PROPER PROJECT
WP1 - PREDICTION OF POLLUTANT LOADS AND CONCENTRATIONS IN ROAD RUNOFF
Task 1.3. Road runoff monitoring data and representative sites

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DELIVERABLE 1.3

Title

PROPER PROJECT - WP1.PREDICTION OF POLLUTANT LOADS AND CONCENTRATIONS IN ROAD RUNOFF
Task 1.3. Road runoff monitoring data and representative sites

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PROPER PROJECT - WP1.PREDICTION OF POLLUTANT LOADS AND CONCENTRATIONS IN ROAD RUNOFF

T1.3. Road runoff monitoring data and representative sites

Abstract

This report stands for the PROPER project deliverable 1.3 and concerns the results from task 1.3: *Road runoff monitoring data and representative sites*.

Following the literature review and the evaluation of the models conducted in previous tasks from WP1, the aim of the present task is to gather road runoff monitoring data from representative sites across Europe. The data will be used in task 1.4 of the project to assess the consistency and suitability of selected tools to predict road runoff characteristics.

In order to accomplish the task objectives, the data should comprise the requirement inputs that are needed to implement the tools such as the characteristics of the road and of the traffic, climate features and monitoring data from precipitation and runoff events.

A total of 22 case studies were gathered from 7 different countries, namely Norway, England, Switzerland, France, the Netherlands and Portugal. The roads and the monitored pollutants are characterized in the present report.

For the purpose of this project and the planned following activities, the objectives were achieved, and a set of roads with wide range and diverse characteristics was gathered.

Keywords: Road runoff, pollution, predicting models

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1 | Introduction

The project PROPER is funded by the Conference of European Directors of Roads (CEDR) and it comprises the characterisation and prediction of road runoff pollution, the evaluation of its potential impacts on receiving water bodies and related ecosystems and the evaluation of treatment systems for impact mitigation during operation and construction of roads. The project has a total duration of 24 months and it has started in September 2017.

The work programme is organised into 6 Work Packages (WPs) where WPs 1 to 4 correspond closely to the scientific objectives of the project, namely:

- **WP1:** Prediction of pollutant loads and concentrations in road runoff;
- **WP2:** Assessing the vulnerability of European surface and ground water bodies to road runoff during the building and operating of roads;
- **WP3:** Sustainable assessment of measures and treatment systems for road runoffs;
- **WP4:** Sustainable assessment of measures and treatment systems for road runoffs during construction work.

WP5 focuses on ensuring maximum impact is achieved through the implementation of a robust dissemination strategy with **WP6** outlining the project management activities which underpin successful project completion.

This report concerns Work package 1. The previous steps of the work have been:

- Preselection of predicting models made in task 1.1, based on literature review and inputs from the consortium partners and the project International Advisory Board (IAB) members;
- Task 1.2 provided an assessment of these preselected models taking into account their requirements, the easiness of applicability and the consistency of the output results. The assessment was mainly performed by analysing the manuals, papers and reports that were produced to help the implementation of each model (at this stage the models have not been implemented). The selected tools were: PREQUALE; HAWRAT; Kayhanian et al. (2007) and SELDM.

The present document stands for the project deliverable 1.3, within WP1, reporting the results from task 1.3 that gathered data from selected representative sites, within Europe, for the assessment of the 4 prediction tools mentioned above. The aim of this task was to gather consistent monitoring data from several case studies at different locations in Europe. The data will be used in a following task to assess the consistency and suitability of selected tools to predict road runoff characteristics.

The project consortium has seven participating partners, representing different countries: Denmark, France, Czech Republic, Slovenia, The Netherlands and Portugal. Since the selection of representative sites from all over Europe is crucial for a robust assessment of the selected tools this task aims at identifying and fully characterizing a set of test roads. Each partner has committed, from the proposal preparation stage, to contribute with data for 3 to 6 roads, representing a range of conditions (climate/road design/ traffic volume and type) of their countries and/or neighbouring countries.

