyhatch Burn	NO873887	Peat and till (Banchory Till Formation)
Green Burn	NO870903	Peat and till (Banchory Till Formation) To the east, Drumlithie Sand and Gravel Formation
Green Ditch	NO872903	Peat and till (Banchory Till Formation)
Allochie Burn	NO869911	Alluvium and till (Banchory Till Formation)
Burn of Muchalls	NO873918	Alluvium and till (Banchory Till Formation)
Burn of Blackbutts	NO874927	Peat overlies bedrock (Glen Effock Schist Formation) and till (Banchory Till Formation)
Cookney Ditch	NO872935	Till (Banchory Till Formation)
Stoneyhill Burn	NO872942	Peat and till (Banchory Till Formation)
Balnagubs Burn	NO874947	Till (Banchory Till Formation) overlies bedrock (Aberdeen Formation)
Burn of Elsick	NO875952	Till (Banchory Till Formation)
Whiteside Burn	NO873960	Till (Banchory Till Formation)
Crossley Burn	NO873963	Till (Banchory Till Formation)
Cairns Burn	NO872964	Till (Banchory Till Formation)
Circle Burn	NO869970	Till (Banchory Till Formation)
Square Burn	NO870970	Till (Banchory Till Formation)
Wedderhill Burn	NO866977	Till (Banchory Till Formation)
Craigentath Burn	NO869979	Till (Banchory Till Formation)

Annex 24 Fluvial Geomorphology Site Photographs

Megray Burn

NO8743087666: View upstream. Woodland just upstream of proposed road crossing. Steep gradient, gravel bed. Stream dry: downstream flow attributed to small tributary (groundwater seepage?) immediately downstream which joins perpendicular to Megray Burn.

NO8746387600: View downstream in location of proposed road crossing (just upstream of bend). Deep ditch, dense vegetation on bank face.

Limpet Burn

NO8759788856: View upstream in vicinity of crossing point. Small channel running through wetland valley. 'Mis-fit' stream – possibly a meltwater valley? In places channel is overgrown with wetland grasses, but where exposed the bed is composed of fine gravels.

Coneyhatch Burn

View upstream in location of proposed road crossing; note the dense vegetation within the watercourse which prevents a clear view of the channel.

Green Burn

NO869169038: View upstream in location of proposed road crossing. Gravel bed, locally steep sections and ponded, low gradient sections.

Burn of Muchalls

NO8725191897: View downstream. Location of proposed road crossing. Straight deep ditch, gravel cobble bed, dense vegetation on banks. Back Burn joins upstream at a perpendicular angle.

Burn of Blackbutts

NO8745792692: View downstream in vicinity of proposed road crossing. Straight ditch on field boundary, vegetation choked.

Cookney Ditch

NO8756893589: View downstream. Proposed road near pylon and slip road near existing road. Possible spoil from channel on left bank.

Stoneyhill Ditch

NO8722194095: View downstream. Straight ditch, choked with vegetation, no perceptible flow, boggy surrounding ground.

Balnagubs Burn

NO8744294661: View upstream near location of proposed road crossing. Deep ditch, embanked on right bank, walled along left in parts.

Tributary of Burn of Elsick

NO8727095143: View downstream towards proposed road crossing. Vegetation choked, gorse, ferns, shrubs on bank.

Whiteside Burn

NO8707496024: View downstream. Straight ditch, no perceptible flow and filled with vegetation. Livestock fencing both sides.

Crossley Burn

NO8717196299: View downstream at location of proposed road crossing. Grasses/sedges in channel, boggy ground, no perceptible flow.

Cairns Burn

NO8719896375: View downstream. No perceptible flow (or distinct channel). Areas of boggy ground and saturated ground, extensive silt.

Wedderhill Burn

NO8696397540: Straightened and walled in places, also evidence of recent channel excavation, with material placed on bank top. Bed material is mixed fines and gravel. Drains into wetland area.

Craigentath Burn

NO8725997460: Straightened field ditch but with quite high gradient. Stream was dry at time of survey. Drains into wetland area.

Annex 25 Water Quality – SEPA Classification Tables

More details are provided on SEPA website.

Notes relating to the Annex 28

a Based upon three years data, minimum of 12 samples, unless there has been a significant change in circumstances (e.g. a discharge eliminated or an identified major pollution incident in a previous year) which justifies an assessment based upon a lesser data set collected after a step change. In such circumstances a minimum monitoring period of 12 months must have elapsed since the change and where there are fewer than 12 samples the significance of the step change should be confirmed by a statistical test. Estimation of percentiles to be by parametric method, assuming DO and pH are normal distributions and BOD and ammoniacal nitrogen are log normal. For pH the 5, 10 and 95 percentiles must be determined from the 3 years data and compared with the class determining limits in the Classification table. Again, the parametric percentile estimation must be made, using the method of moments, and as assumed normal distribution.

b Based on data for one year, preferably three samples (spring, summer and autumn), minimum of two (spring and autumn).

c Based on one year's monitoring data, preferably three samples, minimum of two. The overall class is determined from the mean field score and mean ASPT (Average Score Per Taxon) of the individual samples.

d Aesthetic conditions to be based on one year's data from a minimum of three observations and will be assessed and recorded during ecological and/or chemical sampling visits to programmed sampling points. Aesthetic contamination is assessed as either discharge related (List A) or general (List B).

List A contaminants

Sewage-derived litter and solids, including:

- faeces;
- toilet paper;
- contraceptives;
- sanitary towels;
- tampons;
- cotton buds;
- oils;
- non-natural foam, scum or colour;
- sewage fungus; and
- sewage or oily smells.

