

Drainage Design Calculation Summary

Highway surface water drainage – catchments, modified rational method, pipe sizing, attenuation and SuDS

Project	A999 Example Junction Improvement, Fictional Town	Document no.	RRD-SMP-XX-XX-CA-C-0001
Client	None – illustrative capability sample	Revision / status	P02 / S3
Originator	RoadRail Design (NRDMG Yapı Sistemleri A.Ş.)	Date	09/10/2026
Discipline	Highway drainage	Security	Public – sample
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Approved by	Associate Director – Highways	Classification	Calculation (CA)

Rev	Date	Status	Description	Prepared	Checked	Approved
P01	14/09/2026	S3	First issue for review and comment	Snr Drain. Eng	Prin. Drain. Eng	Assoc. Dir.
P02	09/10/2026	S3	Bus stop drainage revised (RSA 2.8); storage updated to +40% climate change	Snr Drain. Eng	Prin. Drain. Eng	Assoc. Dir.

Illustrative sample. This document describes a fictional scheme prepared solely to demonstrate RoadRail Design's report structure, technical approach and standards knowledge. Locations, data, chainages, survey information, traffic figures and collision records are invented. It is not a client project and must not be relied upon for design. References are to the Design Manual for Roads and Bridges (DMRB) documents current at the date of issue; the applicable version of each standard would be confirmed with the Overseeing Organisation on a live project.

1. Scope

This summary records the surface water drainage design for the fictional A999 Example Junction Improvement (Ch 0+000–1+350 and the B9999 junction). The network collects carriageway, hard strip and footway runoff via gullies and combined kerb drainage units into a carrier pipe system, which discharges through a vortex flow control and an attenuation basin to a vegetated swale and then to the Fictional Brook (ordinary watercourse). Detailed network simulation will verify these hand calculations at the next stage. See drawing RRD-SMP-XX-XX-DR-C-0501.

2. Design criteria

Criterion	Value adopted	Reference
Carrier pipes – no surcharge	1 in 1 year storm	CG 501
Network – no flooding of carriageway	1 in 5 year storm (checked by simulation at next stage)	CG 501
Attenuation / exceedance	1 in 100 year + 40% climate change, no flooding beyond highway boundary	CG 501; LLFA requirement (assumed)
Gully spacing design storm / flow width	1 in 1 year; flow width ≤ 1.0 m (within hard strip)	CD 526
Runoff method	Modified rational: $Q = 2.78 C_v C_r i A$ (l/s; i mm/h; A ha)	Wallingford procedure
Volumetric runoff coefficient C_v / routing coefficient C_r	0.90 (paved) / 1.30	–
Time of entry	4 min	–
Pipe roughness (Colebrook-White) k_s	0.6 mm (concrete / plastic, surface water)	–
Minimum full-bore velocity / min. diameter	1.0 m/s / 225 mm (project requirement)	–
Permitted discharge	Greenfield mean annual flood Q_{BAR} (IH124) for contributing area	LLFA (assumed)
Water quality	HEWRAT assessment; vegetated treatment before outfall	LA 113; CD 532

3. Catchments

Catchment	Description	Chainage	Impermeable area (ha)	Outlet
C1.1	A999 mainline, both carriageways	0+000-0+130	0.18	S1.1
C1.2	A999 mainline, HC1 superelevated	0+130-0+290	0.21	S1.2
C1.3	A999 mainline incl. ghost island	0+290-0+560	0.24	S1.3
C2.1	B9999 minor arm and shared-use path	B 0+000-0+220	0.16	S2.1
C1.4	A999 mainline east of junction incl. bus stop	0+560-0+820	0.22	S1.4
C1.5	A999 mainline, HC2 to sag VC2	0+820-0+980	0.19	S1.5
C1.6	Lay-by / maintenance access to basin	0+980	0.05	S1.6
Total			1.25	Basin B1

Mainline east of VC3 (Ch 1+180-1+350) drains to the existing system at the tie-in and is excluded. Rainfall intensities are illustrative values representative of FEH depth-duration-frequency data for a lowland UK site (SAAR 650 mm).

4. Pipe sizing - modified rational method (1 in 1 year)

Pipe	Length (m)	Gradient (1:x)	Area (ha)	Cum. area (ha)	T _c (min)	i _{1yr} (mm/h)	Q (l/s)	Dia. (mm)	V _{full} (m/s)	Q _{cap} (l/s)	Q/Q _{cap}
S1.1	65	150	0.18	0.18	5.0	53.9	31.6	225	1.06	42.3	0.75
S1.2	72	180	0.21	0.39	6.0	49.7	63.1	300	1.17	82.5	0.76
S1.3	80	200	0.24	0.63	7.1	46.4	95.1	375	1.28	140.9	0.68
S2.1	60	120	0.16	0.16	4.8	54.0	28.1	225	1.19	47.3	0.59
S1.4	75	220	0.22	1.01	8.0	44.0	144.7	450	1.36	217.1	0.67
S1.5	68	250	0.19	1.20	8.9	42.1	164.3	450	1.28	203.5	0.81
S1.6	40	300	0.05	1.25	9.5	41.0	166.5	450	1.17	185.6	0.90

T_c = time of entry + time of flow (L/V_{full}); intensity interpolated log-log at T_c. Full-bore velocity from Colebrook-White. All pipes run below full-bore capacity in the 1 in 1 year storm and exceed the 1.0 m/s self-cleansing velocity. Minimum cover 1.2 m under carriageway.