The data should comprise the requirement inputs that are needed to implement the 4 preselected tools. Therefore, data include the characteristics of the road and of the traffic, climate features and monitoring data from precipitation and runoff events.

The characterization of these relevant variables for each site was structured in a database where all relevant characteristics of roads and traffic are easily displayed. This report (D1.3) presents the data and comments on the characteristics and representativeness of the sites.

2 | Methodology

Since the objective of gathering and organising the monitoring data is to provide information for the assessment of the 4 selected models, the monitored data characteristics must comply with the input data requirements of these models. Such variables, as may be expected, are related to the main drivers that influence road runoff quality.

Therefore, the first step of the process was the identification of the required input data of each model. A summary of these variables is shown in Table 2.1 (adapted from the report D1.1 of Proper Project, Fernandes and Barbosa 2018).

Table 2.1 – Required input data (adapted from Fernandes and Barbosa 2018)

Inputs		**SMCs**	**EMCs**		
		PREQUALE	HAWRAT	Kayhanian et al. (2007)	SELDM
Site and climate characteristics	Climate region		X		
	Drainage area	X		X	X
	Impervious fraction	X			X
	Annual average daily traffic		X	X	X
	Average rainfall event	X			
	Annual average rainfall	X			X
	Other				Drainage Length; Basin Slope; Basin Develop. factor
Event Characteristics	Month		X		
	Total event rainfall			X	X
	Rainfall intensity		X		
	Antecedent dry period		X	X	X
	Cumulative seasonal rainfall			X	
	Other				Average storm duration; Number of storms per year

It should be pointed out that there is a fundamental difference between the results provided by PREQUALE and the other models. The first gives the Site Mean Concentration (SMC) whereas the other provide results in a time series of event mean concentrations (EMCs). This characteristic explains the distinct input data requirements.

The type and amount of suitable monitoring data is crucial for the present analysis and, at the proposal stage, the consortium was aware of the risks that could derive from the inexistence of the required data (variables). The objective was to gather a set of representative road sites all over Europe, with relevant and established data sets.

Taking into consideration the information from Table 2.1, an excel sheet was prepared and sent to the all the Project partners and IAB. All members were asked to provide monitoring data by filling in the excel sheet.

As expected, there are publications of road runoff monitoring results that do not provided all the needed information to test simultaneously the 4 tools. At the end, a set of 22 roads from different European countries could be gathered among all contributors.

The received data were in a standard form. Regarding the event characteristics, different information was received, from a time series to just some statistics. Whenever needed, the authors reached each partner to clarify issues and collect missing information. Road project drawings and confirmations in google earth were also approaches used to get specific information on design features, such as drainage area or length.

Taking into account the output of the predicting tools and the key pollutants of road runoff, the road runoff monitoring variables collected included the TSS and the heavy metals, namely Copper, Zinc, Lead, Cadmium, Iron and Chromium.

3 | Monitoring data

3.1 Location and overview of the 22 road sites

A total of 22 case studies were gathered from 7 different countries. The location of these roads is presented in Figure 3.1, where the dots representing the road sites are depicted in a map of Europe with the annual average precipitation ranges. It can be observed that there is not data from roads in Central and Eastern Europe. It is also seen that the 22 roads are located in regions with annual precipitation values ranging from 500 to 2000 mm, which represent most of the European territory, in area. Note that it was considered, for the purpose of their study, as two different roads the data from France regarding the same road with two different pavements (porous and conventional asphalt).