List B contaminants

- General non sewage derived litter;
- Builders' waste; and
- Gross litter, including:

    shopping trolleys

furniture

motor vehicles

road cones

bicycles/prams

e No list A contaminants, possibly minor List B litter present.

f Traces of List A and/ or occasional List B contamination, especially at easy access points.

g List A contamination widespread and/or occasional conspicuous quantities, and/or widespread or gross amounts of List B contamination. Likely to be the cause of justified public complaints. The annual aesthetics classification is derived from the individual spot samples in the following way. Spot classifications are assigned a numerical value.

Table 1: Spot Classification Value

Class	Value
A1	1
A2	2
C	4

The arithmetic mean value of the spot classes for the year is calculated and the annual class assigned using bands.

Table 2: Annual Class Bands

Mean value	Class
>3.0	C
>1.5	A2
< 1.5	A1

A minimum of three spot values is required for an annual class to be assigned.

Annex 26 Parameters used in the Classification Water Quality at a Monitoring Point

		WATER CHEMISTRY [a]					ECOLOGY				NUTRIENTS[a]	AESTHETIC[d]	TOXIC SUBSTANCES	COMMENT
Class	Description	Dissolved Oxygen (DO) (% sat.) (10%ile)	Ecological Oxygen Demand (BOD) (mg/l) (90%ile)	Ammonia (NH4-N) (mg/l) (90%ile)	Iron (mg/l) Mean	pH %ile	Lab Analysed [b]		Bankside [c]		SRP (µg/l) Mean	Condition (Contaminated)		
							ASPT[1] EQI	TAXA EQI	ASPT	Field Score				
A1	Excellent	≥80	≤2.5	≤0.25	≤1	5%ile≥6 95%ile≤9	≥1.0	≥0.85	≥6.0	≥85	≤20	No A Minor B[e]	Complies with Dangerous Substances EQS's	Sustainable fish population. Natural ecosystem.
A2	Good	≥70	≤4	≤0.6	≤1	10%ile ≥5.2	≥0.9	≥0.70	≥5.0	≥70	≤100	Trace/ Occasional A or B[f]	Complies with Dangerous Substances EQS's	Sustainable fish population. Ecosystem may be modified by human activity.
B	Fair	≥60	≤6	≤1.3	≤2	10%ile <5.2	≥0.77	≥0.55	≥4.2	≥50	>100	-	Complies with Dangerous Substances EQS's	Fish may be present. Impacted ecosystem.
C	Poor	≥20	≤15	≤9.0	>2	-	≥0.50	≥0.30	≥3.0	≥15	-	Gross A or B[g]	>EQS for dangerous substance	Fish sporadically present. Poor ecosystem.
D	Seriously Polluted	<20	>15	>9.0	-	-	<0.50	<0.30	<3.0	<15	-	-	>10 x EQS for dangerous substance	Fish absent or seriously restricted.

[1]. Average Score Per Taxon

Annex 27 Spillage Risk Calculations

Scheme: Aberdeen Western Peripheral Route Fastlink **Job No:** **10332**
Spillage Risk Assessment
Without Mitigation

Item	**Description**	**Units**						
Probability of a serious accidental spillage			**Megray Burn**	**Megray Burn**	**Megray Burn**	**Green Burn**	**Burn of Muchalls**	**Burn of Elsick**
Section of Road or Junction								
			Run A	**Run A**	**Run A**	**Run B**	**Run C**	**Run D**
			Mainline	Roundabout	**Total**	Mainline	Mainline	Mainline
Formula	P_{acc} = RL x SS x (AADT x 365 x 10^{-6}) x (% HGV /100)							
P_{acc}	Probability of a serious accidental spillage in one year over a given road length		0.0029	0.0002		0.0016	0.0058	0.0050
P_{acc} as a probability factor	1 / P_{acc}		350	5187		612	173	199
RL	Road length in kilometres	km	1.736	0.771	2.507	0.994	3.506	3.064
SS	Serious spillage rates (from Volume 11 DMRB: Table 3.2, p A3/4)		0.0022	0.0296		0.0022	0.0022	0.0022
AADT	Annual average daily traffic		12796	7715		12796	12796	12796
% HGV	Percentage of heavy goods vehicles	%	16	0.3		16	16	16
Acceptable risk of a pollution incident - for discharge to aquifers and sensitive watercourses			*1 in a 100 years*	*1 in a 100 years*		*1 in a 100 years*	*1 in a 100 years*	*1 in a 100 years*
Acceptable risk of a pollution incident - for discharge to all other watercourses			*1 in 50 years*	*1 in 50 years*		*1 in 50 years*	*1 in 50 years*	*1 in 50 years*
Probability that a spillage will cause a pollution incident								
Formula	$P_{pol\ per\ year}$ = P_{acc} x P_{pol}		0.0021	0.0001		0.0012	0.0043	0.0038
P_{acc}	see above							
P_{pol}	Risk reduction factor Vol 11 DMRB: Table 3.3, p A3/4; assumed emergency response time >20min		0.75	0.75		0.75	0.75	0.75
P_{pol} as a probability factor	**1 / P_{pol} per year**		467	6916	**438**	**816**	**231**	**265**
Is the spillage risk within acceptable limits?			**Y**	**Y**	**Y**	**Y**	**Y**	**Y**

Scheme: Aberdeen Western Peripheral Route Fastlink **Job No:** **10332**
Spillage Risk Assessment
With Mitigation