5. Gully spacing (CD 526)

Channel flow capacity at the design flow width is calculated for a triangular kerb/edge channel (Manning, n = 0.017, crossfall 2.5%), multiplied by the grating efficiency and divided by the runoff per metre of channel from a 5.15 m drained width at 50 mm/h. Adopted spacings are rounded down and capped at 40 m; spacing at sag VC2 and at the junction is reduced with double gullies at the low point.

Long. gradient	Flow width (m)	Channel capacity (l/s)	Grating efficiency	Runoff (l/s per m)	Calc. spacing (m)	Adopted spacing (m)
0.5%	1.0	3.3	0.80	0.0715	37	35
1.0%	1.0	4.7	0.80	0.0715	53	40
1.5%	1.0	5.8	0.80	0.0715	65	40
2.0%	1.0	6.7	0.80	0.0715	75	40
3.2%	1.0	8.4	0.80	0.0715	94	40

6. Greenfield runoff and attenuation

Parameter	Value
Method	IH124: $Q_{BAR} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$ (50 ha, pro-rata)
SAAR / SOIL (soil type 4)	650 mm / 0.45
Q _{BAR} for 50 ha / per hectare	201.4 l/s / 4.03 l/s/ha
Contributing impermeable area	1.25 ha
Greenfield Q ₁ / Q _{BAR} / Q ₃₀ / Q ₁₀₀ (growth factors 0.85 / 1.00 / 2.13 / 2.61)	4.3 / 5.0 / 10.7 / 13.1 l/s
Limiting discharge adopted	5.0 l/s (Q _{BAR} for all events up to 1 in 100 year + 40%)

Duration (min)	i ₁₀₀ (mm/h)	i _{100+40%} (mm/h)	Inflow vol. (m³)	Outflow vol. (m³)	Storage (m³)
15	102.0	142.8	402	5	397
30	68.0	95.2	536	9	526
60	42.0	58.8	662	18	643

Duration (min)	i_{100} (mm/h)	$i_{100+40\%}$ (mm/h)	Inflow vol. (m ³)	Outflow vol. (m ³)	Storage (m ³)
120	26.0	36.4	819	36	783
240	15.5	21.7	976	73	904
360	11.5	16.1	1087	109	978
720	6.9	9.7	1304	218	1087
1440	4.0	5.7	1531	435	1096
2880	2.3	3.2	1739	870	869

Simplified mass balance assuming constant outflow at the limiting rate; network simulation using the flow control head-discharge curve will refine the volume at the next stage. Critical duration 1440 min.

Attenuation summary	
Required storage (1 in 100 yr + 40% CC)	1096 m³ at critical duration 1440 min
Storage provided	Basin B1: base 18 m × 59 m, side slopes 1:4, max. water depth 0.9 m + 0.3 m freeboard; 1221 m ³ below top water level (111% of required)
Flow control	Vortex flow control, design head 0.9 m, Q = 5.0 l/s; orifice not less than 75 mm equivalent to limit blockage risk
Exceedance	Overland flow route along northern verge to basin; no property flooding

7. SuDS and water quality (CD 532, LA 113)

- Treatment train: gully pots (sediment), attenuation basin with permanent micro-pool, then a 120 m vegetated swale (CD 532) before outfall. Swale base 1.0 m, side slopes 1:4, longitudinal gradient 0.8%, check dams at 30 m centres.
- Swale velocity under the 1 in 1 year flow is below 0.3 m/s and residence time exceeds 9 minutes, supporting filtration and settlement of suspended solids.
- HEWRAT (LA 113) step 1 and 2 assessment for routine runoff (AADT 13,600) shows pass for soluble pollutants and sediment with the vegetated treatment in place (illustrative result). A spillage risk assessment gives an annual probability of a serious pollution incident well below the 1% threshold.
- Outfall headwall with flap valve to Fictional Brook; consent for works to an ordinary watercourse required from the LLFA.

8. Assumptions and limitations

- Rainfall, soil and growth-factor data are illustrative; on a live scheme FEH22 point data and the latest climate change allowances for the relevant management catchment would be used.
- Infiltration not relied upon (assumed clay, soil type 4); to be confirmed by BRE 365-type testing.
- Hand calculations to be verified by network simulation (1, 5, 30 and 100 + CC year storms) at the next design stage.
- Existing drainage at the eastern tie-in is assumed to have adequate capacity (survey to confirm).