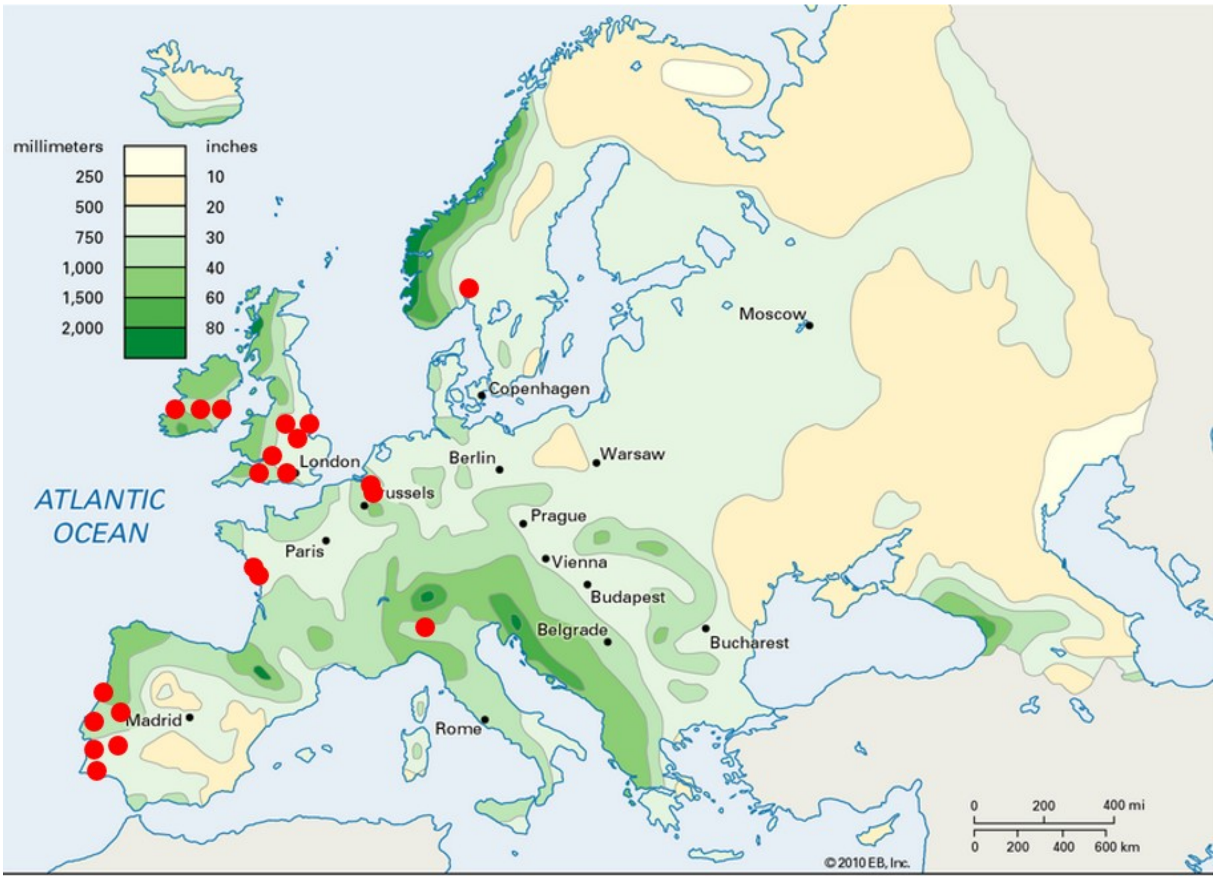

Figure 3.1 – Europe precipitation map with the roads under study[1]. Each dot corresponds to one road

These 22 road sites cover a wide range of conditions; its main characteristics are presented in Table 3.1. The drainage areas (DA) range from 28 m^2 to 58680 m^2; the annual precipitation (P_{annual}) from 510

[1] https://eldoradoweather.com/forecast/climate/climate-maps/europe-annual-precip-map.html

mm to 843 mm and the Annual Average Daily Traffic (AADT) from 2918 up to 70000. For these 3 variables, the lowest value concern to Portuguese roads and the highest to English roads. The lowest impervious fraction of a monitored road catchment also regards a Portuguese road (A1), with around 41% of impervious area. The two countries providing more road sites were Portugal and England. In this sample, Portugal sites overall include the widest variety of DA, IF, P_{annual} and AADT.