Item	**Description**	**Units**						
Probability of a serious accidental spillage			**Megray Burn**	**Megray Burn**	**Megray Burn**	**Green Burn**	**Burn of Muchalls**	**Burn of Elsick**
Section of Road or Junction								
			Run A	**Run A**	**Run A**	**Run B**	**Run C**	**Run D**
			Mainline	Roundabout	**Total**	Mainline	Mainline	Mainline
Formula	P_{acc} = RL x SS x (AADT x 365 x 10^{-6}) x (% HGV /100)							
P_{acc}	Probability of a serious accidental spillage in one year over a given road length		0.0029	0.0002		0.0016	0.0058	0.0050
P_{acc} as a probability factor	1 / P_{acc}		350	5187		612	173	199
RL	Road length in kilometres	km	1.736	0.771	2.507	0.994	3.506	3.064
SS	Serious spillage rates (from Volume 11 DMRB: Table 3.2, p A3/4)		0.0022	0.0296		0.0022	0.0022	0.0022
AADT	Annual average daily traffic		12796	7715		12796	12796	12796
% HGV	Percentage of heavy goods vehicles	%	16	0.3		16	16	16
Acceptable risk of a pollution incident - for discharge to aquifers and sensitive watercourses			*1 in a 100 years*	*1 in a 100 years*		*1 in a 100 years*	*1 in a 100 years*	*1 in a 100 years*
Acceptable risk of a pollution incident - for discharge to all other watercourses			*1 in 50 years*	*1 in 50 years*		*1 in 50 years*	*1 in 50 years*	*1 in 50 years*
Probability that a spillage will cause a pollution incident								
Formula	$P_{pol\ per\ year} = P_{acc} \times P_{pol}$		0.0021	0.0001		0.0012	0.0043	0.0038
P_{acc}	see above							
P_{pol}	Risk reduction factor Vol 11 DMRB: Table 3.3, p A3/4; assumed emergency response time >20min		0.75	0.75		0.75	0.75	0.75
P_{pol} as a probability factor	**1 / P_{pol} per year**		467	6916	**438**	**816**	**231**	**265**
Is the spillage risk within acceptable limits?			**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
WITH MITIGATION MEASURES:								
Control Measure 1:	$P_{pol\ per\ year}$ (reduced by 65%)		0.0007	0.0001		0.0004	0.0015	0.0013
(FILTER DRAIN)	P_{pol} as a probability factor		1335	19759		2331	661	756
Control Measure 2:	$P_{pol\ per\ year}$ (reduced by 65%)		0.0003	0.0000		0.0002	0.0005	0.0005
(TREATMENT POND)	P_{pol} as a probability factor		3814	56456		6660		
Control Measure 3:	$P_{pol\ per\ year}$ (reduced by 65%)		0.0001	0.0000		0.0001		
(TREATMENT POND)	P_{pol} as a probability factor							
Control Measure 4:	$P_{pol\ per\ year}$ (reduced by 65%)							
(TREATMENT POND)	P_{pol} as a probability factor		10896	56456	**10207**	**19030**	**1888**	**2161**
Is the spillage risk with mitigation within acceptable limits?			**Y**	**Y**	**Y**	**Y**	**Y**	**Y**

Annex 28 Pollution Risk Calculation

Scheme: Aberdeen Western Peripheral Route Fastlink **Job No:** **10332**
Routine Runoff Pollution Risk Assessment (Dangerous Substance Directive)
Without Mitigation

95-Percentile EQS

Item	Description	Units	Megray Burn Run A	Green Burn Run B	Burn of Muchalls Run C	Burn of Elsick Run D
Water Quality Prediction						
Data from Regulatory Authority						
Q95 i.e. 95-percentile flow (flow exceeded 95% of the time)		m^3/sec	0.002	0.002	0.024	0.003
Existing Water Quality Class	River Quality Objective				A2	
Hardness	Hardness of watercourse (affects solubility of metals)	mg/l	*120*	*88*	*72*	*120*
C_b	Upstream dissolved copper data as mg/l (assume half of EQS; River Dee - SEPA data)	mg/l	0.056	0.020	0.020	0.056
Zn_b	Upstream total zinc as mg/l (assume half of EQS; River Dee - SEPA data)	mg/l	0.250	0.150	0.150	0.250
EQS Cu based on RQO	*Permitted Environmental Quality Standard for copper as mg/l (95 percentile)*	*mg/l*	*0.112*	*0.040*	*0.040*	*0.112*
EQS Zn based on RQO	*Permitted Environmental Quality Standard for zinc as mg/l (95 percentile)*	*mg/l*	*0.500*	*0.300*	*0.300*	*0.500*
Other data						
AADT	Annual average daily traffic		12796	12796	12796	12796
RL	Road length (m)	m	2507	994	3506	3064
RW	Road width (m)	m				
RC	Runoff coefficient		0.75	0.75	0.75	0.75
Rain	Rainfall depth (from Volume 11, page A3/5 Fig 3.1) (mm)	mm	13.5	13.5	13.5	13.5
PBUR (pollutant build up rate)	See page A3/2 Table 3.1 in Vol.11 - based on traffic flow Cu (dissolved)	kg/ha/annum	0.3	0.3	0.3	0.3
	Zn (total)	kg/ha/annum	1.0	1.0	1.0	1.0
Calculations						
1. Total impermeable area (TIA)	= RL x RW (m^2)	m^2	40678	18488	65211	56990
2. Runoff volume (V)	= TIA x RC x (rain / 1000)	m^3	411.86	187.19	660.26	577.02
3. Q95 in m^3/day	= Q_5 flow x 3600 x 24	m^3/day	172.8	172.8	2073.6	259.2
4. Cu build up rate	5 day build up (M_{cu}) = (PBURCu /365) x 5 x (TIA / 10000)	kg	0.0167	0.0076	0.0268	0.0234
5. Zn build up rate	5 day build up (M_{zn}) = (PBURZn /365) x 5 x (TIA / 10000)	kg	0.0557	0.0253	0.0893	0.0781
Resulting dissolved copper concentration in the water course downstream (C_r):						
Formula	$C_r = \{(C_b \times Q_{95}) + (1000 \times M_{cu})\} / (Q95 + V)$ mg/l (1000 x M_{cu})		16.72	7.60	26.80	23.42
	(Q95 + V)		584.66	359.99	2733.86	836.22
Resulting dissolved copper concentration in the water course downstream (C_r)		**mg/l**	**0.045**	**0.031**	**0.025**	**0.045**
Resulting total zinc concentration in the watercourse (Zn_r):						
Formula	$Zn_r = \{Zn_b \times Q_{95}\} + \{(1000 \times M_{zn})\} / (Q95 + V)$ mg/l		55.72	25.33	89.33	78.07
	(Q95 + V)		584.66	359.99	2733.86	836.22
Resulting total zinc concentration in the watercourse (Zn_r)		**mg/l**	**0.169**	**0.142**	**0.146**	**0.171**
Does predicted dissolved copper concentration comply with the EQS?			Y	Y	Y	Y
Does predicted total zinc concentration comply with the EQS?			Y	Y	Y	Y