Table 3.1 – Characterization of the road sites.

Code	**Country**	**Road/Highway designation**	**Drainage Area (DA)** (m^2)	**Impervious fraction (IF)** (0-1)	**Annual precipitation (P_{annual})*** (mm)	**Annual average daily traffic (AADT)** (no. vehicles)
P1	Portugal	A 1	22800	0,41	646	27746
P2		A 2	1287	1	528	16344
P3		A 6	5580	1	744	2918
P4		A 22	15422	0,85	518	24000
P5		A 25	287,5	1	1014	15673
P6		IP 6	7280	1	709	6539
N1	Netherlands	A 27 - pervious	48590	0,5	776	63000
N2		A 27 - impervious	30510	1	776	63000
N3	Norway	E 6	22000	1	834	42000
F1	France	A 11 - pervious	3200	1	786	24103
F2		A 11 - impervious	3200	0,5	786	24103
I1	Ireland	M 7 - Kildare	14184	1	731	27500
I2		M 7 - Monasterevin	11368	1	731	27500
I3		M 7 - Portlaoise	9600	1	731	27500
E1	England	M 4 - Brinkworth	8755	1	745	70000
E2		M 4 - River Ray	4348	1	745	35000
E3		M 40	58680	1	615	78000
E4		A 417	20232	1	843	24000
E5		A 34 - Gallos Brook	2760	1	660	64000
E6		A 34 - River Enborne	19425	0,5	635	36000
S1	Switzeralnd	A12 Bümplizstrasse	42084	1	986	38985
S2		A1 Gabelbach	12200	1	986	39500

*P_{annual} information was collected from national databases: snirh.apambiente.pt/; www.climatedata.eu; fr.climate-data.org; weather-and-climate.com; www.metoffice.gov.uk; www.meteosuisse.admin.ch

3.2 Characterization of the data

3.2.1 Monitoring data from Portugal (6 roads)

The monitoring data from Portugal were provided by the Project partner **LNEC** and comprise 6 major roads. They were monitored in the scope of national research projects. A summary of the data was published in the final report of G-Terra project (Barbosa et al. 2008).

The roads are identified by its national id. Monitoring data were obtained from the following references:

- A1 and A22 (Barbosa et al. 2011)
- A2 and A6 (Leitão et al. 2005)
- A25 (Antunes 2014)
- IP6 (Barbosa et al. 2006)

The monitoring campaigns for these roads were conducted with automatic sampling of several samples per event and simultaneous measurement of discharge flow and precipitation. First flush effect was identified in some events. The event mean concentration was evaluated by averaging 8 to 10 samples taken per event. On site measurements of rainfall by a rain gauge was part of the procedure.

The main characteristics of the selected road sites in Portugal are presented in Table 3.2.

Table 3.2 – Characteristics of the road sites from Portugal.

Code	P1	P2	P3	P4	P5	P6
National id	**A1**	**A2**	**A6**	**A22**	**A25**	**IP6**
Monitoring period (yr.)	2009	2002-2003	2004	2008-2009	2008-2010	2005-2006
Drainage Area (m^2)	22800	1287	5580	15422	287	7280
Drainage Length (m)	814	117	465	612	25	520
Mean Basin Slope (%)	2.95	7.7	3	3.4	2.5	3.3
Impervious fraction (0-1)	0.412	1	1	0.85	1	1
Number of lanes	4	4	4	4	4	2
Lane Width (m)	4	4	4	3,75	2,875	4
Total Width of the road (m)	-	-	-	22,8	11,5	-
Average daily traffic (veh/d)	27746	16344	2918	24000	15673	6539
Pavement material	Porous asphalt	-	Asphalt	Flexible	Asphalt	Asphalt

Table 3.3 presents the range of the concentrations of key pollutants for all road sites.

Table 3.3 – Summary of monitoring data for road sites in Portugal.

Code	P1	P2	P3	P4	P5	P6
National id	**A1**	**A2**	**A6**	**A22**	**A25**	**IP 6**
TSS (mg/L)	1,2 - 100,8	0,1 - 5	1,6 - 60,3	25,7 - 88,0	2,2 - 207,3	23,8 - 510,0
Cu (µg/L)	7,5 - 32,9	5,4 - 14,0	2,4 - 14,0	20,0 - 30,0	5,5 - 655,8	3,0 - 69,8
Zn (µg/L)	21,1 - 277,0	40 - 97	46,0 – 1443,0	-	30,2 - 406,9	17,5 - 147,1
Pb (µg/L)	0,9 - 9,0	0,1 - 4,1	1 - 4,7	10 - 30	6,5 - 69,7	1 - 23,41
Cd (µg/L)	0,048 - 0,154	-	-	-	-	1 - 1,4286
Fe (µg/L)	0,01 - 1,90	0,1 - 0,12	0,08 - 0,77	0,7 - 3,3	0,04 - 7,35	-
Cr (µg/L)	0,31 - 15,28	-	-	-	-	3 - 16,97

3.2.2 Monitoring data from the Netherlands (2 roads)

The monitoring data from the road sites in the Netherlands were provided by the project partner **TNO** and are available in Brongers (2010) and Brongers (2011). The data comprise a case study in two sections of the highway with national id A27. The characteristics of these road sites are presented in Table 3.4.

Table 3.4 – Characteristics of the road sites from the Netherlands.

Code	N1	N2
National id	**A27 (km108.1-109.7)**	**A27 (km110.3-113.0)**
Monitoring period (yr.)	2009-2010	2009-2010
Type of monitoring performed	Three-monthly average concentration in runoff	Three-monthly average concentration in runoff
Drainage Area (m^2)	48590	30510
Drainage Length (m)	1600	2700
Mean Basin Slope (%)	0,2	0,2
Impervious fraction (0-1)	0,5	1
Number of lanes	4	4
Lane Width (m)	3,5	3,5
Total Width of the road (m)	22,6	22,6
Average daily traffic (veh/d)	63000	63000
Pavement material	Porous asphalt	Normal asphalt

Monitoring campaign included the automatic collection of water samples and measurement of flow discharge. Daily time series of precipitation were available from the Royal Netherlands Meteorological Institute.

Table 3.5 presents the range of the concentrations of key pollutants for the two road sites in the Netherlands.

Table 3.5 – Summary of monitoring data for road sites in the Netherlands.

Code	N1	N2
National id	A27 (km108.1-109.7)	A27 (km110.3-113.0)
TSS (mg/L)	-	-
Cu (µg/L)	11 - 420	11 - 77
Zn (µg/L)	17 - 1900	54 - 270
Pb (µg/L)	5 - 130	9 - 27
Cd (µg/L)	1 - 2	1 - 1
Fe (µg/L)	-	-
Cr (µg/L)	10 - 52	10 - 29

3.2.3 Monitoring data from Norway (1 road)

The monitoring data from Norway were collected by the research project **Aalborg University**. The monitoring campaign took place in the national road E6, near the region of Skulerud, between January 2003 and May 2004. Data were published in the following report:

- Åstebøl, S.O. and Coward, J.E. (2004) Monitoring of runoff from Highway E6, Skullerudkrysset, Oslo, 2003-2004. Report from Statens Vegvesen 29 pp. (in Norwegian)

The monitoring campaign had as primary objective the evaluation of the performance of a treatment pond. The monitoring comprised among others, the measurement of discharge flow, precipitation and temperature. An automatic sampler was used to collect water samples upstream and downstream the treatment pond.

Table 3.6 presents the main characteristics of the road.

Table 3.6 – Summary of monitoring data for road in Norway.

Code	N3
National id	E6
Monitoring period (yr.)	2003-2004
Drainage Area (m^2)	22000
Drainage Length (m)	1630
Mean Basin Slope (%)	3.4
Impervious fraction (0-1)	1
Number of lanes	4
Lane Width (m)	-
Total Width of the road (m)	-
Average daily traffic (veh/d)	42000
Pavement material	Asphalt

Table 3.7 presents the range of the concentrations of key pollutants for this road site in Norway.