Percentage over Base Line Value	**Copper**	**%**	-19%	54%	25%	-19%
	Zinc	**%**	-32%	-5%	-2%	-32%

Note: Spreadsheet incorporates Volume 11 of Design Manual for Roads and Bridges amendment dated November 2002

NOTES:
No junctions included in the new drainage system
RW (road width) values were not required to calculate TIA (Total Impermeable Area) as these were provided by the engineers
A conservative run-off co-efficient value of 0.75 has been assumed for all runs within the Fastlink Section

Scheme: Aberdeen Western Peripheral Route Fastlink **Job No:** **10332**
Routine Runoff Pollution Risk Assessment (Dangerous Substance Directive)
Without Mitigation

Annual Average EQS (Using DMRB Method but based on Annual Averages)

Item	Description	Units	Megray Burn	Green Burn	Burn of Muchalls	Burn of Elsick
			Run A	Run B	Run C	Run D
Water Quality Prediction						
Data from Regulatory Authority						
Q50 i.e. 50-percentile flow (flow exceeded 50% of the time)		m^3/sec	0.007	0.01	0.103	0.013
Existing Water Quality Class	River Quality Objective				A2	
Hardness	Hardness of watercourse (affects solubility of metals)	mg/l	*120*	*88*	*72*	*120*
C_b	Upstream dissolved copper data as mg/l (assume half of EQS; River Dee - SEPA data)	mg/l	0.014	0.005	0.005	0.014
Zn_b	Upstream total zinc as mg/l (assume half of EQS; River Dee - SEPA data)	mg/l	0.063	0.038	0.038	0.063
EQS Cu based on RQO	*Permitted Environmental Quality Standard for copper as mg/l (Annual Average)*	*mg/l*	*0.028*	*0.010*	*0.010*	*0.028*
EQS Zn based on RQO	*Permitted Environmental Quality Standard for zinc as mg/l (Annual Average)*	*mg/l*	*0.125*	*0.075*	*0.075*	*0.125*
Other data						
AADT	Annual average daily traffic		12796	12796	12796	12796
RL	Road length (m)	m	2507	994	3506	3064
RW	Road width (m)	m				
RC	Runoff coefficient		0.75	0.75	0.75	0.75
Rain	Rainfall depth (from Volume 11, page A3/6 Fig 3.2) (mm)	mm	2.7	2.7	2.7	2.7
PBUR (pollutant build up rate)	See page A3/2 Table 3.1 in Vol.11 - based on traffic flow Cu (dissolved)	kg/ha/annum	0.3	0.3	0.3	0.3
	Zn (total)	kg/ha/annum	1.0	1.0	1.0	1.0
Calculations						
1. Total impermeable area (TIA)	= RL x RW (m^2)	m^2	40678	18488	65211	56990
2. Runoff volume (V)	= TIA x RC x (rain / 1000)	m^3	82.37	37.44	132.05	115.40
3. Q50 in m^3/day	= Q_{50} flow x 3600 x 24	m^3/day	604.8	864	8899.2	1123.2
4. Cu build up rate	5 day build up (M_{cu}) = (PBURCu /365) x 5 x (TIA / 10000)	kg	0.0167	0.0076	0.0268	0.0234
5. Zn build up rate	5 day build up (M_{zn}) = (PBURZn /365) x 5 x (TIA / 10000)	kg	0.0557	0.0253	0.0893	0.0781
Resulting dissolved copper concentration in the water course downstream (C_r):						
Formula	$C_r = \{(C_b \times Q_{50}) + (1000 \times M_{cu})\} / (Q50 + V)$ mg/l (1000 x M_{cu})		16.72	7.60	26.80	23.42
	(Q50 + V)		687.17	901.44	9031.25	1238.60
Resulting dissolved copper concentration in the water course downstream (C_r)		**mg/l**	**0.037**	**0.013**	**0.008**	**0.032**
Resulting total zinc concentration in the watercourse (Zn_r):						
Formula	$Zn_r = \{Zn_b \times Q_{50}\} + \{(1000 \times M_{zn})\} / (Q50 + V)$ mg/l		55.72	25.33	89.33	78.07
	(Q50 + V)		687.17	901.44	9031.25	1238.60
Resulting total zinc concentration in the watercourse (Zn_r)		**mg/l**	**0.136**	**0.064**	**0.047**	**0.120**
Does predicted dissolved copper concentration comply with the EQS?			**N**	**N**	**Y**	**N**
Does predicted total zinc concentration comply with the EQS?			**N**	**Y**	**Y**	**Y**