Table 3.7 – Summary of monitoring data for road sites in Norway.

Code	N3
National id	**E6**
TSS (mg/L)	39 - 606
Cu (µg/L)	25.4 - 133
Zn (µg/L)	63.3 - 544
Pb (µg/L)	1.5 - 33
Cd (µg/L)	0.06 - 1
Fe (µg/L)	-
Cr (µg/L)	-

3.2.4 Monitoring data from France (1 road/2 different pavements)

The monitoring data from France were provided by the project partner **IFSTTAR** and are related to a national highway (French id – A11), located near Nantes in western part of the country. There were two campaigns performed in this site. The first one took place between March 1995 and February 1996 and the second one between June 1997 and May 1998. An important change between the two campaigns was the renewal of the pavement. It was impervious in the first campaign and porous in the second and for this reason data are considered to belong to 2 different road sites.

The main parameters are provided in the Table 3.8.

Table 3.8 – Summary of monitoring data for the French road.

Code	F1	F2
National id	A11 pervious	A11 impervius
Monitoring period	06/1997-05/1998	03/1995- 02/1996
Drainage Area (m^2)	3200	3200
Drainage Length (m)	275	275
Mean Basin Slope (%)	2.5	2.5
Impervious fraction (0-1)	1	0.5
Number of lanes	4	4
Lane Width (m)	3.5	3.5
Total Width of the road (m)	23.3	23.3
Average daily traffic (veh/d)	24103	24103
Pavement material	Porous Asphalt	Conventional Asphalt

For each monitoring campaign A11 (pervious or impervious), more than 50 events were monitored using automatic sampling. Hourly time series of precipitation were available from *Météo France* at the Nantes airport, located 15 km from the monitoring site.

A summary of the monitoring data is presented in Table 3.9. The range of values refer to event mean concentrations.

Table 3.9 – Summary of monitoring data for French road.

Code	F1	F2
National id	**A11**	**A11**
TSS (mg/L)	16.3 - 267	2 - 63.1
Cu (µg/L)	11.2 - 146	4.9 - 150.1
Zn (µg/L)	104 - 1544	42 - 1096
Pb (µg/L)	13.7 – 188.0	2 - 60.8
Cd (µg/L)	0.21 - 4.16	0.04 - 2.40
Fe (µg/L)	-	-
Cr (µg/L)	-	-

3.2.5 Monitoring data from Ireland (3 roads)

The monitoring data from Ireland and England were provided by the project partner **Middlesex University.**

Data from Ireland are available in the following references:

- Higgins N. (2007) Analysis of Highway Runoff in Ireland, Trinity College. Department of Civil, Structural and Environmental Engineering, 2007, 443 pp.
- Bruen, M.; Johnston, P.; Quinn, M.; Desta, M.; Higgins, N.; Bradley, C. and Burns, S. (2006) Impact Assessment of Highway Drainage on Surface Water Quality, Report 2000-MS-13-M2, Environment Protection Agency (EPA), Dublin, Ireland

The monitoring campaigns include the measurement of precipitation, flow discharge in the drainage system and the automatic collection of road runoff samples.

The dataset relates to the quality of runoff of major highway surfaces in Ireland. It has two levels of detail. The first level, corresponding to a scoping study, measured water quality (Cu, Pb, Zn, Cd, Nitrates, Phosphates) at 14 sites. The second level acquired all of the data at three sites that were selected for detailed analysis. These are the roads which data are used here.

The main parameters characterizing these 3 sites are provided in the Table 3.10.

Table 3.10 – Summary of monitoring data for the Irish roads.