Percentage over Base Line Value	**Copper**	**%**	162%	164%	58%	126%
	Zinc	**%**	118%	71%	25%	92%

Note: Spreadsheet incorporates Volume 11 of Design Manual for Roads and Bridges amendment dated November 2002

NOTES:
No junctions included in the new drainage system
RW (road width) values were not required to calculate TIA (Total Impermeable Area) as these were provided by the engineers
A conservative run-off co-efficient value of 0.75 has been assumed for all runs within the Fastlink Section

Scheme: Aberdeen Western Peripheral Route Fastlink **Job No: 10332**
Routine Runoff Pollution Risk Assessment (Freshwater Fisheries Directive)
Without Mitigation

95-Percentile EQS

Item	Description	Units	Megray Burn Run A	Green Burn Run B	Burn of Muchalls Run C	Burn of Elsick Run D
Water Quality Prediction						
Data from Regulatory Authority						
Q95 i.e. 95-percentile flow (flow exceeded 95% of the time)		m^3/sec	0.002	0.002	0.024	0.003
Existing Water Quality Class	River Quality Objective				A2	
Hardness	Hardness of watercourse (affects solubility of metals)	mg/l	*120*	*88*	*72*	*120*
C_b	Upstream dissolved copper data as mg/l (assume half of EQS; River Don - SEPA data)	mg/l	0.056	0.020	0.020	0.056
Zn_b	Upstream total zinc as mg/l (assume half of EQS; River Don - SEPA data)	mg/l	0.250	0.150	0.150	0.250
EQS Cu based on RQO	*Permitted Environmental Quality Standard for copper as mg/l (95 percentile)*	*mg/l*	*0.112*	*0.040*	*0.040*	*0.112*
EQS Zn based on RQO	*Permitted Environmental Quality Standard for zinc as mg/l (95 percentile)*	*mg/l*	*0.500*	*0.300*	*0.300*	*0.500*
Other data						
AADT	Annual average daily traffic		12796	12796	12796	12796
RL	Road length (m)	m	2507	994	3506	3064
RW	Road width (m)	m				
RC	Runoff coefficient		0.75	0.75	0.75	0.75
Rain	Rainfall depth (from Volume 11, page A3/5 Fig 3.1) (mm)	mm	13.5	13.5	13.5	13.5
PBUR (pollutant build up rate)	See page A3/2 Table 3.1 in Vol.11 - based on traffic flow Cu (dissolved)	kg/ha/annum	0.3	0.3	0.3	0.3
	Zn (total)	kg/ha/annum	1.0	1.0	1.0	1.0
Calculations						
1. Total impermeable area (TIA)	= RL x RW (m^2)	m^2	40678	18488	65211	56990
2. Runoff volume (V)	= TIA x RC x (rain / 1000)	m^3	411.86	187.19	660.26	577.02
3. Q95 in m^3/day	= Q_5 flow x 3600 x 24	m^3/day	172.8	172.8	2073.6	259.2
4. Cu build up rate	5 day build up (M_{cu}) = (PBURCu /365) x 5 x (TIA / 10000)	kg	0.0167	0.0076	0.0268	0.0234
5. Zn build up rate	5 day build up (M_{zn}) = (PBURZn /365) x 5 x (TIA / 10000)	kg	0.0557	0.0253	0.0893	0.0781
Resulting dissolved copper concentration in the water course downstream (C_r):						
Formula	C_r = {(C_b x Q_{95}) + (1000 x M_{cu})} / (Q95 +V) mg/l (1000 x M_{cu})		16.72	7.60	26.80	23.42
	(Q95 + V)		584.66	359.99	2733.86	836.22
Resulting dissolved copper concentration in the water course downstream (C_r)		**mg/l**	**0.045**	**0.031**	**0.025**	**0.045**
Resulting total zinc concentration in the watercourse (Zn_r):						
Formula	Zn_r = {Zn_b x Q_{95})+ {(1000 x M_{zn})} / (Q95 +V) mg/l		55.72	25.33	89.33	78.07
	(Q95 + V)		584.66	359.99	2733.86	836.22
Resulting total zinc concentration in the watercourse (Zn_r)		**mg/l**	**0.169**	**0.142**	**0.146**	**0.171**
Does predicted dissolved copper concentration comply with the EQS?			Y	Y	Y	Y
Does predicted total zinc concentration comply with the EQS?			Y	Y	Y	Y

Percentage over Base Line Value	**Copper**	**%**	-19%	54%	25%	-19%
	Zinc	**%**	-32%	-5%	-2%	-32%

Note: Spreadsheet incorporates Volume 11 of Design Manual for Roads and Bridges amendment dated November 2002

NOTES:
No junctions included in the new drainage system
RW (road width) values were not required to calculate TIA (Total Impermeable Area) as these were provided by the engineers
A conservative run-off co-efficient value of 0.75 has been assumed for all runs within the Fastlink Section

Aberdeen Western Peripheral Route

Environmental Statement Appendices 2007

Part D: Fastlink

Appendix A39.4 – Water Environment Annexes

Scheme: Aberdeen Western Peripheral Route Fastlink **Job No:** **10332**

Routine Runoff Pollution Risk Assessment (Dangerous Substance Directive)