Code	I1	I2	I3
National id	**M7 Kildare side**	**M7 Monasterevin section**	**M7 Portlaoise section**
Monitoring period (month/yr.)	05/2004-07/2005	08/2005-10/2005	03/2005-09/2005
Drainage Area (m^2)	14184	11368	9600
Drainage Length (m)	1200	480	800
Mean Basin Slope (%)	0.94	0.5	0.5
Impervious fraction (0-1)	1	1	1
Number of lanes	2	2	2
Lane Width (m)	5.91	5.6	5.8
Total Width of the road (m)	11.82	11.2	11.6
Average daily traffic (veh/d)	27500	27500	27500
Pavement material	Rolled asphalt	Rolled asphalt	Rolled asphalt

A summary of the monitoring data is presented in Table 3.9.

Table 3.11 – Summary of monitoring data for Irish roads.

Code	I1	I2	I3
National id	**M7 Kildare, Ireland**	**M7 Monasterevin, Ireland**	**M7Portlaoise, Ireland**
TSS (mg/L)	125 - 2340	60.9 - 258	14.5 - 116
Cu (µg/L)	39.7 - 293	40.9 - 69.1	6 - 43
Zn (µg/L)	109 - 1750	138 - 318	18 - 154
Pb (µg/L)	14.8 - 373	50.5 - 86.9	52 - 95
Cd (µg/L)	0.66 - 18.9	2.66 - 7.07	2 - 24
Fe (µg/L)	-	-	-
Cr (µg/L)	-	-	-

3.2.6 Monitoring data from England (6 roads)

The monitoring data from England were also provided by the Project partner **Middlesex University** and comprise 6 roads.

Data from each site were collected from reports produced by the Highway Agency. The characteristics of the roads are presented in Table 3.12.

Table 3.12 – Summary of monitoring data for the English roads.

Code	E1	E2	E3	E4	E5	E6
National id	M4 Brinkworth	M4 River Ray	M40 Souldern Brook	A417 River Frome	A 34 Gallos Brook	A 34 River Enborne
Monitoring period (month/yr.)	12/1997-12/1998	01/1999-03/2000	08/1999-11/2000	06/1998-07/1999	09/2000-03/2002	05/2001-06/2002
Drainage Area (m^2)	8755	4348	58680	20232	2760	19425
Drainage Length (m)	724	303	1800	735	250	25
Mean Basin Slope (%)	1.1	0.66	2.4	3.1	0.8	0.19
Impervious fraction (0-1)	1	1	1	1	1	1
Number of lanes	6	3	3	4	4	4
Lane Width (m)	3.6	3.6	3.6	3.9	3	3.4
Total Width of the road (m)	32.7	14.35	18.3	18.6	14.8	16.6
Average daily traffic (veh/d)	70000	35000	78000	24000	64000	36000
Pavement material	Hot rolled asphalt	Hot rolled asphalt	Hot rolled asphalt	Hot rolled asphalt	Concrete	Porous asphalt

The monitoring campaigns were conducted in a similar way. Their objective was not only characterizing the road runoff pollution but also evaluate the impacts on the receiving water bodies. Therefore, four programmes of data collection were conducted during the monitoring period:

- continuous data collection throughout the monitoring period of rainfall and river flows;
- monthly river water sampling and in-situ water quality readings upstream and downstream of the highway runoff discharge point, where possible during periods of established dry weather;
- sampling of the highway runoff and in-situ water quality monitoring of the watercourse during storm events;
- sediment sampling at the commencement and conclusion of the monitoring period from the upstream and downstream watercourse and highway runoff monitoring locations.

The range of concentrations for each site and pollutant are presented in Table 3.11.

Table 3.13 – Summary of monitoring data for English roads.

Code	E1	E2	E3	E4	E5	E6
National id	M4 Brinkworth	M4 River Ray	M40 Souldern Brook	A417 River Frome	A 34 Gallos Brook	A 34 River Enborne
TSS (mg/L)	15.15 - 246.5	62 - 1350	29.27 - 87.41	16.3 - 184.8	18.42 - 231	38.5 - 136.6
Cu (µg/L)	13 - 67	13 - 242	20.9 - 93.8	10.2 - 49.7	20.2 - 108	11 - 75.9
Zn (µg/L)	32 - 246	51 - 688	21.1 - 379	20.5 - 72.2	41 - 397	8.5 - 60
Pb (µg/L)	-	23.4 - 178	4.83 - 36	0.2 - 7.44	3.5 - 99	2 - 48.4
Cd (µg/L)	-	0.4 - 5.4	0.14 - 0.79	0.1 - 0.4	0.16 - 1.11	0.09 - 0.64
Fe (µg/L)	-	-	-	-	-	-
Cr (µg/L)	-	3.3 - 49.9	1.9 - 9.5	0.9 - 4.3	4.64 - 15.8	1.5 - 30

3.2.7 Monitoring data from Switzerland (2 roads)

The monitoring data from Switzerland were provided by the project IAB member ***Bundesamt für Strassen*** (ASTRA). The information was condensed in two reports which investigated the performance of treatment systems installed in two roads (with national ids A12 and A1):

- Scheiwiller, E. (2016) SABA Gäbelbach Leistungsprüfung der SABA mit technischem Filter im Jahr 2014/15. Report TBA des Kantons Bern (in German)
- Scheiwiller, E. (2014) SABA Pfaffensteig (Bümpliz) Probebetrieb und Leistungsprüfung der SABA mit technischem Filter im Jahr 2012/13. Report TBA des Kantons Bern (in German)

The monitoring campaigns were conducted between 2012 and 2015 and comprised the collection of road runoff upstream and downstream the treatment systems, and several additional measurements (precipitation, turbidity, water depths, etc.).

The characteristics of the roads are presented in Table 3.14.

Table 3.14 – Summary of monitoring data for the Swiss roads.

Code	S1	S2
National id	A12 Bümplizstrasse	A1 Gabelbach
Monitoring period (yr.)	2012-13	2014-15
Drainage Area (m^2)	42084	12200
Drainage Length (m)	1625	5000
Mean Basin Slope (%)	-	-
Impervious fraction (0-1)	1	1
Number of lanes	4	5
Lane Width (m)	-	-
Total Width of the road (m)	20	25
Average daily traffic (veh/d)	38985	39500
Pavement material	-	-

Site mean concentrations for 3 of the 7 key pollutants focused in this study are presented in Table 3.15.

Table 3.15 – Summary of monitoring data for Swiss roads.

Code	S1	S2
National id	A12 Bümplizstrasse	A1 Gabelbach
TSS (mg/L)	87,8	40,9
Cu (µg/L)	66,9	29,4
Zn (µg/L)	349,4	130,4
Pb (µg/L)	-	-
Cd (µg/L)	-	-
Fe (µg/L)	-	-
Cr (µg/L)	-	-

4 | Final remarks

The work of collecting specific data representing monitoring studies of highway/road runoff in Europe showed that it is not easy to find these data. A total of 22 case studies were gathered from 7 different countries. The features of the roads and the pollutant concentrations are presented in this report.

The results from the monitoring studies are from 1995 up to 2015. The French roads represent the oldest data sets (from 1995 to 1998) and the Swiss roads the most recent, from 2012 to 2015.

For all the 22 cases there is data on concentrations of TSS, Zn and Cu, except for the 2 Dutch roads that miss TSS data.

TSS are a good indicator not just of the presence of particles but also on the particulate pollutants. They are a result of the land use surrounding the road site.

For the purpose of this project and the planned following activities, the objectives were achieved, and a set of roads with wide range and diverse characteristics was gathered.

The models to predict the concentration of the most relevant pollutants in road runoff were identified in task 1.2 of the Project Proper. The assessment of these models will be conducted by comparing their predictions with monitoring data. In this report the representative sites to be implemented where presented. It is expected to conclude on the suitability of each to reproduce the real data obtained from the 22 roads monitoring.

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