With Mitigation

95-Percentile EQS

Item	Description	Units	Megray Burn Run A	Green Burn Run B	Burn of Muchalls Run C	Burn of Elsick Run D
Water Quality Prediction						
Data from Regulatory Authority						
Q95 i.e. 95-percentile flow (flow exceeded 95% of the time)		m^3/sec	0.002	0.002	0.024	0.003
Existing Water Quality Class	River Quality Objective				A2	
Hardness	Hardness of watercourse (affects solubility of metals)	mg/l	*120*	*88*	*72*	*120*
C_b	Upstream dissolved copper data as mg/l (assume half of EQS - River Don SEPA data)	mg/l	0.056	0.020	0.020	0.056
Zn_b	Upstream total zinc as mg/l (assume half of EQS - River Don SEPA data)	mg/l	0.250	0.150	0.150	0.250
EQS Cu based on RQO	*Permitted Environmental Quality Standard for copper as mg/l (95 percentile)*	*mg/l*	*0.112*	*0.040*	*0.040*	*0.112*
EQS Zn based on RQO	*Permitted Environmental Quality Standard for zinc as mg/l (95 percentile)*	*mg/l*	*0.500*	*0.300*	*0.300*	*0.500*
Other data						
AADT	Annual average daily traffic		12796	12796	12796	12796
RL	Road length (m)	m	2507	994	3506	3064
RW	Road width (m)	m				
RC	Runoff coefficient		0.75	0.75	0.75	0.75
Rain	Rainfall depth (from Volume 11, page A3/5 Fig 3.1) (mm)	mm	13.5	13.5	13.5	13.5
PBUR (pollutant build up rate)	See page A3/2 Table 3.1 in Vol.11 - based on traffic flow Cu (dissolved)	kg/ha/annum	0.029	0.060	0.084	0.084
	Zn (total)	kg/ha/annum	0.031	0.023	0.088	0.088
Calculations						
1. Total impermeable area (TIA)	= RL x RW (m^2)	m^2	40678	18488	65211	56990
2. Runoff volume (V)	= TIA x RC x (rain / 1000)	m^3	411.86	187.19	660.26	577.02
3. Q95 in m^3/day	= Q_5 flow x 3600 x 24	m^3/day	172.8	172.8	2073.6	259.2
4. Cu build up rate	5 day build up (M_{cu}) = (PBURCu /365) x 5 x (TIA / 10000)	kg	0.0016	0.0015	0.0075	0.0066
5. Zn build up rate	5 day build up (M_{zn}) = (PBURZn /365) x 5 x (TIA / 10000)	kg	0.0017	0.0006	0.0078	0.0068
Resulting dissolved copper concentration in the water course downstream (C_r):						
Formula	$C_r = \{(C_b \times Q_{95}) + (1000 \times M_{cu})\} / (Q95 + V)$ mg/l (1000 x M_{cu})		1.64	1.52	7.50	6.56
	(Q95 + V)		584.66	359.99	2733.86	836.22
Resulting dissolved copper concentration in the water course downstream (C_r)		**mg/l**	**0.019**	**0.014**	**0.018**	**0.025**
Resulting total zinc concentration in the watercourse (Zn_r):						
Formula	$Zn_r = \{Zn_b \times Q_{95}\} + \{(1000 \times M_{zn})\} / (Q95 + V)$ mg/l		1.71	0.57	7.82	6.83
	(Q95 + V)		584.66	359.99	2733.86	836.22
Resulting total zinc concentration in the watercourse (Zn_r)		**mg/l**	**0.077**	**0.074**	**0.117**	**0.086**
Does predicted dissolved copper concentration comply with the EQS?			Y	Y	Y	Y
Does predicted total zinc concentration comply with the EQS?			Y	Y	Y	Y
Percentage over Base Line Value	**Copper**	**%**	-65%	-31%	-10%	-55%
	Zinc	**%**	-69%	-51%	-22%	-66%

		Run A	Run B	Run C	Run D
	Original PBUR (pollutant build up rate)				
	Diss Cu	0.300	0.300	0.300	0.300
	Total Zinc	1.000	1.000	1.000	1.000
	With Filter Drain reduction				
20% reduction	Diss Cu	0.240	0.240	0.240	0.240
75% reduction	Total Zinc	0.250	0.250	0.250	0.250
	With Treatment Pond reduction				
65% reduction	Diss Cu	0.084		0.084	0.084
65% reduction	Total Zinc	0.088		0.088	0.088
	With Treatment Pond reduction				
65% reduction	Diss Cu	0.029			
65% reduction	Total Zinc	0.031			
	With 60m Swale reduction				
50% reduction	Diss Cu		0.120		
70% reduction	Total Zinc		0.075		
	With 60m Swale reduction				
50% reduction	Diss Cu		0.060		
70% reduction	Total Zinc		0.023		
		2TP	2 x 60m Swale	1 TP	1 TP

Note: Spreadsheet incorporates Volume 11 of Design Manual for Roads and Bridges amendment dated November 2002

NOTES:

RW (road width) values were not required to calculate TIA (Total Impermeable Area) as these were provided by the engineers

A conservative value of 0.75 has been assumed for the run-off co-efficient

Note: Mitigation assumes the following:

Filter drains: 75% reduction total zinc and 20% reduction dissolved copper

Treatment Pond: 65% reduction total zinc and 65% reduction dissolved copper

Swale: 70% reduction total zinc and 50% reduction dissolved copper

Scheme: Aberdeen Western Peripheral Route Fastlink **Job No:** **10332**
Routine Runoff Pollution Risk Assessment (Dangerous Substance Directive)
With Mitigation
Annual Average EQS (Using DMRB Method but based on Annual Averages)

Item	Description	Units	Megray Burn	Green Burn	Burn of Muchalls	Burn of Elsick
			Run A	Run B	Run C	Run D
Water Quality Prediction						
Data from Regulatory Authority						
Q50 i.e. 50-percentile flow (flow exceeded 50% of the time)		m^3/sec	0.007	0.01	0.103	0.013
Existing Water Quality Class	River Quality Objective				A2	
Hardness	Hardness of watercourse (affects solubility of metals)	mg/l	*120*	*88*	*72*	*120*
C_b	Upstream dissolved copper data as mg/l (assume half of EQS - River Don SEPA data)	mg/l	0.014	0.005	0.005	0.014
Zn_b	Upstream total zinc as mg/l (assume half of EQS - River Don SEPA data)	mg/l	0.063	0.038	0.038	0.063
EQS Cu based on RQO	*Permitted Environmental Quality Standard for copper as mg/l (Annual Average)*	*mg/l*	*0.028*	*0.010*	*0.010*	*0.028*
EQS Zn based on RQO	*Permitted Environmental Quality Standard for zinc as mg/l (Annual Average)*	*mg/l*	*0.125*	*0.075*	*0.075*	*0.125*
Other data						
AADT	Annual average daily traffic		12796	12796	12796	12796
RL	Road length (m)	m	2507	994	3506	3064
RW	Road width (m)	m				
RC	Runoff coefficient		0.75	0.75	0.75	0.75
Rain	Rainfall depth (from Volume 11, page A3/6 Fig 3.2) (mm)	mm	2.7	2.7	2.7	2.7
PBUR (pollutant build up rate)	See page A3/2 Table 3.1 in Vol.11 - based on traffic flow Cu (dissolved)	kg/ha/annum	0.029	0.060	0.084	0.084
	Zn (total)	kg/ha/annum	0.031	0.023	0.088	0.088
Calculations						
1. Total impermeable area (TIA)	= RL x RW (m^2)	m^2	40678	18488	65211	56990
2. Runoff volume (V)	= TIA x RC x (rain / 1000)	m^3	82.37	37.44	132.05	115.40
3. Q50 in m^3/day	= Q_{50} flow x 3600 x 24	m^3/day	604.8	864	8899.2	1123.2
4. Cu build up rate	5 day build up (M_{cu}) = (PBURCu /365) x 5 x (TIA / 10000)	kg	0.0016	0.0015	0.0075	0.0066
5. Zn build up rate	5 day build up (M_{zn}) = (PBURZn /365) x 5 x (TIA / 10000)	kg	0.0017	0.0006	0.0078	0.0068
Resulting dissolved copper concentration in the water course downstream (C_r):						
Formula	$C_r = \{(C_b \times Q_{50}) + (1000 \times M_{cu})\} / (Q50 + V)$ mg/l (1000 x M_{cu})		1.64	1.52	7.50	6.56
	(Q50 + V)		687.17	901.44	9031.25	1238.60
Resulting dissolved copper concentration in the water course downstream (C_r)		**mg/l**	**0.015**	**0.006**	**0.006**	**0.018**
Resulting total zinc concentration in the watercourse (Zn_r):						
Formula	$Zn_r = \{Zn_b \times Q_{50}\} + \{(1000 \times M_{zn})\} / (Q50 + V)$ mg/l		1.71	0.57	7.82	6.83
	(Q50 + V)		687.17	901.44	9031.25	1238.60
Resulting total zinc concentration in the watercourse (Zn_r)		**mg/l**	**0.057**	**0.037**	**0.038**	**0.062**
Does predicted dissolved copper concentration comply with the EQS?			Y	Y	Y	Y
Does predicted total zinc concentration comply with the EQS?			Y	Y	Y	Y

Percentage over Base Line Value	**Copper**	**%**	5%	30%	15%	29%
	Zinc	**%**	-8%	-2%	1%	0%

Original PBUR (pollutant build up rate)

	Diss Cu	0.300	0.300	0.300	0.300
	Total Zinc	1.000	1.000	1.000	1.000
	With Filter Drain reduction				
20% reduction	Diss Cu	0.240	0.240	0.240	0.240
75% reduction	Total Zinc	0.250	0.250	0.250	0.250
	With Treatment Pond reduction				
65% reduction	Diss Cu	0.084		0.084	0.084
65% reduction	Total Zinc	0.088		0.088	0.088
	With Treatment Pond reduction				
65% reduction	Diss Cu	0.029			
65% reduction	Total Zinc	0.031			
	With 60m Swale reduction				
50% reduction	Diss Cu		0.120		
70% reduction	Total Zinc		0.075		
	With 60m Swale reduction				
50% reduction	Diss Cu		0.060		
70% reduction	Total Zinc		0.023		
		2 TP	2 x 60m Swale	1 TP	1 TP

Note: Spreadsheet incorporates Volume 11 of Design Manual for Roads and Bridges amendment dated November 2002
NOTES:
RW (road width) values were not required to calculate TIA (Total Impermeable Area) as these were provided by the engineers
A conservative value of 0.75 has been assumed for the run-off co-efficient

Note: Mitigation assumes the following:
Filter drains: 75% reduction total zinc and 20% reduction dissolved copper
Treatment Pond: 65% reduction total zinc and 65% reduction dissolved copper
Swale: 70% reduction total zinc and 50% reduction dissolved copper

Scheme: Aberdeen Western Peripheral Route Fastlink **Job No:** **10332**
Routine Runoff Pollution Risk Assessment (Freshwater Fisheries Directive)
With Mitigation
95-Percentile EQS

Item	Description	Units	Megray Burn	Green Burn	Burn of Muchalls	Burn of Elsick
			Run A	Run B	Run C	Run D
Water Quality Prediction						
Data from Regulatory Authority						
Q95 i.e. 95-percentile flow (flow exceeded 95% of the time)		m^3/sec	0.002	0.002	0.024	0.003
Existing Water Quality Class	River Quality Objective				A2	
Hardness	Hardness of watercourse (affects solubility of metals)	mg/l	*120*	*88*	*72*	*120*
C_b	Upstream dissolved copper data as mg/l (assume half of EQS - River Don SEPA data)	mg/l	0.056	0.020	0.020	0.056
Zn_b	Upstream total zinc as mg/l (assume half of EQS - River Don SEPA data)	mg/l	0.250	0.150	0.150	0.250
EQS Cu based on RQO	*Permitted Environmental Quality Standard for copper as mg/l (95 percentile)*	*mg/l*	*0.112*	*0.040*	*0.040*	*0.112*
EQS Zn based on RQO	*Permitted Environmental Quality Standard for zinc as mg/l (95 percentile)*	*mg/l*	*0.500*	*0.300*	*0.300*	*0.500*
Other data						
AADT	Annual average daily traffic		12796	12796	12796	12796
RL	Road length (m)	m	2507	994	3506	3064
RW	Road width (m)	m				
RC	Runoff coefficient		0.75	0.75	0.75	0.75
Rain	Rainfall depth (from Volume 11, page A3/5 Fig 3.1) (mm)	mm	13.5	13.5	13.5	13.5
PBUR (pollutant build up rate)	See page A3/2 Table 3.1 in Vol.11 - based on traffic flow Cu (dissolved)	kg/ha/annum	0.029	0.060	0.084	0.084
	Zn (total)	kg/ha/annum	0.031	0.023	0.088	0.088
Calculations						
1. Total impermeable area (TIA)	= RL x RW (m^2)	m^2	40678	18488	65211	56990
2. Runoff volume (V)	= TIA x RC x (rain / 1000)	m^3	411.86	187.19	660.26	577.02
3. Q95 in m^3/day	= Q_5 flow x 3600 x 24	m^3/day	172.8	172.8	2073.6	259.2
4. Cu build up rate	5 day build up (M_{cu}) = (PBURCu /365) x 5 x (TIA / 10000)	kg	0.0016	0.0015	0.0075	0.0066
5. Zn build up rate	5 day build up (M_{zn}) = (PBURZn /365) x 5 x (TIA / 10000)	kg	0.0017	0.0006	0.0078	0.0068
Resulting dissolved copper concentration in the water course downstream (C_r):						
Formula	$C_r = \{(C_b \times Q_{95}) + (1000 \times M_{cu})\} / (Q95 + V)$ mg/l (1000 x M_{cu})		1.64	1.52	7.50	6.56
	(Q95 + V)		584.66	359.99	2733.86	836.22
Resulting dissolved copper concentration in the water course downstream (C_r)		**mg/l**	**0.019**	**0.014**	**0.018**	**0.025**
Resulting total zinc concentration in the watercourse (Zn_r):						
Formula	$Zn_r = \{Zn_b \times Q_{95}\} + \{(1000 \times M_{zn})\} / (Q95 + V)$ mg/l		1.71	0.57	7.82	6.83
	(Q95 + V)		584.66	359.99	2733.86	836.22
Resulting total zinc concentration in the watercourse (Zn_r)		**mg/l**	**0.077**	**0.074**	**0.117**	**0.086**
Does predicted dissolved copper concentration comply with the EQS?			Y	Y	Y	Y
Does predicted total zinc concentration comply with the EQS?			Y	Y	Y	Y
Percentage over Base Line Value	**Copper**	**%**	-65%	-31%	-10%	-55%
	Zinc	**%**	-69%	-51%	-22%	-66%

Original PBUR (pollutant build up rate)

		Run A	Run B	Run C	Run D
	Diss Cu	0.3	0.3	0.3	0.3
	Total Zinc	1.0	1.0	1.0	1.0
	With Filter Drain reduction				
20% reduction	Diss Cu	0.240	0.240	0.240	0.240
75% reduction	Total Zinc	0.250	0.250	0.250	0.250
	With Treatment Pond reduction				
65% reduction	Diss Cu	0.084		0.084	0.084
65% reduction	Total Zinc	0.088		0.088	0.088
	With Treatment Pond reduction				
65% reduction	Diss Cu	0.029			
65% reduction	Total Zinc	0.031			
	With 60m Swale reduction				
50% reduction	Diss Cu		0.120		
70% reduction	Total Zinc		0.075		
	With 60m Swale reduction				
50% reduction	Diss Cu		0.060		
70% reduction	Total Zinc		0.023		
		2 TP	2 x 60m Swale	1 TP	1 TP

Note: Spreadsheet incorporates Volume 11 of Design Manual for Roads and Bridges amendment dated November 2002

NOTES:

RW (road width) values were not required to calculate TIA (Total Impermeable Area) as these were provided by the engineers

A conservative value of 0.75 has been assumed for the run-off co-efficient

Note: Mitigation assumes the following:

Filter drains: 75% reduction total zinc and 20% reduction dissolved copper
Treatment Pond: 65% reduction total zinc and 65% reduction dissolved copper
Swale: 70% reduction total zinc and 50% reduction dissolved copper